INTERNATIONAL GAMMA RAY ASTROPHYSICS LABORATORY

SPECTROMETER USER MANUAL

INSTRUMENT DEFINITION

VOLUME 1

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Management configuration	OUI	X
	NON	

Applicable document	OUI	
	NON	

Models	**SSTM**	**STM**	**SEM**	**EM**	**FM**	**ALL**	**OTHERS**
						X	

FOREWORD

The Spectrometer User's Manual is made up of four volumes:

Volume 1 "Spectrometer Definition"

Provides the instrument description, the different functioning modes at instrument and sub-assembly levels, instrument system budgets. It describes all the interfaces such as mechanical, thermal, electrical data flows and on-board software functioning. A list of each telecommand and telemetry packet and the definition of each parameter are also included.

Volume 2 "Instrument Operations"

Gives all the information needed to operate the spectrometer, particularly a functioning description of some special modes such as eclipse management, cooling management, ..., tables showing equipment temperatures ranges, power consumption, allowed TC's, downlinked TM's according to the running instrument mode. The flight procedures are also given.

Volume 3 "Annexes"

Gathers main documents giving additional information which allows a better understanding of the instrument functioning for example, TM/TC and electrical diagrams, science data format, observer manual inputs, complementary documents of on-board software.

Volume 4 "Data Base Description"

Contains a precise description of each telecommand and telemetry packet, and all parameters characteristics.

DOCUMENTATION CHANGE RECORD

Issue	Revision	Date	Modified Pages	Observations
DRAFT	**DRAFT**	**26/09/97**		**DRAFT VERSION**
DRAFT A	**DRAFT A**	**22/10/97**	**ALL**	
1	0	25/05/98	ALL	
1	1	06/07/98	ALL	
1	2	07/08/98	Pages 158a - 158b added Pages 166.1 -166.23 Pages 205a - 205b added Chapter 7.6 deleted Chapter 8 modified TM/TC Diagram updated	Draft version except the chapter 8 which is under configuration control
1	3	15/10/98	Chapter 8 modified Pages 258 to 490	Inconsistencies and typing errors corrected. Destination field value modified in TC packets (DM 136) and TID, FID values consequently. PSD TC and TM packets inserted and parameters definition (DM 137). MF n° E0520 modified, MF n° E0521 to E0525 created (DM 7-15-IASW). S/C data base RTU parameters identifiers included. E0029 deleted (DM 7-12-IASW). Packet n° 63843 created (DM 7-15-IASW) including also IASW configuration parameters and s/a on/off status (DM 181 et 182). On-request memory dump TC packets created. DM 143 is closed by this issue.

Issue	Revision	Date	Modified Pages	Observations
1	4	01/12/98	Chapter 8 modified Pages 277, 357, 358, 365, 376, 377, 410, 433	OBT inserted in the science HK data (DM 157) + (DM 170)
1	4a	25/01/99	Chapter 8 modified Pages 321, 329, 331, 332, 333, 468, 469, 470, 483, 484	TID, FID fields modifications for IASW configuration TC, related OR TK and related TM (DM 199). S/A status order in CSSW HK packet.
1	5	02/03/99	Chapter 8 modified	DM's taken into account: (DM-1-171), (DM-7-180), (DM-7-181), (DM-7-182), (DM-132-189), (DM-1-218), (DM-7-219),(DM-422-221), (DM-132-222). Calibration curves and aliases gathering in chapter 8.5. The margin marks show the modifications from 1.3 version
1	5a	23/03/99	Chapter 8 modified	Chapter 8.5 rewritten. Calibration curves and alias references number included in the chapters 8.1 and 8.3 Typing errors and some minor details: Page 344 param E0003 E0004 added, E0004 modified and become E0006. Page 354 param E1091 ident name and short name changed, param E1492 added. Page 412 20 Hex become 21 Hex in pkt 60602. Page 483 TID FID etc was missing in pkt 64046. Page 526 FTPN added.

Issue	Revision	Date	Modified Pages	Observations
2	Draft	03/05/99	Chapter 1 modified	Pages 13, 14, 15, 16, 17 moved from Chapter 4
				Pages 25, 26, 27, 44, 45
				§ 1.4.1, § 1.4.2, § 1.4.3, § 3.2.1 (version 1.2) deleted
			Chapter 3 modified	Figures pages 79, 80
				§ 3.3.1 Coast phase deleted
				§ 3.3.5 (version 2.1) deleted
				§ 3.4.3 and 3.4.5
				§ 3.6.1 beginning
				§ 3.7.1
				§3.7.3 quite completely re-written
				The § 4.2.1 (version 2.1) has moved in this chapter.
				§ 3.7.4
				§ 3.7.7, 3.7.8, 3.7.9, 3.7.10 have been completed
			Chapter 4 re-written	
			Chapter 6 re-written	
			Chapter 7 deleted	
			Chapter 8 modified	This chapter is the version (1.5a) which is the reference for EM delivery +
				TC packet E0223 deleted (DM-7-232)
				Broadcast packet added
				TC for cryocoolers management
				TM parameters for cryocoolers
				Cryocoolers telemetry.

Issue	Revision	Date	Modified Pages	Observations
2	0	01/12/99	See vertical lines	Change request taken into account: DM-1-90-MPE DM-7-135-CNES DM-7-227-CNES DM-7-231-CNES DM-7-233-CNES DM-5/1-235-CNES DM-9-240-CNES DM-0-242-CNES DM-0-243-CNES DM-422-250-CNES DM-0-254-CNES DMS-S-259-CNES DM-7-262-CNES DM-7-264-CESR DM-0-273-CNES DM-422-274-CNES DM-0-276-CNES DM-422-282-CNES DM-S-285-CNES DM-9-291-CNES DM-9-292-CNES DM-1-293-CNES DM-7-295-CNES DM-1-298-CNES
2	1	25/02/00	Chapter 3.7.10 and 3.7.12 deleted, replaced by chapter 3.7.11 TM and TC parameters description. Modifications related to DM-7-295 deleted Chapter 8 modified for taking into account the following change requests: See vertical lines	DM-0-266-CNES-1 DM-7-302-CNES DM-423-312-CNES Dm-13-318-CNES DM-0-320-CNES DM-0-325-CNES DM-0-330-CNES DM-0-338-CNES

Issue	Revision	Date	Modified Pages	Observations
2	2	13/03/00	Mistakes corrected after SEM Data Base validation in chapter 8. Modifications related to DM-S-285-CNES deleted See vertical lines	DM-0-349-CNES DM-S-285-CNES has been cancelled. DM-0-242-CNES implementation corrected: E4339 and E4359 parameters added in CSSW HK packet.

3	0	19/04/00		SPI-DM-0-351-CNES Identical issue as 2.2 regarding the information content.
3	1	20/06/00	Parameters description improvement	SPI-DM-0-387-CNES Chapters 3.7.9, 3.7.10 and 3.7.11 changed
3	2	07/08/00	Page 237 Page 229 Pages 57 to 61 Pages 220, 223, 227, 237, 250 Pages 264 to 267 Pages 221, 222, 227, 229, 237, 238, 242, 260, 274, 275	SPI-DM-0-393-CNES-1 SPI-DM-0-372-CNES SPI-DM-42-287-CNES-1 SPI-DM-0-383-CNES SPI-DM-0-390-CNES SPI-DM-0-376-CNES SPI-DM-0-400-CNES

Issue	Revision	Date	Modified Pages	Observations
4	0	10/11/00		This issue supersedes issue 3/2 dated 07/08/00. It takes into account discrepancies entailing layout improvement and corrections of typing errors. Only major corrections and implementation of new DMs are identified with a revision bar. A list of tables and a list of figures have been added.
			Page 163	SPI-DM-0-266-CNES-1
			Pages 141 to 148	SPI-DM-0-339-CNES
			Page 57	SPI-DM-0-348-CNES
			Page 209	SPI-DM-0-363-CNES-1
			Page 223	SPI-DM-0-372-CNES
			Pages 71, 198, 199, 204 to 206	SPI-DM-0-376-CNES
			Pages 149 to 152	SPI-DM-0-382-CNES
			Pages 69, 72, 154, 155, 199	SPI-DM-0-390-CNES
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			Pages 200, 202	SPI-DM-7-313-CNES
			Pages 173 to 176	SPI-DM-7-394-CNES
			Page 231	SPI-DM-423-386-CNES
			Pages 234, 235, 268, 269	SPI-DM-0B1-404-CNES
			Page 226	NCR 693
			Page 224	NCR 703
			Page 224	NCR 705
			Page 212	NCR 723
			Page 213	NCR 730
			Page 258	NCR 809

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4	1	25/01/01	Page 67	SPI-DM-0-412-CNES
			Page 168	SPI-DM-7-418-CNES
			Page 232	SPI-DM-0-414-CNES, SPI-DM-0B-439-CNES, SPI-DM-0B-441-CNES
			Page 240a	SPI-DM-0-411-CNES
			Pages 262, 263	SPI-DM-0B1-417-CNES
			Page 265	SPI-DM-7-420-CNES
			Pages 230, 230a	SPI-DM-0-430-CNES
			Pages 239, 241, 244, 256, 257, 258, 260, 269	SPI-DM-0B1-450-CNES
			Pages 262, 263, 265, 266	SPI-DM-7-447-CNES
			Page 266	SPI-DM-0B1-446-CNES
4	2	06/03/01	Page 222	SPI-DM-0B-452-CNES
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			Page 225	SPI-DM-0B-451-CNES SPI-DM-0B-453-CNES
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			Page 237	SPI-DM-0B1-462-CNES
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4	3	24/04/01	Page 257	SPI-DM-0-469-CNES
			Pages 69, 72, 199, 207	SPI-DM-0-473-CNES
			Pages 197, 197a, 197b	SPI-DM-0-474-CNES
			Pages 177, 177a, 177b, 177c, 177d	SPI-DM-0-478-CNES
4	4	19/06/01	Page 105	SPI-DM-4-432-CNES
			Pages 14, 16, 17, 45, 58, 75, 76, 105, 106, 108, 114, 199, 205, 205.a, 207, 211, 212, 213, 216, 217, 220, 221, 221.a, 222, 231, 234, 234.a, 235, 240.a, 251, 252, 260, 262, 263, 266, 267, 271, 274, 276.a, 277, 278	SPI-DM-0-492-CNES

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4	5	24/09/01	Pages 102, 107, 115, 120, 121 Page 237 Pages 262, 263	SPI-DM-0-498-CNES SPI-DM-0B1-499-CNES SPI-DM-0B1-500-CNES
5	0	28/02/02	Pages 230, 231, 232, 233 Pages 262, 263, 264 Pages 35, 64, 67, 71, 81, 94, 95, 96, 98, 99, 106, 117, 125, 126, 131, 132, 133, 136, 156, 158, 159, 160, 161, 163, 165, 166, 169, 172, 174, 182 Pages 217 to 296 Page 300 Page 294 Page 106 Page 231 Pages 95, 96, 132	SPI-DM-0B1-521-CNES SPI-DM-0B1-519-CNES SPI-DM-0-523-CNES SPI-DM-0B1-526-CNES SPI-DM-7-528-CNES SPI-DM-0-497-CNES SPI-DM-41-529-CNES SPI-DM-7-395-CNES-3 SPI-DM-0-523-CNES
5	1	17/03/02	Page 171 Pages 230, 276, 277, 278, 282, 286 Pages 69, 95, 95a, 182, 232, 237, 252, 253, 286, 290, 294	SPI-DM-0-537-CNES SPI-DM-0-534-CNES SPI-DM-0-542-CNES
5	2	09/09/02	Pages 95, 105, 126 Page 281	SPI-DM-0-541-CNES SPI-DM-0B1-544-CNES
5	3	18/03/03	Page 171 Pages 46, 230 Page 140 Page 281 Pages282,282a	SPI-DM-0-573-CNES SPI-DM-0-563-CNES SPI-DM-7-562-CNES SPI-DM-7-567-CNES-1 SPI-DM-0-575-CNES
6	**0**	**08/02/07**	Pages 232, 233, 234, 281, 285, 286, 291	Update of IASW (see also doc SPI-NT-0-4319-CESR) *First version recorded on Baghera*

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0. INTRODUCTION

0.1. PURPOSE

This document provides all technical information to permit ESA to perform the following:

- control and validate the Spectrometer functioning for Ground Testing Purposes and Launch preparation,
- operate and control the Spectrometer from satellite launch until completion of its Mission, both in nominal and in contingency situations.

0.2. APPLICABLE AND REFERENCE DOCUMENTS

0.2.1. Applicable documents

AD1	ESA-EID-Part A	Issue 1, rev 5.
AD2	ESA-DV-0-30-CNES	
AD3	INT-RP-AI-0030	Issue 5

0.2.2. Reference documents

RD2	SPI-Functional Analysis	SPI-NT-0-1100-CNES
RD3	Product Assurance Plan	SPI-PA-0-50-CNES
RD4	Instrument Mission Specification	SPI-SM-0-90-CSCI
RD5	Instrument and System Specification	SPI-ST-0-91-CNES
RD6	General Electrical Specification	SPI-SG-0-80-CNES
RD7	General Mechanical Design Specification	SPI-SG-0-82-CNES
RD8	General Thermal Design Specification	SPI-SG-0-83-CNES
RD9	Electromagnetics Requirements	SPI-SG-0-84-CNES
RD10	General Modelling Specification	SPI-SG-0-85-CNES
RD11	Lower Structure Sub-assembly Specification	SPI-ST-2-1042-CNES
RD12	Mask Sub-assembly Specification	SPI-ST-3-1043-CNES

RD13	Anticoincidence Sub-assembly Specification	SPI-ST-1-1041-CNES
RD14	Specification Technique de Besoin du DFEE	SPI-ST-5-1045-CNES
RD15	User Requirement Document for DPE Software	SPI-ST-7-1047-CNES
RD16	Camera Sub-assembly Specification	SPI-ST-4-1044-CNES
RD17	DPE Hardware Specification	INT-SP-AL-0001
RD18	Instrument Design Report	SPI-DD-1088-CNES
RD19	Specifications of the Integral Spectrometer Finite Element Model Reduction	SPI-SP-0-3023-CNES
RD20	EID-B	SPI-SG-0/SAT-1111-CNES
RD21	SPI Interfaces Specification	SPI-SI-0-1324-CNES
RD22	SPI System Telemetry Budget	SPI-NT-0-13037-CNES
RD23	SPI Science Data Format Specification	SPI-NT-0-2911-CNES
RD24	SPI Instrument and System Geometrical Quality Budget	SPI-NT-0-13067-CNES

0.3. ACRONYMS

ACC	Active Cooling
ACS	Anticoincidence Sub-assembly
AD	Applicable Document
ADC	Analogue to Digital Converter
AFEE	Analogue Front End Electronics
AIT	Assembly Integration and Tests
AMA	Absolute Measurement Accuracy
AO	Announcement of Opportunity
AOCS	Attitude & Orbit Control System
APD	Absolute Pointing Drift
APE	Absolute Pointing Error

APID	Application Identifier
ASIC	Application Specific Integrated Circuit
BCP	Broadcast Packet
BGO	Bismuth Germanate
CDE	Compressor Drive Electronics
CDMU	Command & Data Management Unit
CEA	Commissariat à l'Energie Atomique
CNES	Centre National d'Etudes Spatiales
COM	Centre Of Mass
COMPTEL	Compton Telescope
CSA	Charge Sensitive Amplifier
CsI	Caesium Iodide
CSSW	Common Services Software
CU	Control Unit
DAFEE	Detector Analogic Front End Electronics
DBI	Data Bus Interface
DBU	Data Bus Unit
DC-DC	Direct Current-Direct Current Converter
DDFEE	Detector Digital Front End Electronics
DFEE	Digital Front End Electronics
DMA	Direct Memory Access
DPE	Data Processing Electronics
DRD	Document Requirements Description
EID	Experiment Interface Document
EM	Engineering Model

EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interface
ESA	European Space Agency
FEA	Front End Amplifier
FEE	Front End Electronics
FM	Flight Model
FMECA	Failure Mode Effects and Criticality Analysis
FOV	Field Of View
FS	Flight Spare
FWHM	Full Width at Half Maximum
Ge	Germanium
GeD	Germanium Detector
HTP	High Temperature Protection
HURA	Hexagonal Uniformly Redundant Array
HV	High Voltage
HVPS	High Voltage Power Supply
IASW	Instrument Application Software
ICB	Interface Communication Buffer
I/F	Interface
ISDC	Integral Science Data Centre
ISOC	Integral Science Operation Centre
LCL	Latching Current Limiters
LCR	Lower Collimator Ring
LET	Linear Energy Transfer
LLD	Lower Level Discriminator

LSA	Low Structure Assembly
LTP	Low Temperature Protection
LV	Low Voltage
LVPS	Low Voltage Power Supply
LVS	Lower Veto Shield
MCC	Mission Control Centre
MKA	Mask Tube
MLI	Multi Layer Insulation
MSB	Most Significant Byte
NA	Not Applicable
OBDH	On-Board Data Handling
OBT	On-Board Time
OMC	Optical Monitor Camera
OSSE	Oriented Scintillation Spectroscopy Experiment
PA	PreAmplifier
PAC	Passive Cooling
PDU	Power Distribution Unit
PEA	PSAC Electronic Assembly
PHA	Pulse Height Analyser
PLM	Pay Load Module
PMA	PSAC Mechanical Assembly
PM / PMT	Photo Multiplier (Tubes)
PSA	Pulse Shape Amplifier
PSAC	Plastic Scintillator Anticoincidence sub-assembly
PSD	Pulse Shape Discriminator

PSM	Power Supply Module
RBI	Remote Bus Interface
RD	Reference Document
RPE	Relative Pointing Error
RTU	Remote Terminal Unit
SEL	Single Event Latch-up
SEU	Single Event Upset
SIS	Spacecraft Interface Simulator
SPF	Single Point Failure
SPI	Spectrometer Integral
SRD	Software Requirement Document
SRTU	Satellite Remote Terminal Unit
SSA	Side Shield Assembly
SSM	Second Surface Mirror
STM	Structure and Thermal Model
SVM	SerVice Module
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	TeleCommand
TM-TC	TeleMetry-TeleCommand
TRP	Temperature Reference Point
UCR	Upper Collimator Ring
ULD	Upper Level Discriminator
UTC	Universal Time Coordinate

UVS	Upper Veto Shield
VS	Veto-Shield
VCU	Veto-Shield Control Unit
XMM	X-Ray Multiple Mirrors Mission
XRM	X-Ray Monitor

0.4. DOCUMENT STRUCTURE

This document follows the requirements provided in the DRD – 33-1 of EID-A (AD1).

Chapter 1 describes briefly the scientific purposes of the instrument, gives a functional then hardware and software description. Finally, an overview of its operational functioning is provided by a spectrometer and sub-assemblies modes description.

Chapter 2 gives some system budget information; mass, power and telemetry. It gives also some instrument characteristics.

Chapter 3 describes the different interfaces; mechanical including system alignment budget, thermal design, electrical design and electromagnetic compatibility. It gives also a data flow description including housekeeping and science data between each sub-assemblies and the DPE, a summary of the available telecommands and telemetry packets, and a list of the different housekeeping digital and analogue links. Then, an important part is dedicated to the instrument software and its interfaces. First, the instrument software architecture is described including CSSW and IASW then the internal application software functioning and finally the interfaces characteristics between IASW and the sub-assemblies.

The last part of this chapter gives a definition list of all telecommands, telemetry packets and parameters.

1. INSTRUMENT DEFINITION

1.1. SCIENTIFIC OBJECTIVES

High resolution gamma-ray spectroscopy explores the most energetic phenomena that occur in nature and addresses some of the most fundamental problems in physics and astrophysics. It embraces a great variety of processes: nuclear deexcitation, radiative capture, positron annihilation, compton scattering, bremsstrahlung, synchrotron emission; and an even greater diversity of astrophysical sources: solar flares, gamma-ray bursts, novae, supernovae, cosmic-ray interaction and sources, neutron stars, black holes, active galactic nuclei, cosmic gamma-ray background.

1.1.1. Galactic point sources

The centre of our galaxy has been shown from observations in the radio and infra-red windows to be the site of violent activity. The highly variable 511 keV broad line emission from the galactic centre source (1E 1740.7-2942) is a typical example. The behaviour of this source and potential other black holes candidates is not well understood, mainly due to the lack of good spectral resolution in the previous experiments. The SPI will be able to analyse, in details, the spectral structure of these categories of objects.

The majority of the transient sources lies within ± 10° of the galactic plane. Recent observations of Nova Muscae show that the variations observed in the X-Ray Nova are extreme at energies above 100 keV. A more detailed spectrum, obtained with SPI, in terms of energy resolution of the lines, is necessary to tackle the physics behind X-Ray novae.

There are about 100 binary X-Ray sources known to emit in the energy range of the SPI in our galaxy and the large Magellanic Cloud. Of particular interest for the SPI are the black holes candidates and X-Ray pulsars.

Several black holes candidates have highly variable emission in the 400-500 keV band. The sensitivity of the SPI will allow these "lines" to be measured at much lower fluxes needed to establish duty cycles for these presumed positron injection events. This will also allow a sensitive search for the transient narrow 511 keV line signature.

The search for gamma-rays produced by the decay of radioactive nuclei represents a fundamental test for theories of the explosive nucleosynthesis of the elements. The observation of these nuclear gamma-ray lines provides a direct method to determine the amount of a specific isotope generated in a supernovae explosion. Moreover, the shapes of the gamma-ray line profiles provide information about the expansion velocity and density distribution inside the envelope.

Neon-rich novae which are speculated to be substantial producers of radioactive ^{22}Na, would be observable through its beta-decay gamma-ray lines at 0.511 and 1.275 MeV with the SPI sensitivity for nova out to distances of several kpc.

A primary goal of the SPI is the detailed study of nucleosynthetis processes through observations of the gamma-ray line emission from radioactive elements produced in nucleosynthesis events.

Such observations will lead a wealth of information on the site of nucleosynthesis (both hydrostatic and explosive) and on the details of explosion mechanisms and subsequent dynamics in supernovae.
The spectral resolution of the SPI will allow fundamentally new measurements of nucleosynthetic processes. In addition to the greatly increased sensitivity to narrow lines from low velocity material, high resolution spectroscopy allows the precise determination of line centroids and profiles, thus allowing the determination of the physical parameters of the high velocity materials, including Doppler shifts, velocity distributions, mixing and inhomogeneity, and time-evolution of the explosion dynamics.

The primary sites of explosive nucleosynthesis are Type I and Type II supernovae, and the SPI is expected to make significant new observations of these classes of sources, both by studying new and recent events, and by identifying historical sites of nucleosynthesis in our galaxy. Any standard supernova nucleosynthesis scenario involves production of iron group elements. A small amount of ^{56}Ni has been observed in SN 1987 A. The gamma-ray line fluxes from Type II supernovae are much smaller than for Type I supernovae (due to a smaller amount synthesised as well as to the absorbing massive ejecta).
Type II supernovae will be detectable by the Spectrometer within a ≈ 1 Mpc radius.
Due to a larger amount of ^{56}Ni synthesised in Type I supernovae, 847 keV and 1238 keV lines are major goals for the SPI.

Concerning the ^{56}Al, the Spectrometer is particularly well suited for the study of ^{26}Al nucleosynthesis in the local spiral arms of our Galaxy, as well as in young objects (Vela and Cygnus regions).

A recent ^{44}Ti observation, by COMPTEL, of CAS A supernova remnant , is very promising to detect hidden galactic supernovae, principally in the galactic centre region.

1.1.2. Galactic diffuse sources

SMM has established that there is an extended component of positron annihilation radiation at 511 keV, distributed along the Galactic plane, which was clearly detected, but not mapped. This, and many other observations, have been shown to be consistent with a diffuse Galactic ridge component produced in interstellar space, with a longitude extent of the order of 40°, and a possible variable compact source near the Galactic Centre. OSSE has shown the general distribution of the emission to be consistent with a Galactic ridge, as well as a ≈ 10° bulge-like component, with the latter containing about 75 % of the total Galactic flux.

The SPI will be an order of magnitude more sensitive at the annihilation energy than the current balloon/satellite experiments and have much better angular resolution. It will therefore be able to map the diffuse emission, resolve the point sources and measure the spectrum of each component with high accuracy.

The 1809 keV gamma-ray line mapping of the Galactic plane by COMPTEL provides a milestone in nucleosynthesis research. This line originates from ^{26}Al decay with 10^6 years lifetime, thus probing the Galactic element formation processes in the recent past of Galactic history.

The recent COMPTEL maps however revealed not only substantial structure of the emission on a finer scale, but also significant emission from regions other than the inner Galaxy. The irregularity of the emission may be interpreted as a hint towards an origin of ^{26}Al predominantly in massive stars. The SPI should be able to provide new insight into the Galactic distribution of the sources through a precise determination of the line energy, which can be converted into a source distance measure. In this way, the SPI is capable of mapping the Galaxy in 3 dimensions for the brightest 1809 keV emission spots: an emission feature with a flux of 2×10^{-5} ph.cm^{-2} s^{-1} could thus be measured in line energy to a precision of $\approx$ 0.15 keV, corresponding to a velocity accuracy of $\approx$ 25 km s^{-1}; Utilising the Galactic rotation pattern, the distance of such an emission feature can be determined to several kpc. This will allow the COMPTEL map to be decomposed into distinct emission features and an underlying Galaxy-wide component.

^{60}Fe another long-lived radioactive isotope decaying into ^{60}Ni, and thus could be detected through its gamma-ray decay lines (1.173 MeV and 1.332 MeV). Due to its abundance and its slightly longer decay time compared to ^{26}Al, the detection of ^{60}Fe is within the sensitivity of the INTEGRAL Spectrometer.

Energetic particles (cosmic rays) mainly in the range 1-30 MeV can initiate nuclear deexcitation lines which may be detectable by the SPI. The possible detection by COMPTEL of intense ^{12}C (4.4 MeV) and ^{16}O (6.1 MeV) lines from the ORION molecular cloud complex implies a much more favourable situation as a target for the SPI which will be able to make a distinction between the two possible physical processes involved (nuclei in the interstellar gas excited by collisions with cosmic ray protons, or energetic nuclei self-excited by collisions and producing an in-flight decay).

1.1.3. Extragalactic astrophysics

The field of view of the SPI is well matched to view the whole of galaxies which are member of the local group and to detect gamma-rays from objects with MeV luminosities like that of CYG X-1 in its γ-1 state at the distance of the LMC and SMC. There are at least two black hole candidates in the LMC (LMC X-1 and LMC X-3).

The extragalatic Type Ia supernovae will be important targets for the Spectrometer, since the predicted flux at 847 keV for a supernovae explosion at 15 Mpc producing 0.5 solar mass of ^{56}Ni is: 9.10^{-6} photons.cm^{-2}.s^{-1} (3 times the SPI sensitivity)

Moreover, differences of 10-20 keV are predicted between the line profiles in the detonation and deflagration models, and thus the INTEGRAL Spectrometer will be able to clearly distinguish between the models.

In both models, at early times, the lines are very strongly blueshifted and broadened, so that the ^{56}Ni and ^{56}Co lines will overlap. High resolution spectroscopy will be essential to measure the relative abundance and time evolution of the lines.

Beside the normal galaxies, several show various types of activity, as well as clusters of galaxies and active galactic nuclei. Observations of gamma-ray from these sources with the SPI will give important clues on the origin of activity in regions difficult to observe in other spectral bands.

1.2. SCIENTIFIC PERFORMANCES SUMMARY

Energy range : 20 keV to 8 MeV

Energy resolution : ΔE = 2 keV at 1.33 MeV for each detector and ΔE = 3 keV for the whole spectrometer

Angular resolution : ~ 2°

Field of view : fully coded ± 8° (corner to corner)
partially coded ± 12.5°
zero sensitivity ± 17,5° (corner to corner)

See Figure 1.1.

Narrow line sensitivity

3×10^{-6} ph cm^{-2} s^{-1} (at 1 MeV) and similar number in the overall energy range, excepted at 511 keV: 2×10^{-5} ph cm^{-2} s^{-1}

Dating accuracy:

- relative time accuracy of 60 µs between the instrument time tag and the instrument clock,
- absolute precision of the event datation of 160 µs with a 100 µs on-board time precision in relation to U.T for the spacecraft system allocation.

1.3. INSTRUMENT DESCRIPTION

The Spectrometer is made up of the following sub-systems:

- The Passive Mask
- The Plastic Scintillator (PSAC)
- The Camera including:
  - Detection sub-assembly including 19 detectors, 19 PA1, 19 PA2 as well as Analogue Front End Electronics (AFEE1, AFEE2) and Pulse Shape Discriminator (PSD).
  - Cryostat
- The Anti-coincidence sub-system (ACS)
- The Digital Front End Electronics (DFEE)
- The Data Processing Electronics (DPE) including the Instrument Application Software (IASW)
- The Low Structure Assembly (LSA)

1.3.1. Functional description

See figures 1.2 and 1.3 for functional diagram.

See also figures 1.9 for spectrometer logic of work.

The incident radiation, coming from an emitting source located in the field of view, is intercepted by a PASSIVE MASK composed of plates which either block γ ray or allow them to pass through.

Then, it goes through the Plastic Scintillator which is located below the mask. The Plastic Scintillator detects the 511 keV background emission due to the charged particles interaction.

Once the γ photon beam has been coded by the mask, it reaches a pixelised DETECTION PLANE and projects on it, a coded mask shadowgram characteristic of the sources location in the sky. The disposition of the plates on the mask array is such that each shadowgram is independent from the other through an autocorrelation function. Such a mask is called HURA (Hexagonal Uniformly Redundant Array). This leads to a ground deconvolution possibility without any source location misinterpretation.

The role of the Detection plane made up of Germanium Detectors cooled at a temperature ≤ 85 K by a CRYOSTAT, is to convert the energy deposited by photons into an equivalent electrical value.

Detection-plane is composed of 19 hexagonal detectors for a global area of 500 cm². An analogue to digital conversion system is used to digitise the signals coming from the 19 detectors (AFEE).

The distance between the mask and the detection-plane as well as the respective area of these two sub-assemblies determine the coded field of view.

In order to shield the Ge detector and the field of view against background radiation, the cryostat with its Ge detector array is surrounded by an Anti-coincidence Sub-assembly. This sub-assembly is made up of crystal scintillator in which charged particles and γ photons are detected and converted in an electrical signal.

All the signal output data produced from the detection plane (after digitalisation) and the active shielding are directed towards the DFEE which format the data, time-tags and identifies the photon considered "good" since they are coming from the field of view, from those coming from shielding and thus outside the field of view.

All the signal output data produced from detection plane are also directed towards PSD which, by analysis of the signal shape, is able to minimise the background in the range 200 keV – 2 MeV.

The data from DFEE and PSD is then sent to the DPE which insures correlation between PSD events and detection plan events, some spectra elaboration, the two-ways link with the satellite (TM-TC) and the on-board instrument management.

<u>On-board calibration:</u> not applicable

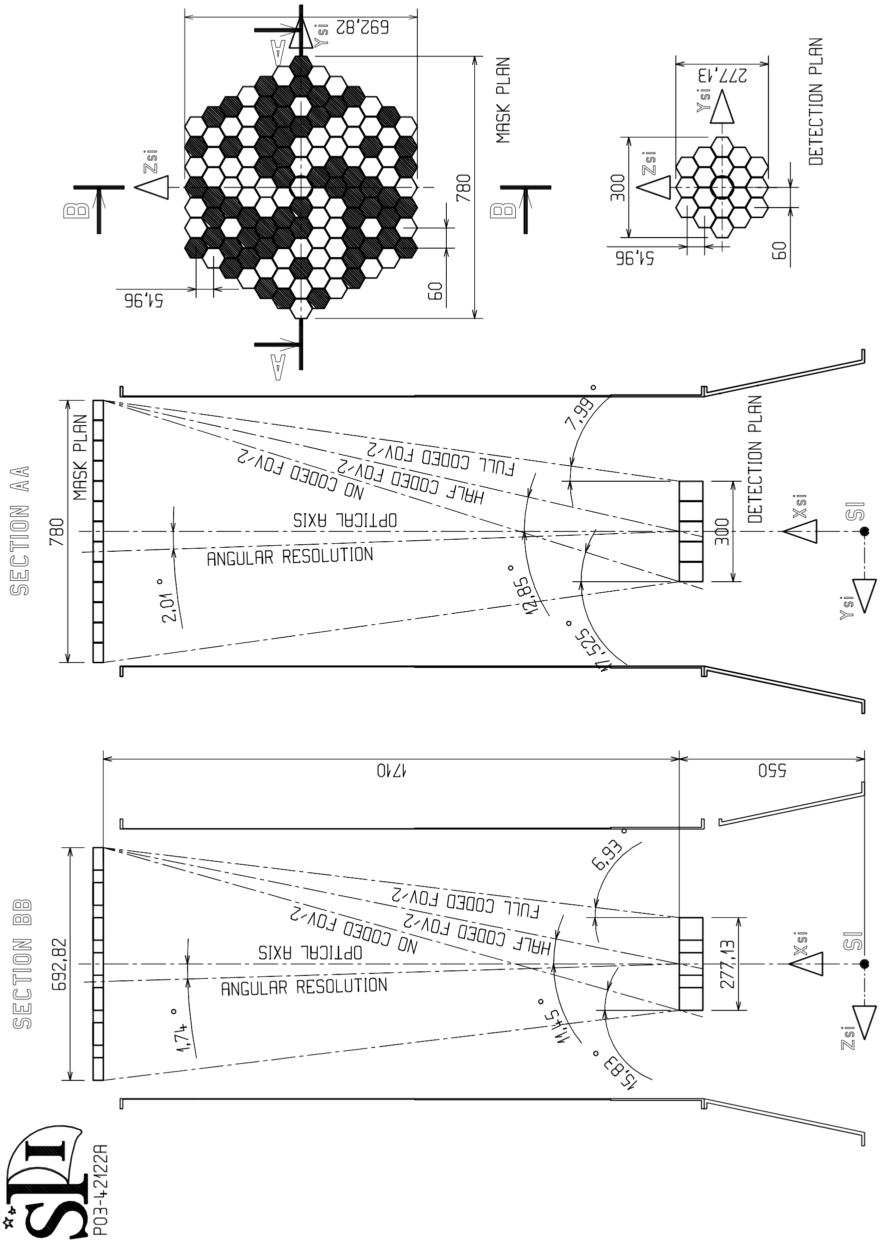


Figure 1.1 - Field of View Definition

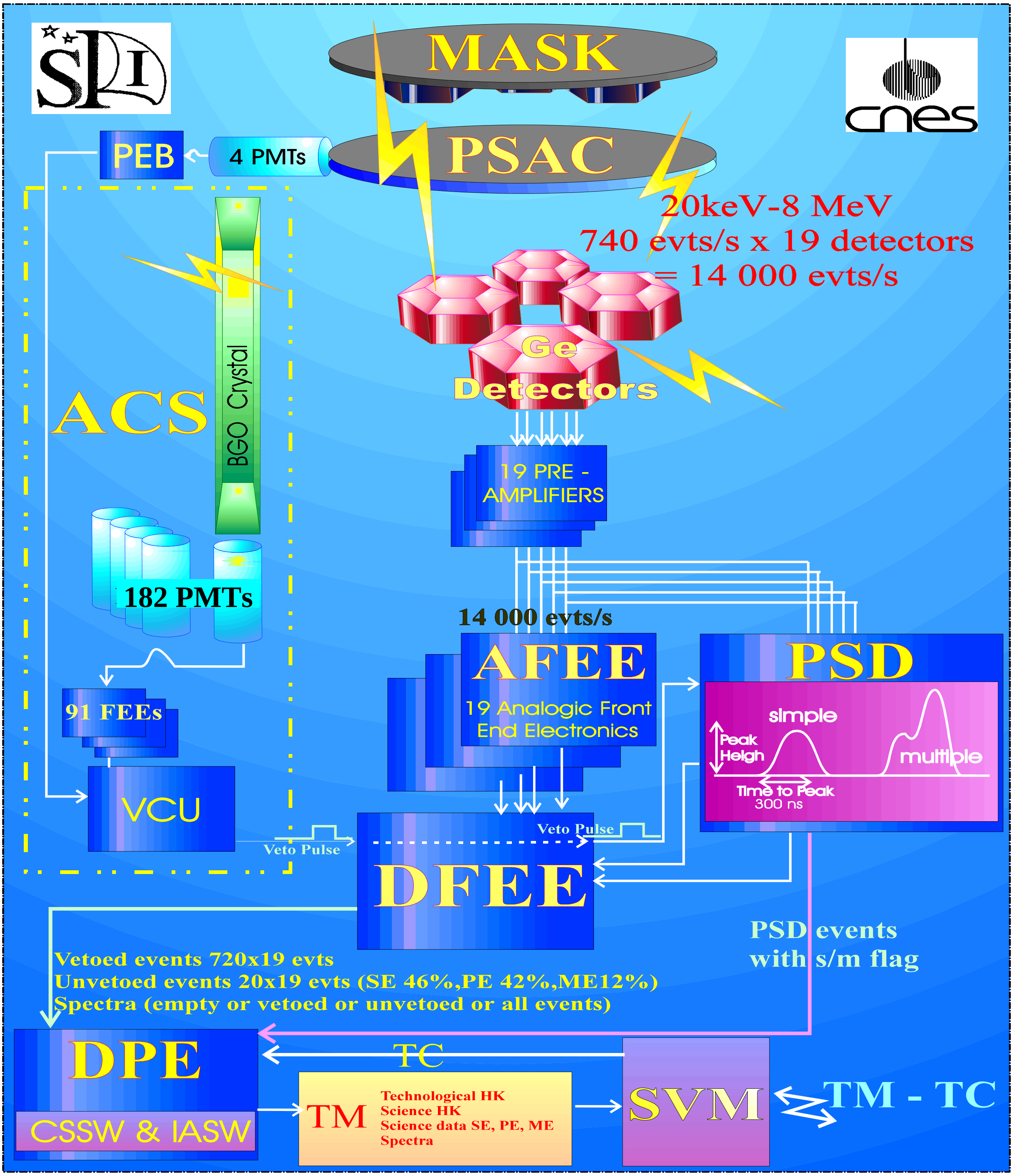


Figure 1.2 - Instrument Functioning Principle

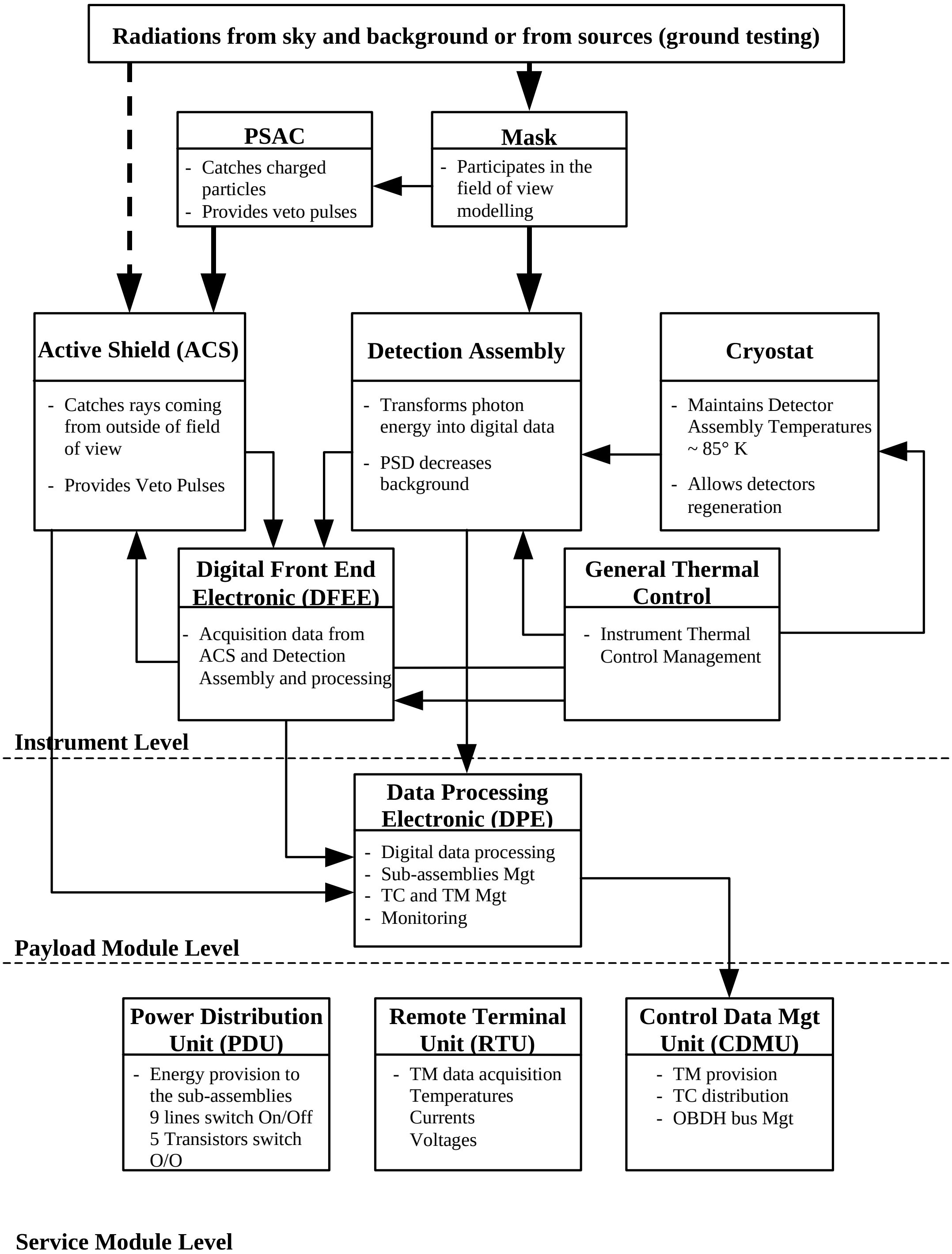


Figure 1.3 - Functional Diagram

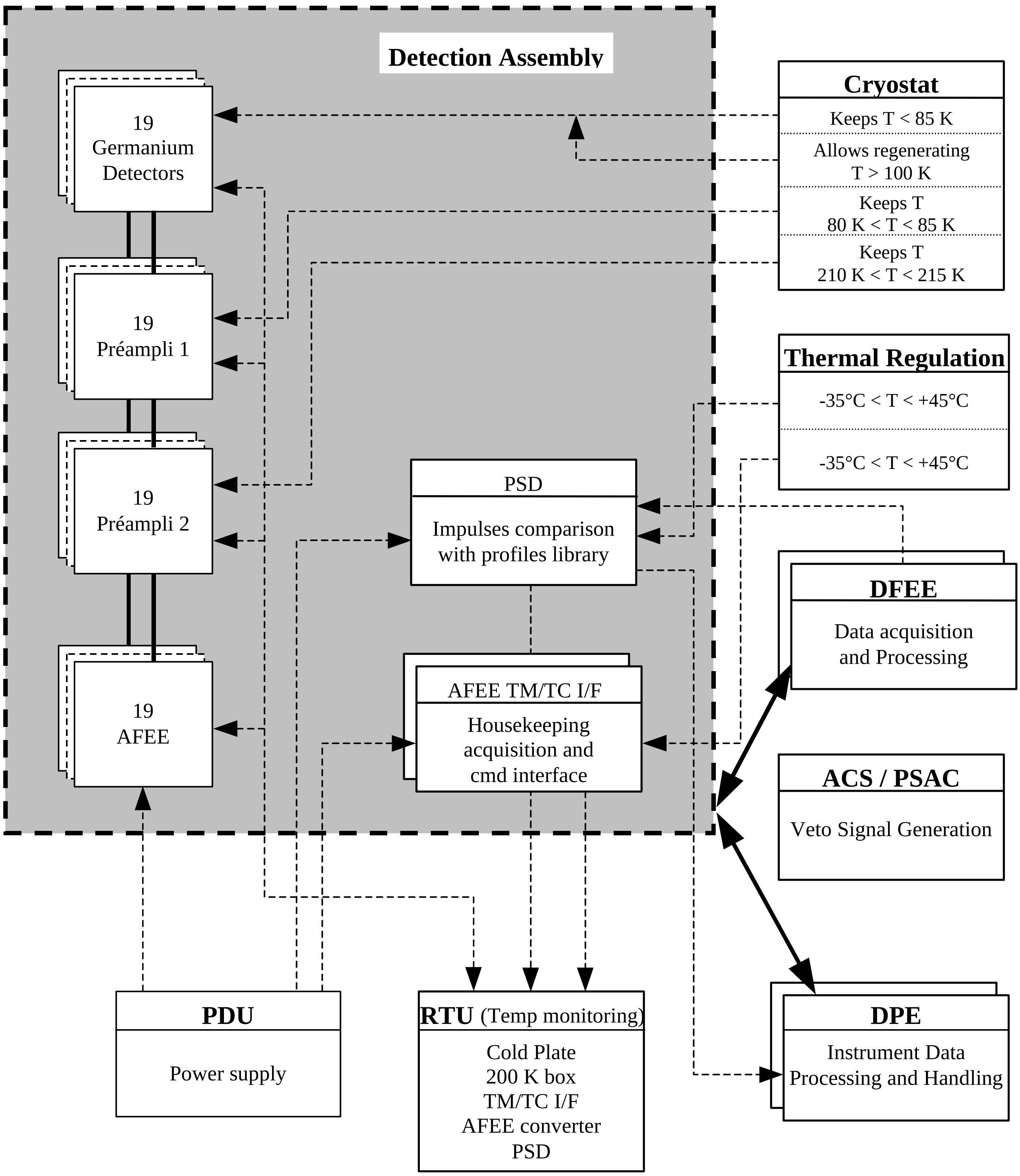


Figure 1.4 - Detection Assembly Operational Environment

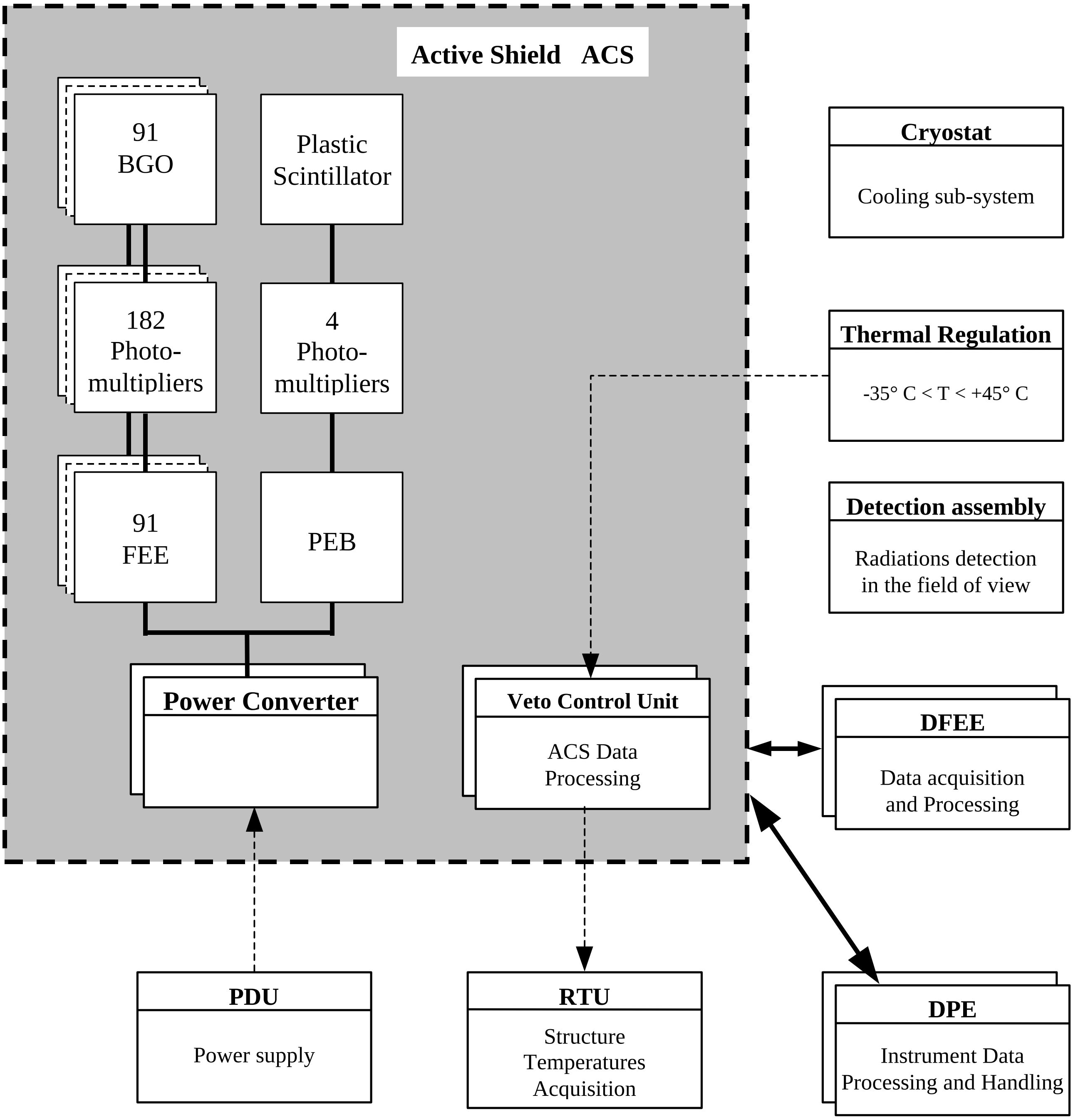


Figure 1.5 - ACS Operational Environment

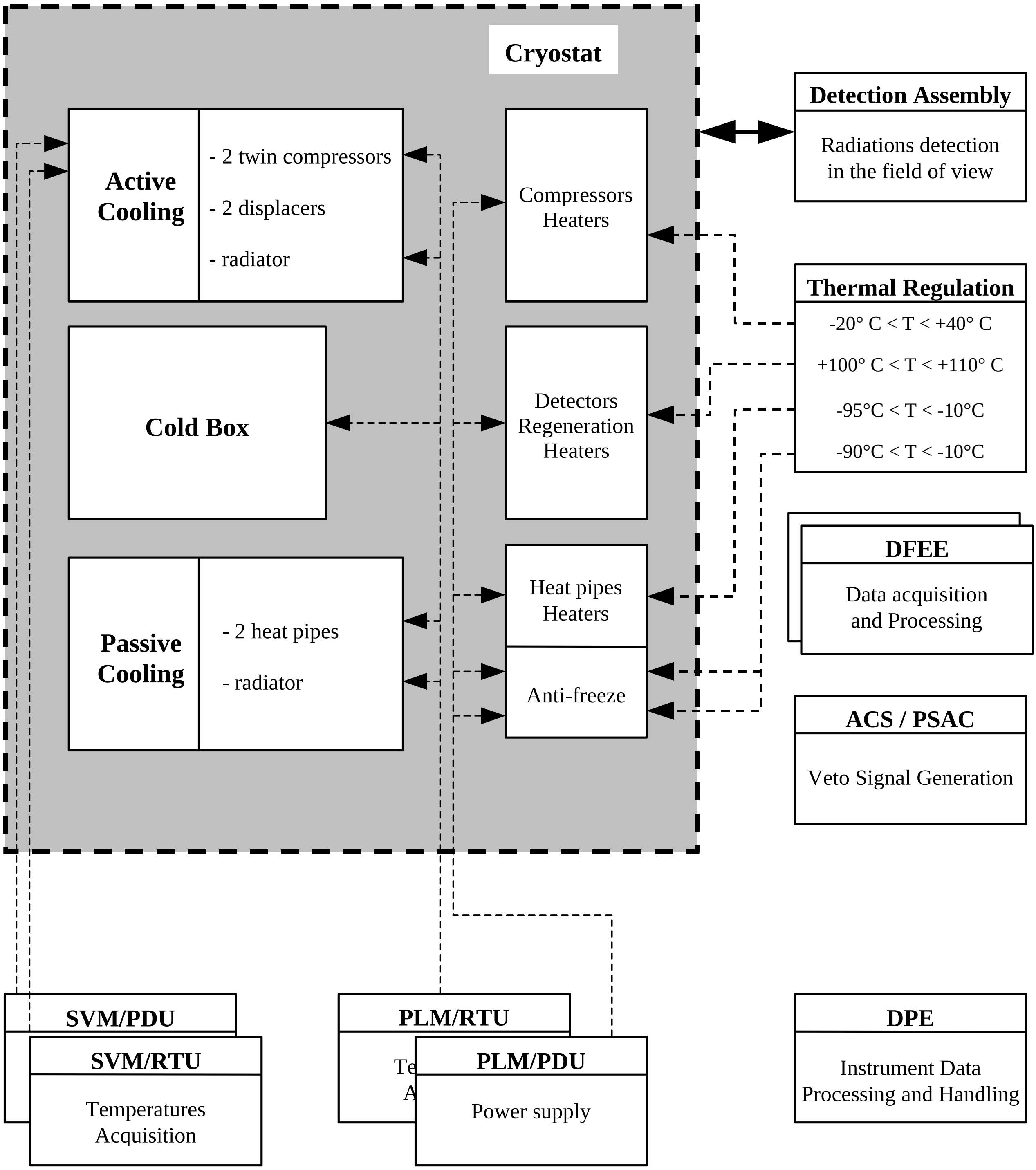


Figure 1.6 - Cryostat Operational Environment

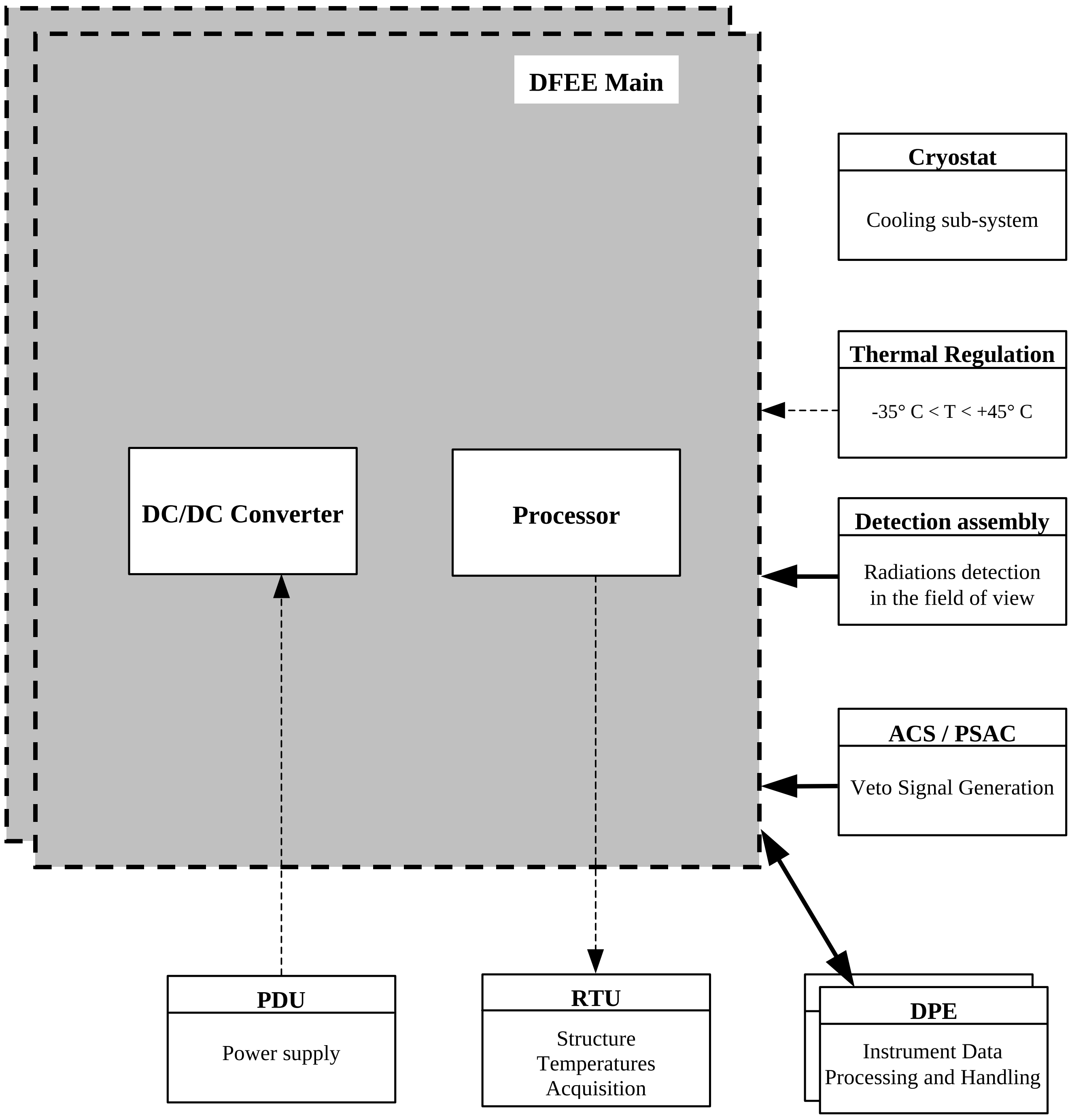


Figure 1.7 - DFEE Operational Environment

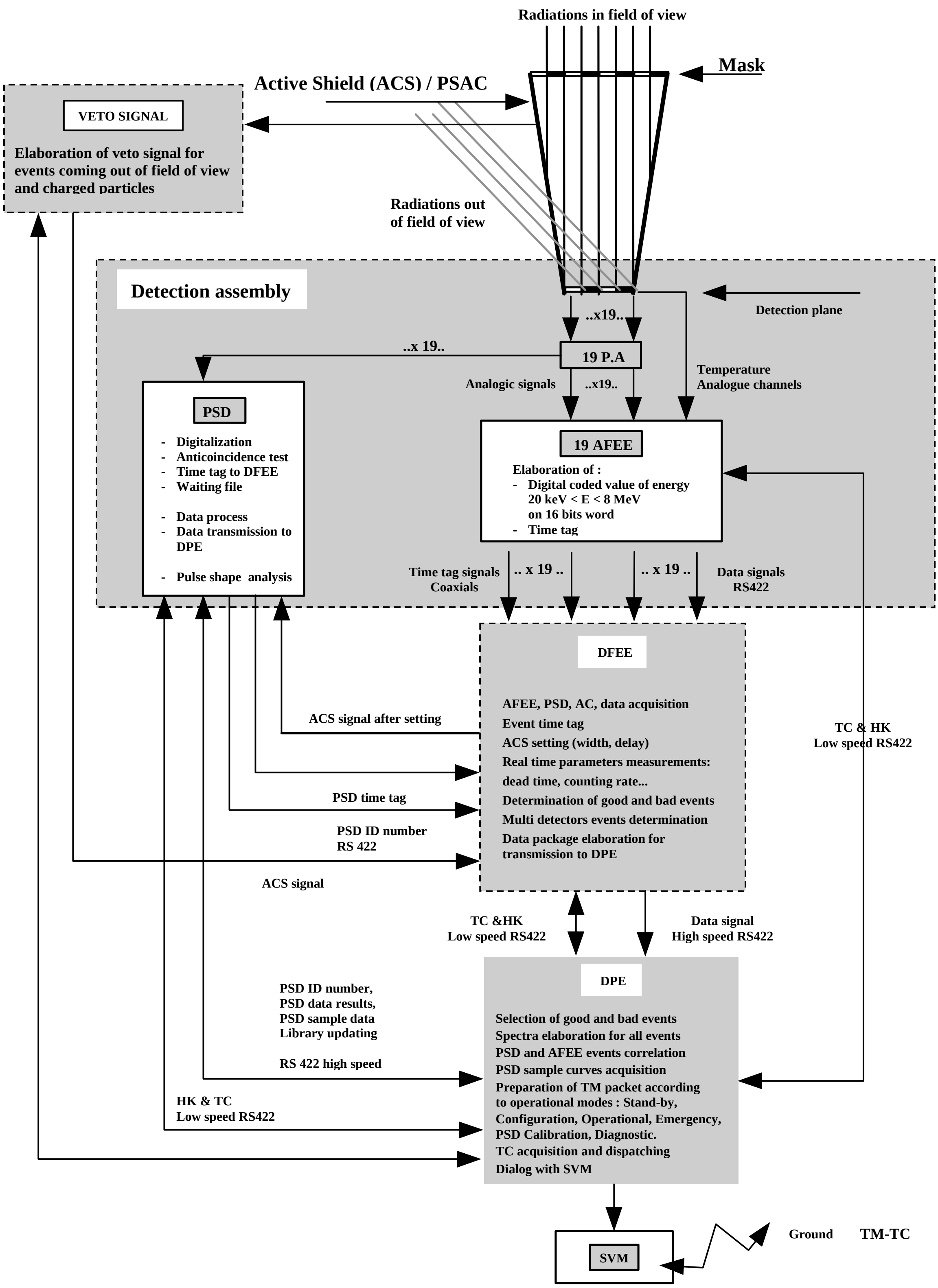


Figure 1.8 - Data Flow Diagram

1.3.1.1. Passive mask functional description

Essential need

- to code the gamma picture in the field of view area of the instrument to give an imagery capability to the Spectrometer.

Primary functions

- to close the tube, in order to take part to the primary structure stiffness,
- to guarantee the alignment possibility of the sight line,
- to close the tube, in order to take part to the global thermal balance.

Secondary functions

- to support a part of the global MLI,
- to support possibly heaters in order to guarantee the internal minimum temperature in a passive mode.

1.3.1.2. Plastic scintillator functional description

Primary functions

- to actively detect charged particles which deposit energies higher than 300 keV (TBC) in the scintillator material,
- to send an associated signal compatible with the ACS FEE veto signals to the VCU.

Secondary functions

- to support the mask,
- to support the MLI of the instrument,
- to generate housekeeping data, digitise and transmit them in a digital form to the VCU,
- to provide thermal sensor signal to the VCU.

1.3.1.3. Detection sub-assembly functional description

The Detection sub-assembly is set up:

- 19 Germanium detectors plane and their preamplifiers,
- 19 independent amplification chains,
- an Analogue Front End Electronic TM/TC Interface,
- a Pulse Shape Discriminator.

Essential need

- to detect the gamma photons in the field of view within 20 keV and 8 MeV energy range,
- to determine the event energy and origin direction by associating mask coding.

Primary functions

- to detect the gamma rays by cooled Germanium detectors,
- to keep detectors within operational temperature range,
- to arrange measurements analogue signals,
- to analyse the pulses shape,
- to supply power for detectors and associated electronics.

Secondary functions

- to heat detector for regeneration,
- to calibrate electronics in flight,
- to generate housekeeping data, digitise and transmit them in a digital form to the DPE.

1.3.1.3.1. 19 Germanium detectors plane and their preamplifiers

Primary functions

- to detect the gamma photons coming on the detection plane within 20 keV and 8 MeV energy range,
- to preamplify electrical signal coming from detectors.

1.3.1.3.2. 19 independent amplification chains

Primary functions

- to amplify and arrange analogue pulses provided by preamplifiers,
- to process analogue pulses arranged in order to obtain:
  - a time-tag signal,
  - a digital information which represent the energy level or a saturated pulse if the energy is more than 8 MeV.

Secondary functions

- to provide power:
  - low voltage for the preamplifiers and amplifiers,
  - high voltage for the detectors polarisation,
- to provide power for internal cryostat temperatures sensors and perform related temperatures measurements.

1.3.1.3.3. Analogue front end electronic TM/TC interface

- to ensure the dialog with DPE for commands acquisition and housekeeping parameters transmission.

1.3.1.3.4. Pulse shape discriminator (PSD)

Primary functions

- to measure shape characteristics of the current pulses delivered by the 19 GeD,
- to take into account shield veto signals provided by DFEE at fixed delayed time after the beginning of the event,
- to deliver a time-tag signal to DFEE if there is no veto signal from DFEE,
- to send identification data to DFEE for time-tagged events,
- to analyse digitised current pulses by software algorithms,
- to send to DPE for each processed event its identification data and current pulse shape characteristics (multiple site or single site) .

Secondary functions

- in nominal mode, to transmit periodically to the DPE, one event digital curves sampling (80 samples with 9 bits),
- in calibration mode, to transmit to the DPE all the processed events digital curves sampling. Maximum number is fixed by telemetry capability,
- to digitise and transmit housekeeping data to the DPE,
- to collect and process digital command data transmitted from the DPE.

1.3.1.4. Cryostat

The Cryostat is set up of three sub-assemblies:

1.3.1.4.1. Active cooling

- to cool down the detection plane,
- to keep the detection plane at 85 K.

1.3.1.4.2. Cold box

- to support mechanically the detection plane,
- to provide two cold partitions 85K and 210 K,
- to insulate thermically the detection plane from the external environment,
- to allow the detection ground tests with the ambient environment (pressure and temperature).

1.3.1.4.3. Passive cooling

- cryostat precooling at 210 K

1.3.1.5. ACS functional description

Primary functions

- to passively shield the GE detector against the background radiation out of the SPI FoV,
- to actively shield the GE detector against the background radiation out of the SPI FoV by providing a Veto-Pulse to the DFEE, for each detected event in the active shield scintillator material,
- to produce a Veto Pulse for each detected event by the PSAC,
- to define the SPI field of view.

Secondary functions

- to support the mask and the plastic scintillator (PSAC),
- to support some parts of the camera: passive cooling, PSD, AFEE2,
- to support the MLI of the instrument,
- to ensure the global mechanical behaviour of the veto shield,
- to collect housekeeping data from the ACS, digitise and transmit them in a digital form to the DPE,
- to transfer housekeeping data from the PSAC to the DPE,
- to transfer all the required control data to the PSAC,
- to supply secondary AC power to the PSAC,
- to measure and transmit count rates of received γ photons to the DPE for each individual PMT or pair of PMTs,
- to measure the arrival time of a gamma ray burst.

1.3.1.6. DFEE functional description

Primary functions

- to acquire Time-Tag and event energy data detected by detection plane after amplifying and encoding by AFEE,
- to sort event detected in the field of view and out of the field of view by the means of the veto signal provided by ACS,
- to date the non vetoed events,

- to acquire PSD Time-Tags and the corresponding event identifier in order to allow DPE associating it to the PSD detected event, the corresponding energy and time,
- to transmit the following data to the DPE:
  - for each non vetoed event:
    . energy put down in the detector by the incident photon,
    . event detection time,
    . related detector address,
    . PSD identifier (delivered by PSD to DFEE) for the PSD processed events,
    - for the multiple events (Multi-detectors events):
      the time between Multi-detectors events (for a same incident event)
      the events number inside a multiple.
  - for each "spectrum" which are either all events or vetoed events or non vetoed events (depends upon configuration parameters)
    . energy put down by the incident photon in the detector,
    . the concerned detector address.

<u>Secondary functions</u>

- to digitise and transmit housekeeping data in digital form to the DPE,
- to collect and process command data transmitted in digital form from the DPE.

1.3.1.7. DPE functional description

The DPE performs the following functions:

- telecommand acquisition, in form of TC source packets, through the OBDH bus, verification and distribution to the Scientific instruments via four low speed bi-directional serial lines,
- HK telemetry collection from instrument through the four low speed serial lines, formatting into TM source packets, acquisition and distribution to the CDMU via OBDH bus,
- scientific data acquisition from instrument through two high speed unidirectional serial lines, limited data processing, formatting and routing to the OBDH S/S,
- instrument monitoring and control via discrete analog (voltage, temperatures) and digital (relay driving, status) I/O signals,

- instrument operating modes management (Off, Init, Reset, Running, Wait and Power Saving mode),
- memory storage for program and data,
- time maintenance and distribution to the Instrument S/S.

1.3.2. Instrument running summary - Logic of work

- At the time of one event detected in one of the 19 Germanium detectors, the associated AFEE generates an analogical signal to the DFEE for providing the precise time when the events took place. Then it transforms the detected signal amplitude in 16 bits word which is immediately transmitted to the DFEE for record.
- The analogical signal is also received by the PSD in order to analyse its temporal shape and to distinguish the case of a γ ray hitting the detector from a background event. The PSD provides for each analysed event a quick signal (time tag) to the DFEE. When its decision taken, the PSD transmits it to the DFEE which performs the appropriate event classification.
- At the time of an event on BGO shield, the ACS generates during some µs a signal to the DFEE in order to inform the DFEE of the BGO activity. Therefore, the DFEE will be able to reject the events producted simultaneously in GE detectors.
- From the information provided by the ACS (veto sub-system), the DFEE is able to declare as "good" events the photons whose their temporal tag do not coincide with the passage of a photon or a particle through one shield part. It adds also some additional information such as relative on-board time, marks for multiple events and for rejected events after pulse shape analysis.
- The DPE receives data from the DFEE, adds information given by the PSD about PE classified events, builds the spectra and transmits all the data to the telemetry system for sending to the ground.

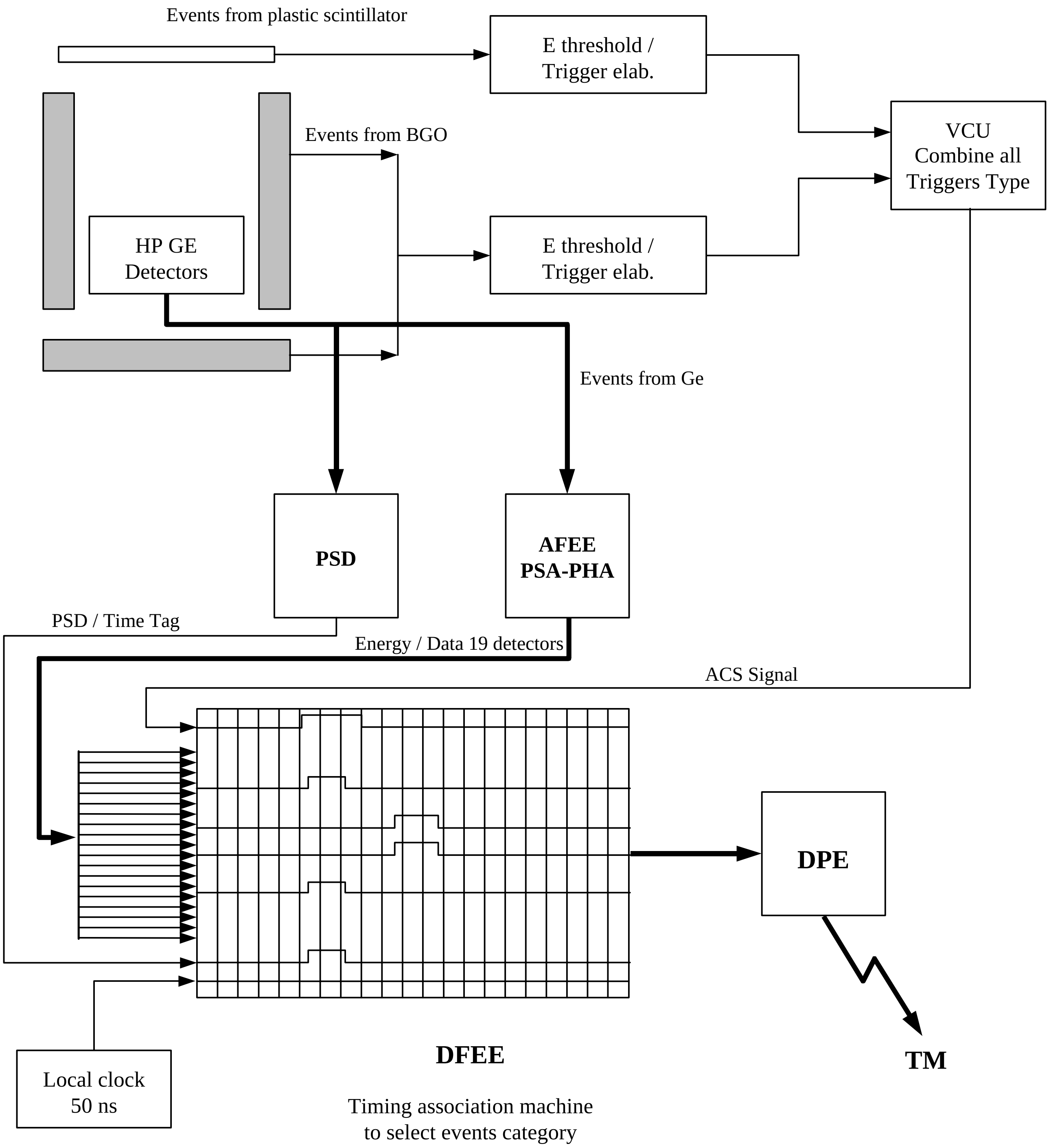


Figure 1.9 - Spectrometer - Logic of Work

1.3.3. Hardware description

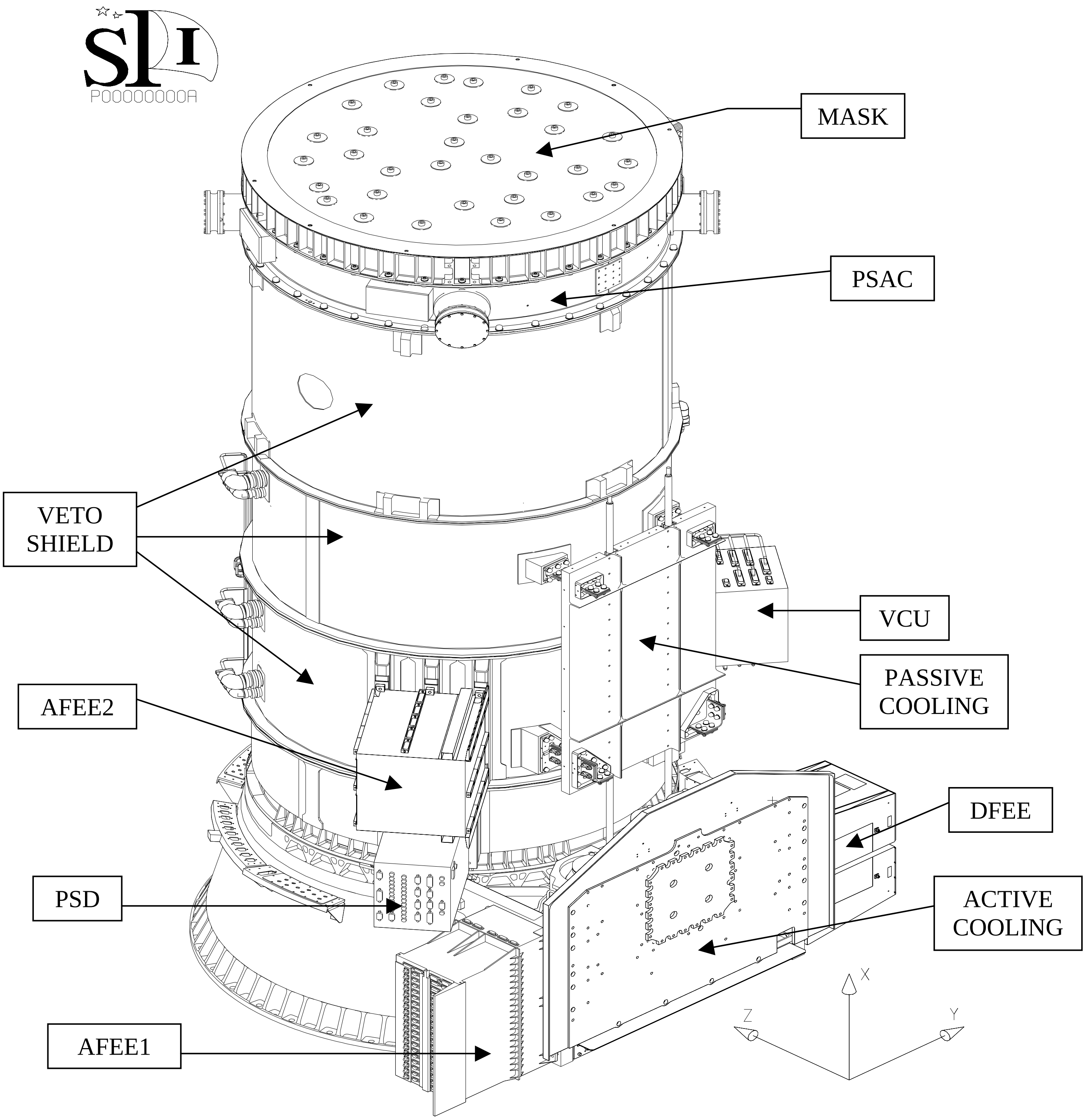


Figure 1.10 - General Spectrometer Design

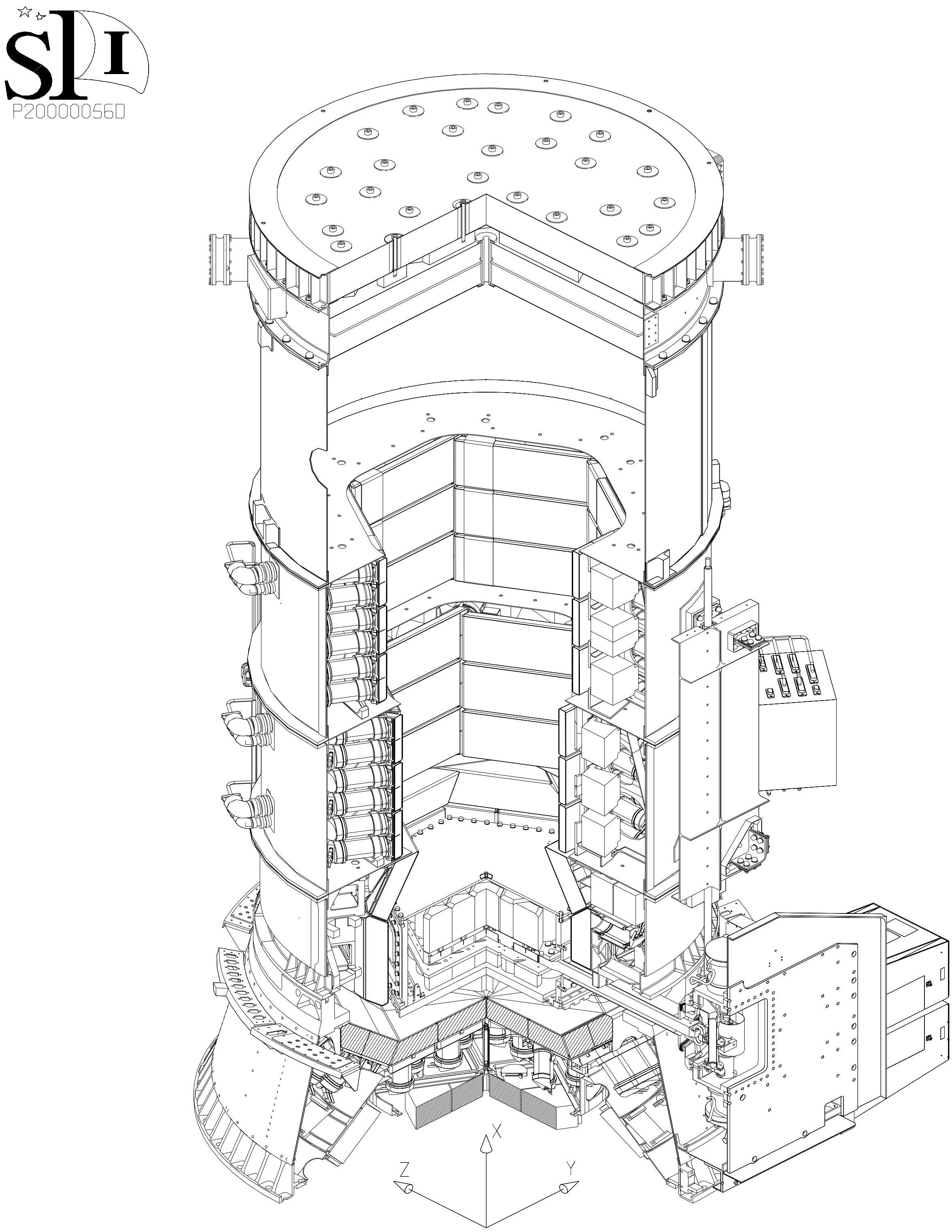


Figure 1.10 - General Spectrometer Design (cont'd)

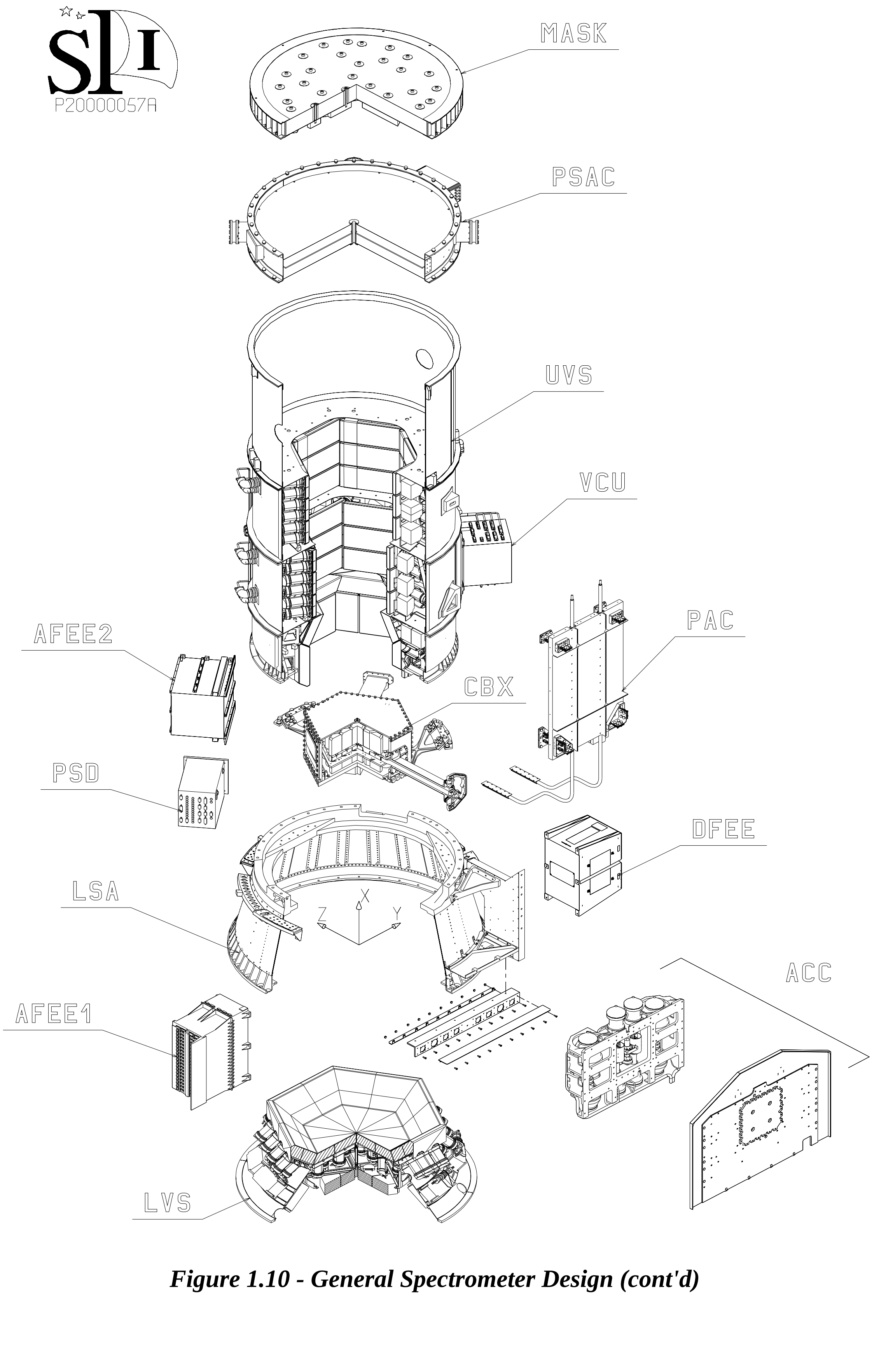


Figure 1.10 - General Spectrometer Design (cont'd)

1.3.3.1. Passive code mask

The mask is located on the top of the SPI instrument, above the plastic scintillator.

The main parts are:

- a sandwich structure of 80 mm thickness made of a nomex honeycomb core covered by 2 CFRP skins,
- a titanium ring interfaced with the PSAC flange , in which the sandwich structure is potted,
- a coded motif made of tungsten blocks sticked and screwed on the -X face of the sandwich structure.

The weight of different components are about 7.6 kg for the sandwich structure, 10 kg for the titanium ring and 107 kg for the tungsten motif. The difference with the total mass budget of 139.4 kg is made by assembly components (inserts, screws, washers, potting).

The function of the tungsten code is to code the mask with a specific transparency and geometry.

The mask is made of 127 hexagonal elements which characteristics are as follow:

- the global coded motif has an hexagonal shape, it is inscribed in a 780mm diameter circle,
- 63 elements are opaque,
- 64 elements are transparent,
- each elementary opaque hexagonal element is 30 mm thick and its size is 60 mm side to side.

The tungsten blocks have to stop the gamma ray in the range 20 keV - 8 MeV with an effective absorption capability greater than 95 % at 1 MeV.

The holes of the mask will have a gamma ray transparency of:

- 60 % at 20 keV,
- 80 % at 50 keV.

The tungsten code reference is defined at the -X face of the tungsten code. It is located at 1710 mm from the detector array plate in the spectrometer field of view.

By juxtaposing "holes" allowing the gamma rays to pass through and solid elements forming screens, the different configurations may be projected, according to the targets observed, onto the detection plane.

The deconvolution of the image takes place on ground using an autocorrelation method between the image diagram and the coded mask, in order to establish location of the sources.

The completely coded field of view is 16°, resolution is 2°.

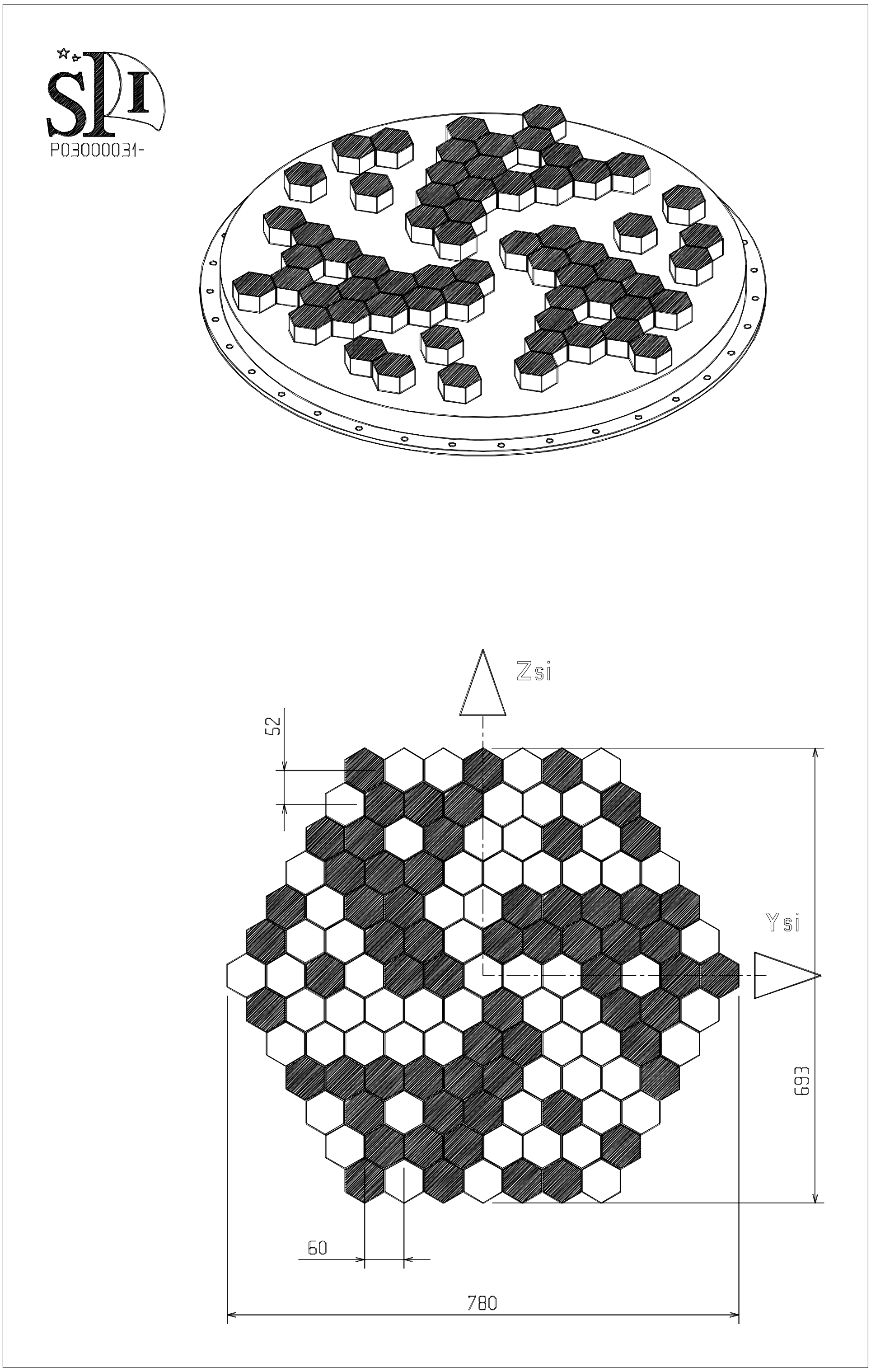


Figure 1.11 - Mask

1.3.3.2. Camera

1.3.3.2.1. Detection sub-assembly

The detection sub-assembly comprises the following:

- a detection-plane,
- amplification chains,
- a command/housekeeping acquisition interface,
- a PSD system.

1.3.3.2.1.1. The detection plane

The detection plane is made up 19 encapsulated hexagonal High-Purity Germanium detectors mounted on the cold plate 1 (CP1) at 85 K, as close as possible to each others. This cold plate 1 supports also 19 printed boards with proximity electronics (PA1). Preamplifiers (PA2) are mounted on the cold plate 2 (CP2) at 210 K.

Detectors

The main characteristics for the detectors are:

- Distance between axis of two elements: 6 cm
- Hexagonal section
- Minimum space between them
- Central hole </= 6 mm
- Thickness of material in front of the detector such to have a good transparency at 20 keV
- Applied voltage < 5000 volts
- Possibility to support > 10 annealing cycles

Note : See figure 1.15 for detectors numbering rule.

Cold Plate 1

The cold plate is made of beryllium. The bottom side is hollowed in order to mount inside each of the 19 holes a printed board PA1.

It is equipped with:

- 8 thermal sensors (PT 500 - 4 wires) in order to monitor temperature of the cold stage in the 75 K - 100 K range.

  These sensors are powered and monitored by the CMD/HK (N/R) modules of the AFEE.

- 4 thermal sensors (PT 500 - 4 wires) for monitoring temperature during annealing phase (90°C - 120°C)
- 2 thermal sensors (PT 500 - 2 wires) for monitoring cold plate temperature during transition phases (80 K to 100°C)
- 2 heaters, one on nominal and one on redundant, located on the periphery of the plate.

Cold Plate 2

Made in Beryllium, the 19 preamplifiers (PA2) are screwed on it. In front of each PA2 one hole permits the connection with the PA1 with a cryogenic cable.

Preamplifiers

The PA1 includes:

- High Voltage Filter
- Connection between detector and CSA (Charge Sensitive Amplifier)

The PA2 includes:

- A-250 Amplifier
- Current source generator
- Fast Inverting Amplifier
- Temperature Sensor

1.3.3.2.1.2. The amplification chain

The energy signals from the PA are sent to an amplification chain made up of a Pulse Shape Amplifier (PSA) and a Pulse Height Analyser (PHA).

Pulse Shape Amplifier (PSA)

PSA shapes the signals to optimise the spectrometer performances by making a compromise between:

- achieving the best possible signal/ratio noise,
- permitting operation in the 20 keV - 8 MeV energy range without degrading resolution and adapted to the Analogue/Digital conversion,
- making the output pulse amplitude insensitive to rise time fluctuations in the detector signal,
- power allocation.

Pulse Height Analyser (PHA)

PHA keeps the energy resolution in 20 keV - 2 MeV or 2 MeV - 8MeV range.

High Voltage Power Supply (HVPS)

The High Voltage Power Supply provides voltage for one detector in the 0 - 5000 volts range. The HVPS consists of an input limiter, a free running oscillator, a transformer, a six-stage Cockroft-Walton type voltage multiplier, a voltage divider network, an error amplifier, an output filter, a differential input amplifier and a monitoring Amplifier.

The output of the voltage multiplier is connected to an internal load in a form of a network of resistors that provides a small feedback voltage to the error amplifier. This one compares the feedback voltage with the command voltage received through a differential amplifier in order to regulate the amplitude of the oscillator.

The voltage multiplier output is filtered with a time constant of 14 seconds yielding a high voltage of up to 5 kVdc with a ripple of about 1 mV peak to peak.

The main characteristics are:

Input voltage	25 V ± 4 V
Current	7 mA max. at 5 kV
Command voltage	0, + 2,55 V
Output voltage	0, + 5,11 V
Output ripple	1 mV peak to peak
Time constant for rise time	14 sec
Time constant for decay time	56 sec

The analogue command voltage is provided by the CMD/HK module and the high-voltage control is sent to the same module for monitoring.

Low Voltage Power Supply (LVPS)

In order to have 19 independent amplification chains and two identical interfaces modules (nominal and redundant) with the DPE, power to these units is provided by:

- 19 Low Voltage Power Supply LVPS - Ge (each one is associated to a amplification chain)

Each LVPS - Ge, switched ON/OFF with a signal generated by the CMD/HK module, provides the following outputs:

Voltage	Nominal Current (mA)
+ 6,6 V	32
- 6,6 V	12
+ 10 V	41
- 10 V	46
+ 5 V Logic	68
+ 24 V	7

The total power needed at secondary outputs is 1,645 W.

The main characteristics are:

- Primary Power: 28 v ± 2 V
- Insulation between primary and secondary voltages
- ON/OFF command isolated
- In rush current: max. 1,5 In during 1,5 msec
- Noise on secondary outputs < 5 mVc.c. with a bandwidth of 20 MHz

This LVPS is made with DC/DC converters operating at a frequency around 370 kHz.

These DC/DC converters are powered from the nominal and redundant primary powers through diodes and a filter.

The filter provides:

- A soft start with possibility of switch ON/OFF
- Under-voltage lockout
- Attenuation for the current noise of the converters (50 dB from 200 MHz to 50 MHz and 30 dB at 100 MHz).

Secondary outputs are filtered with L-C filter to the mechanical structure and with capacitor between output and return.

- 2 Low Voltage Power supply LVPS - CMD (each one associated to a CMD/HK module).

  Each LVPS provides the following outputs:

Voltage	Nominal Current (mA)
+ 12 V	52
- 12 V	72
+ 5 V logic	127

  Total power needed at secondary outputs: 2,3 watts.

  These LVPS are identical to those dedicated to the spectrometry chains except that they are automatically turns on when voltage is applied by the spacecraft PDU.

1.3.3.2.1.3. PSD

By comparing the form of impulsions produced by the preamplifiers of the detectors with the profiles archived in a library, the PSD system stipulates the type of signal captured, either simple or multiple, and consequently the form of processing necessary according to the scientific application required. PSD process only non vetoed events.

This data is supplied to the DPE. Its working energy range is 200keV - 2MeV.

There is no redundancy for PSD.

In view of pulse shape discrimination library modification checking, every 4s for each detector digitised samples of pulses are sent to the DPE in order to build updated library.

Twice a year (TBC) a new library is up-linked from ground to PSD memory.

1.3.3.2.2. Cryostat

The cryostat has to support and to bring to 85 K the detection plane (cold plate supporting 19 detectors).

This cryostat is composed by 3 sub-systems named: active cooling, passive cooling and cold box.

See figures 1.12 and 1.17.

- **Active cooling**

  The cold plate is brought to 85 K by two couples of cryocoolers (4 compressors and 4 displacers) which are fixed on a radiator outside the shielding and are controlled by two independent electronics (CDE).

  In operation mode, the two couples of cryocoolers operate simultaneously in nominal case. In case of failure of one couple or of one CDE, the spectrometer is functional in a degraded mode (detection plane can reach the temperature of 110K Max).

To limit the temperature variations of the detectors during eclipses, the machine needs to be powered. During launch, the compressors need power to block a dedicated system in order to withstand the mechanical environments.

Measurement of the temperature is made by dedicated sensors, digitised by the AFEE TM/TC electronics and sent to the DPE via the Low Speed Link (LSL) and monitored on ground.

See figure 1.13.

- **Cold box**

The detection plane is placed in a thermally insulated chamber whose temperature is maintained at approximately 210 K by the passive cooling.

For ground tests facilities, this chamber is airtight and vacuum can be made by a pumping tube connected to pump outside the SPI.

To limit the background noise on the detectors, structures of the cold box are made of beryllium when possible.

See figure 1.14.

- **Passive cooling**

The passive cooling is composed by two ammonia heat pipes linked to a radiator which reject the heat of the cold box into space.

The temperature will be defined by the dimension of the radiator but an electronical thermostat will avoid the frost of ammonia.

See figure 1.16.

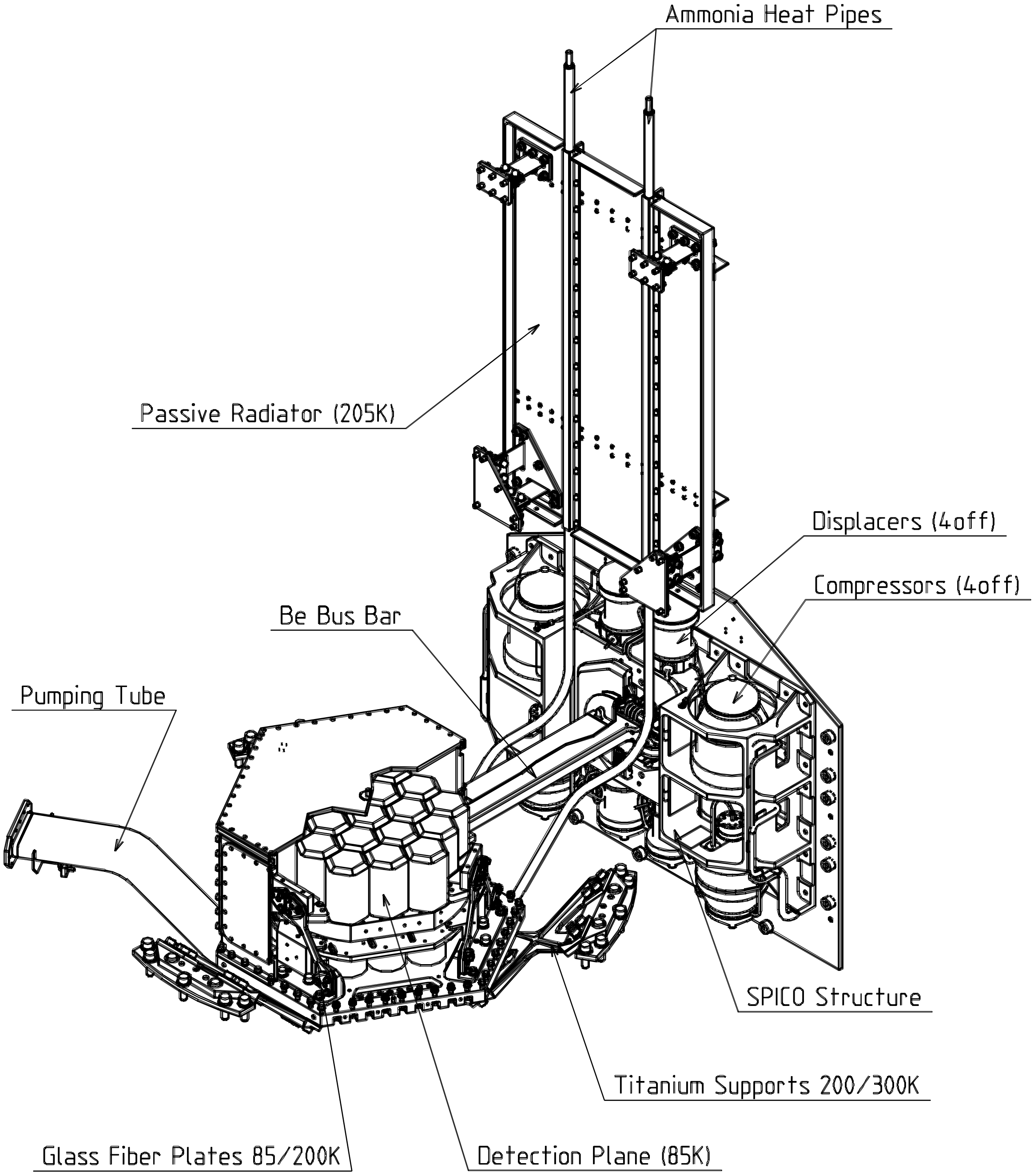


Figure 1.12 - Cryostat Overview

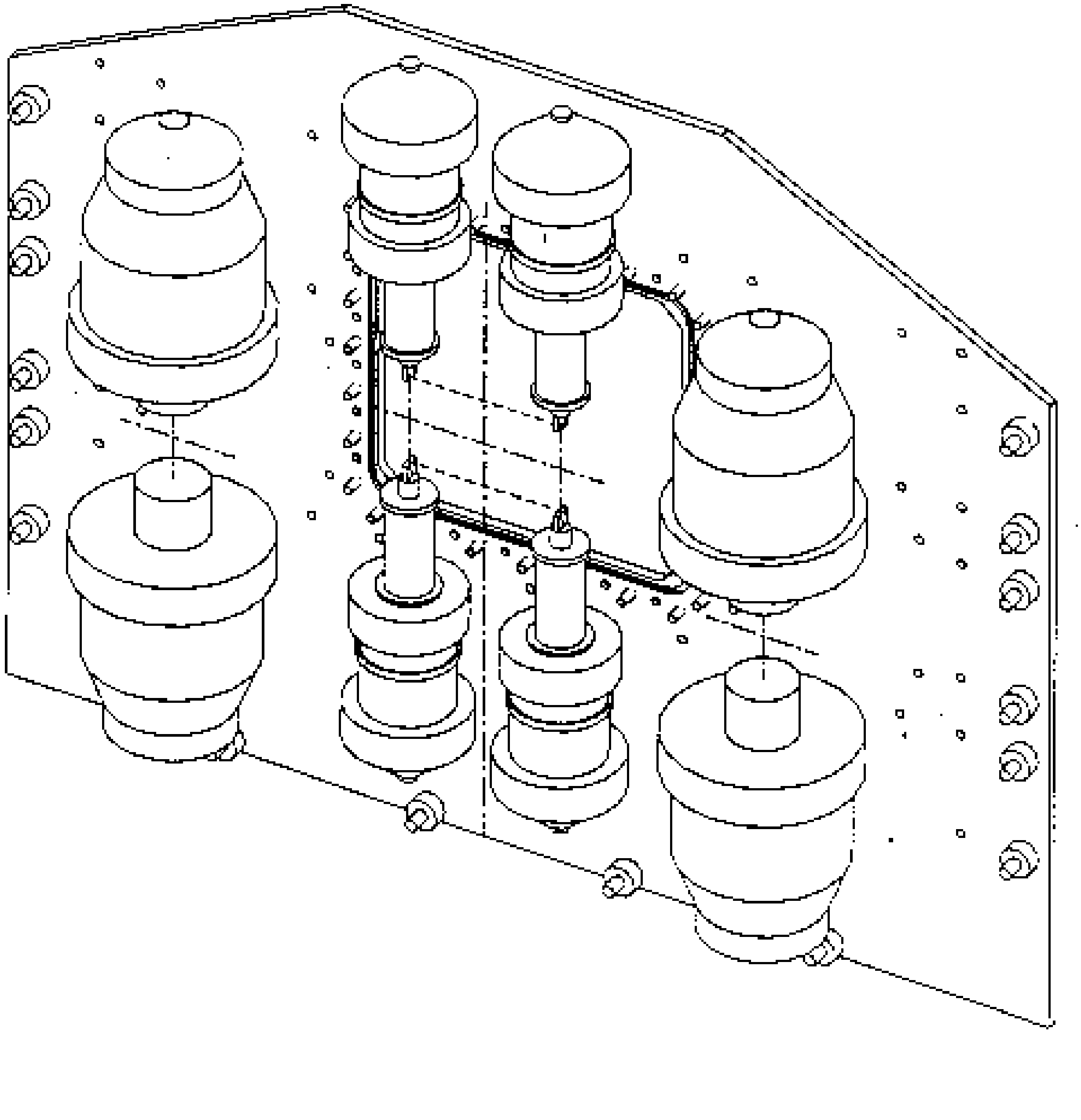


Figure 1.13 - Active Cooling Overview

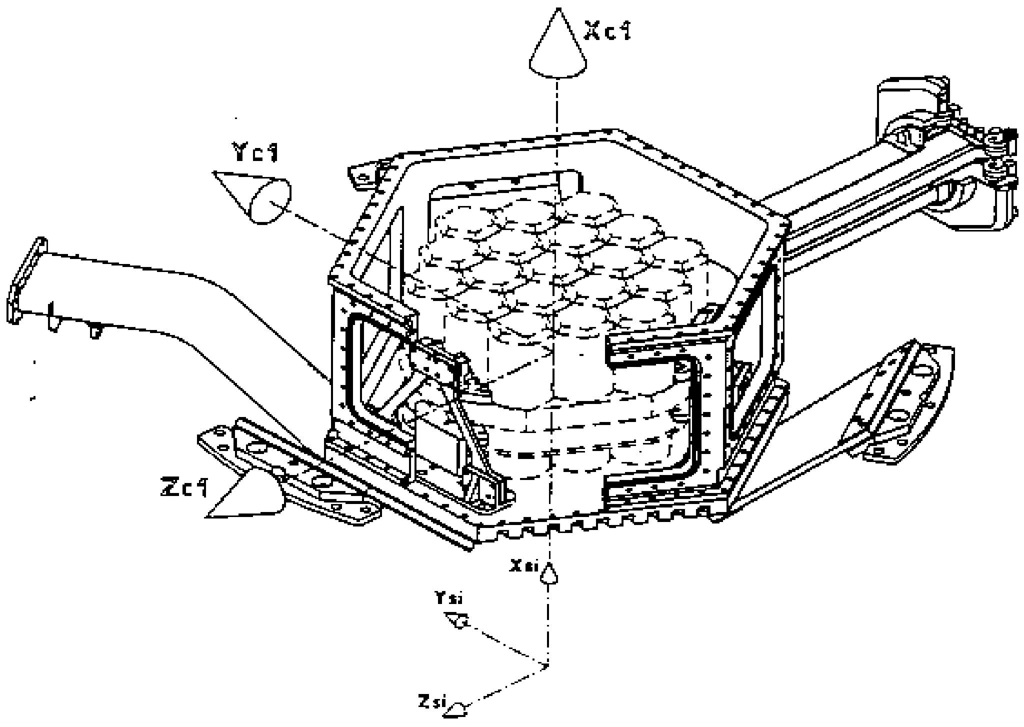


Figure 1.14 - Cold Box Overview

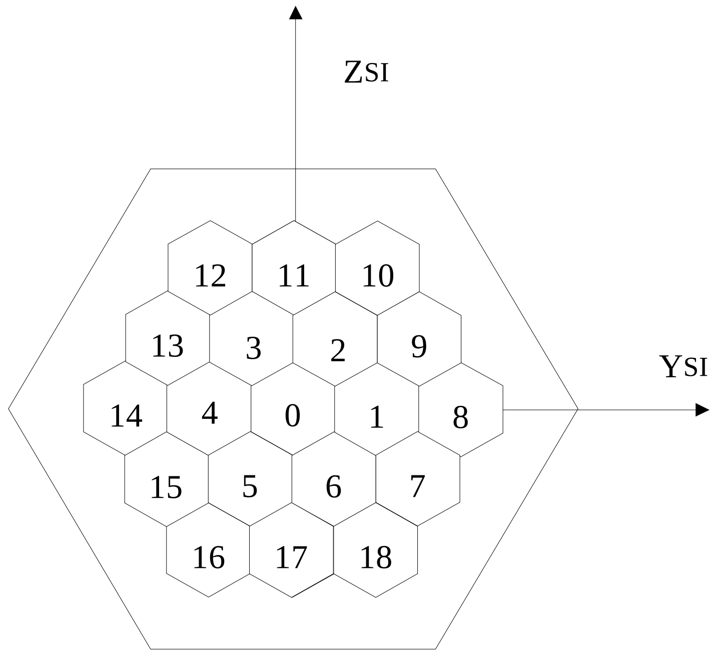


Figure 1.15 - Detectors Numbering

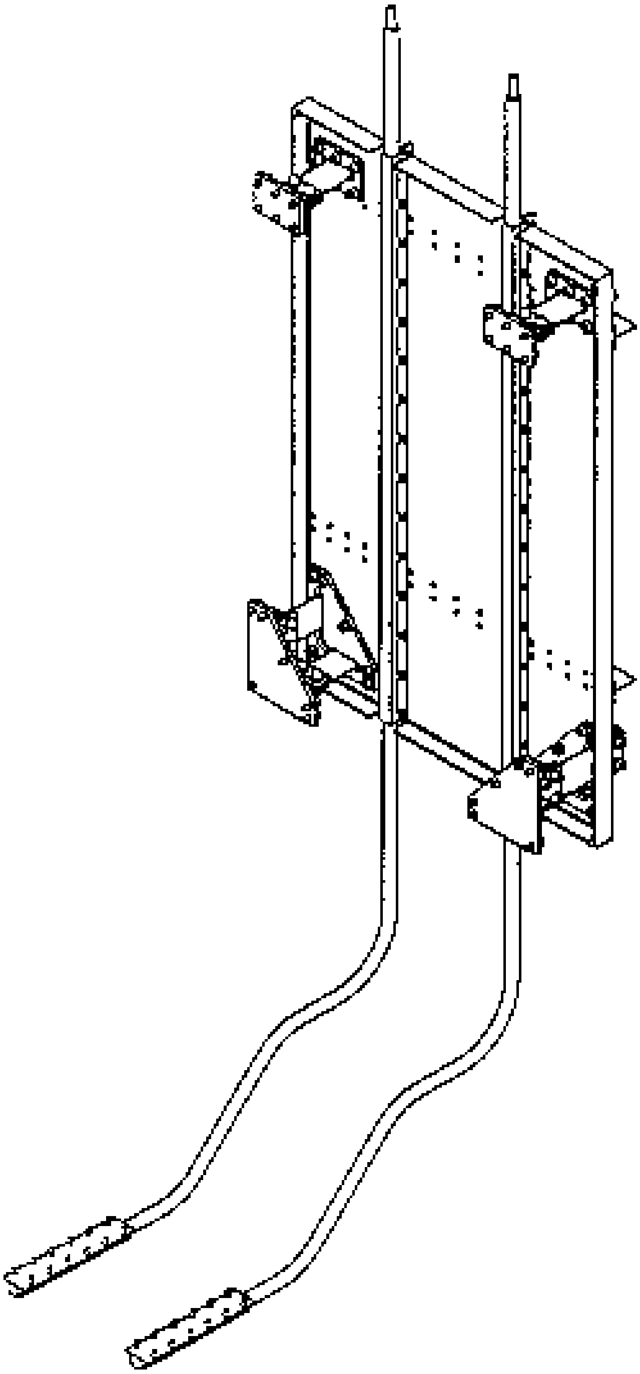


Figure 1.16 - Passive Cooling Overview

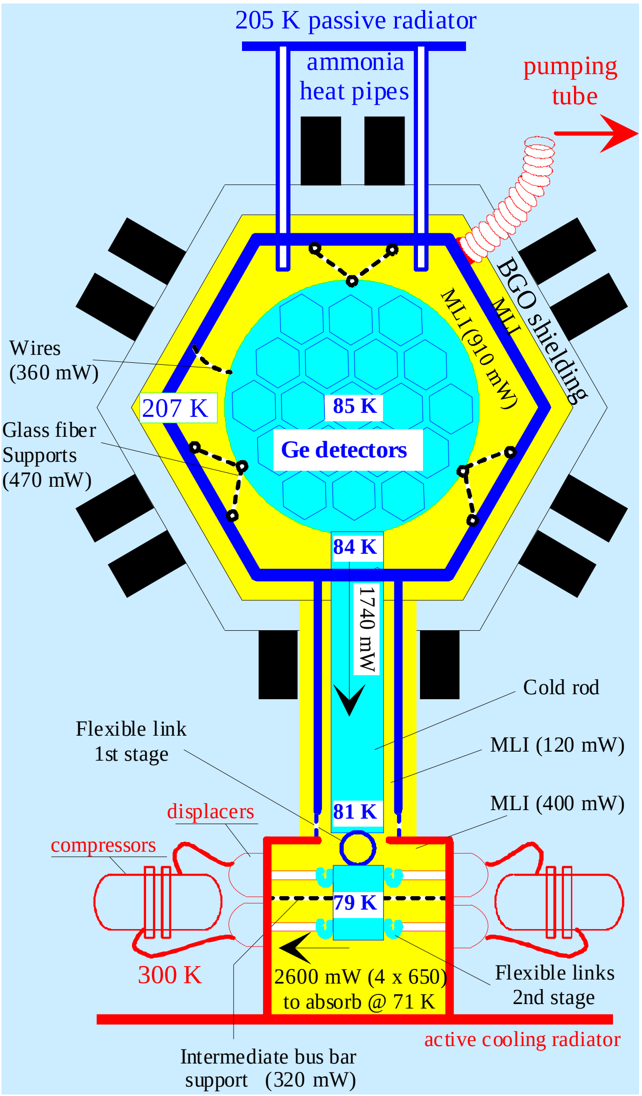


Figure 1.17 - Thermal Architecture Principle

1.3.3.3. Anticoincidence sub-assembly

The main function of the active Anticoincidence Sub-assembly (ACS) is to protect the Ge detector against the background (photons and charges particles) from sources located outside the field of view. BGO scintillator crystals have to convert all incoming events to photons in the 480 nm region.

Photomultiplier tubes convert the light flashes into electrical pulses, which are sorted, normalised and summed up by the ACS electronics. The fraction of a given period with a veto signal active describes the Deadtime of the Spectrometer detection system. This Deadtime has to be minimised to achieve reasonable measurement times of the Spectrometer.

All the digital output data produced by the ACS is directed toward the DFEE which formats the data and time tags the events. It identifies the photons as "good" if they are not in coincidence with a veto event, and rejects those in coincidence with a veto event.

The ACS consists of the following elements:

Main Structure	- Upper Veto Shield (UVS) - Lower Veto Shield (LVS)	- Mask Tube (MKA) - Upper Collimator Ring (UCR) - Lower Collimator Ring (LCR) - Side Shield Assembly (SSA)
Detector S/S (mechanical)	UVS Detector S/S - LVS Detector S/S	- UCR Detector S/S - LCR Detector S/S - SSA Detector S/S
Electrical S/S	- Photomultipler Tube (PMT) - Voltage Divider - Front End Electronic (FEE) - Veto Shield Control Unit (VCU)	 - Analogue/Digital Electronics - High-Low Voltage Supply (HV/LV) - Veto Control electronics - Power Supply Module (PSM)
Thermal S/S	- Thermal monitoring (TM) - Thermal Control (TC)	- Thermistors - Heaters - Thermostats

The active anticoincidence system is made up of scintillator crystal (BGO), photomutipliers tubes (182 PMT) and associated electronics (91 FEE) and a redundant Veto Shield Control Unit (VCU). All the electronics which are necessary to operate together with the PMTs and the VCU are contained in the FEEs.

The main functions of each FEE is to generate a veto signal having a fixed time relation to the PMT output signal. The FEE has to trigger on the first single photonelectron pulse which appear at the anode of the PMT. Furthermore, the veto signal will be generated only for energies above a certain energy threshold. The event-trigger and energy-discriminator threshold are adjustable by telecommand.

The FEE is divided in two compartments, the power compartment and the signal compartment. The power compartment provides all low voltages for the FEE electronics and the high voltages for the supply of two related PMTs. The signal compartment contains the analogue and digital electronics which is necessary for the requested signal processing.

The Veto Shield Control Unit (VCU) is responsible for the correct functioning and health of the ACS. It performs the overall monitoring and control. It controls and switches the operational modes and acquires relevant housekeeping data within the ACS. Telemetry and telecommand functions are performed via a serial link to the DPE. Its main task is the electrical processing of all VETO input signals from each FEE providing a resulting VETO signal with well defined delay and distortion characteristics to the DFEE. Furthermore it has to provide the power to the ACS which is derived from the DC primary power bus of the PDU.

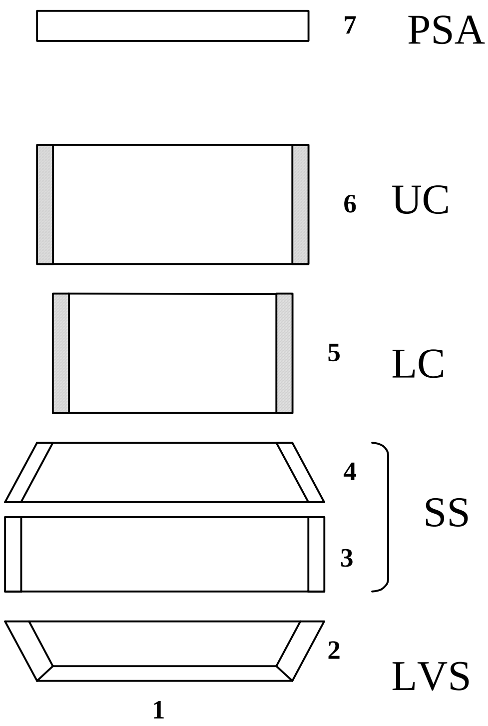


Figure 1.17a: ACS part identification

- For FEE associated to each part, refer to annex 14 in vol 3

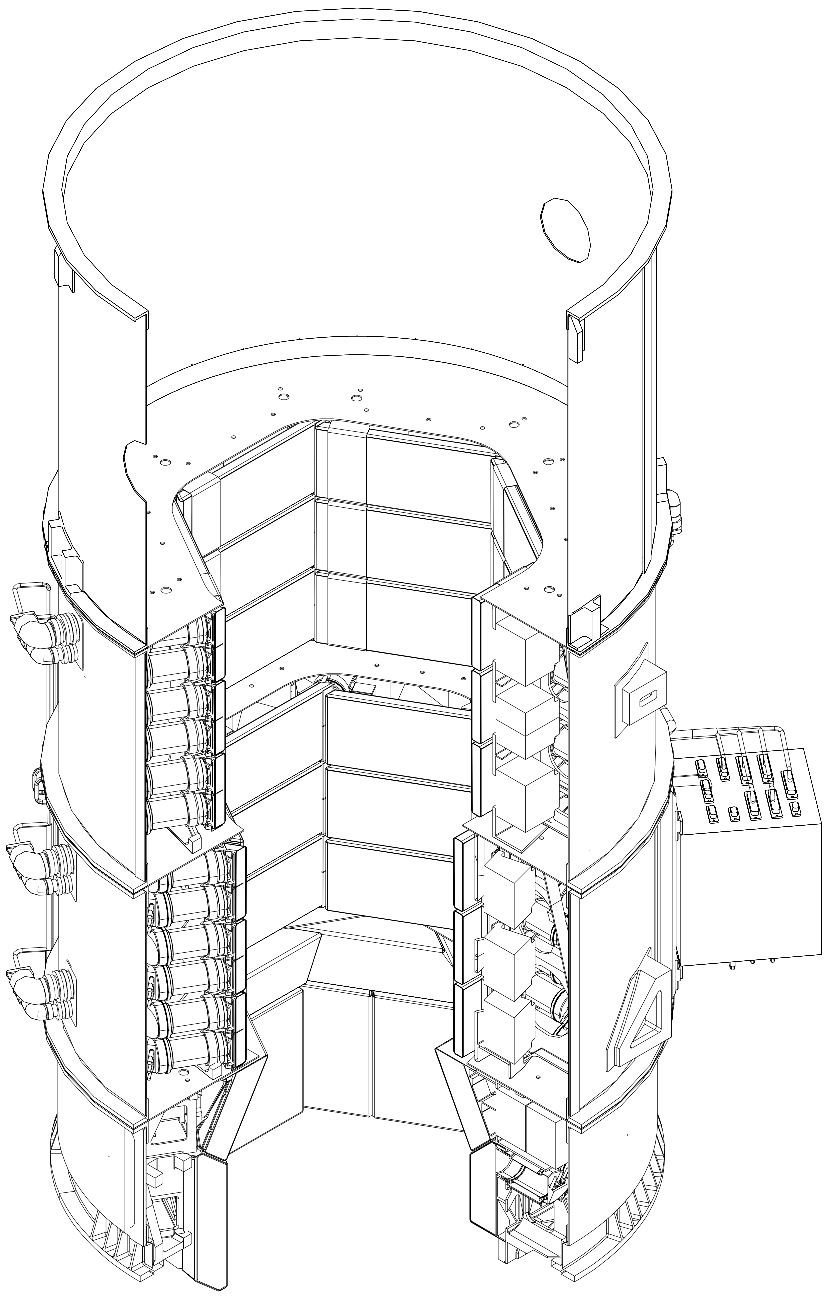


Figure 1.18 - UVS Overview

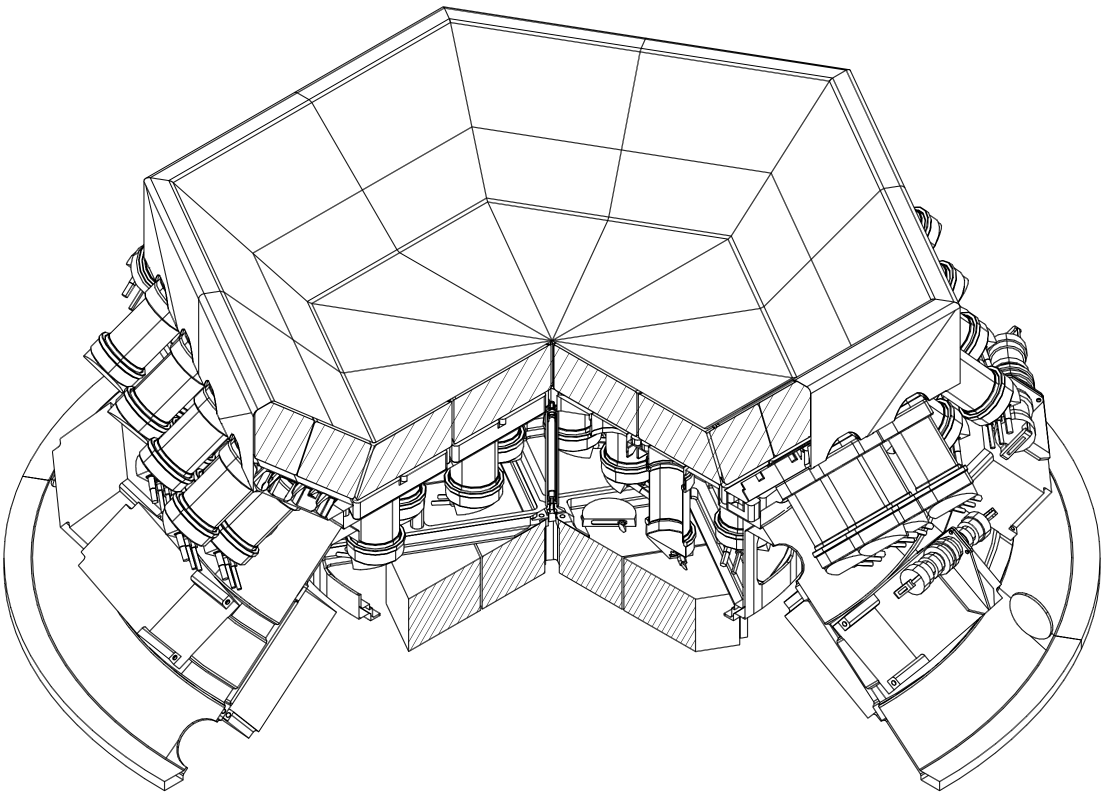


Figure 1.19 - LVS Overview

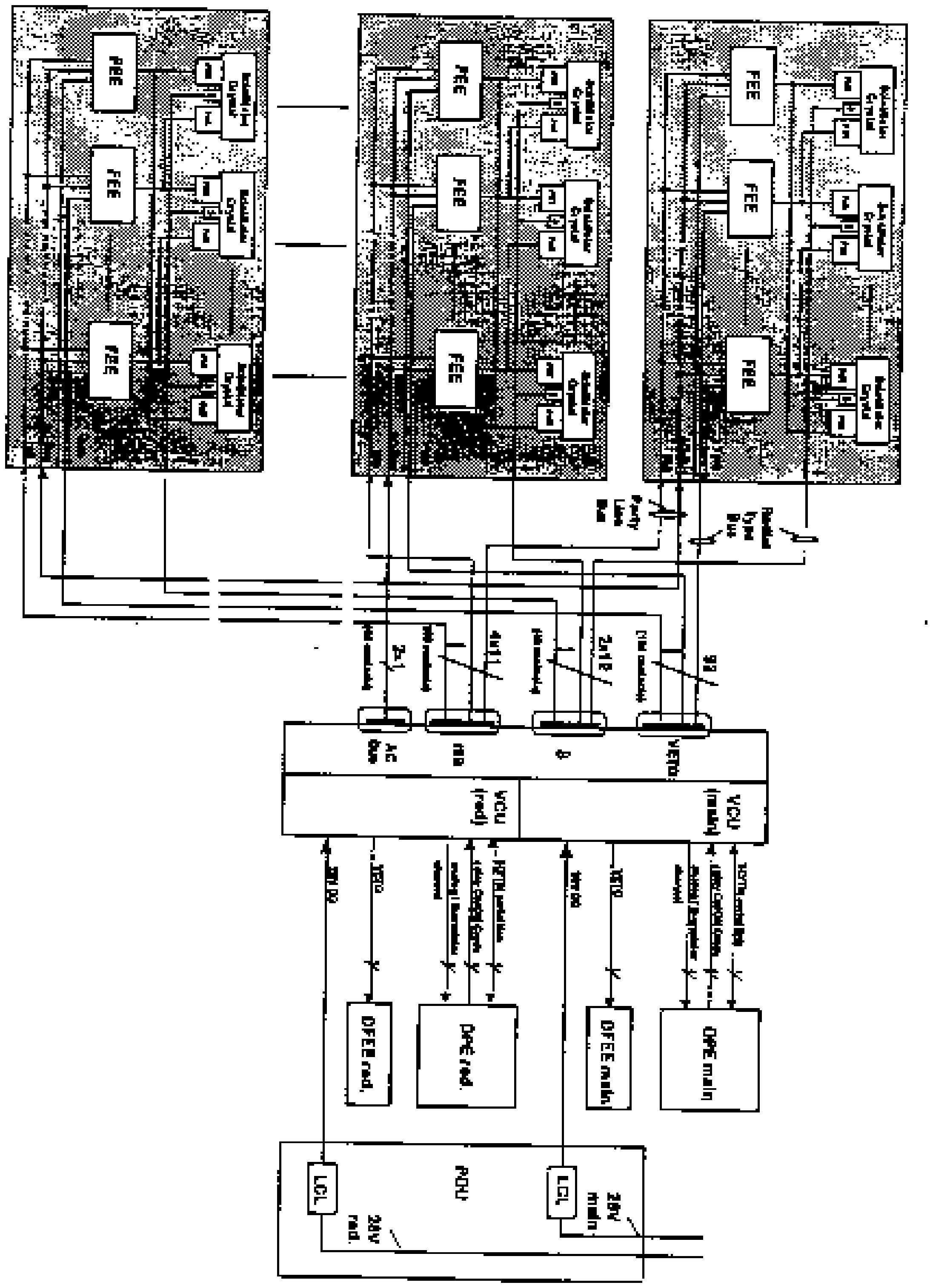


Figure 1.20 - ACS Electrical Overall Configuration

1.3.3.4. Plastic scintillator anticoincidence sub-assembly (PSAC)

The main purpose of the PSAC is to reduce the 511 keV background due to the mask emission. The detector is made of a plastic scintillator in a lighttight box located just below the mask. It has a good transparency for the gamma rays. It actively detects particles which deposit energies higher than 300 keV (TBC).

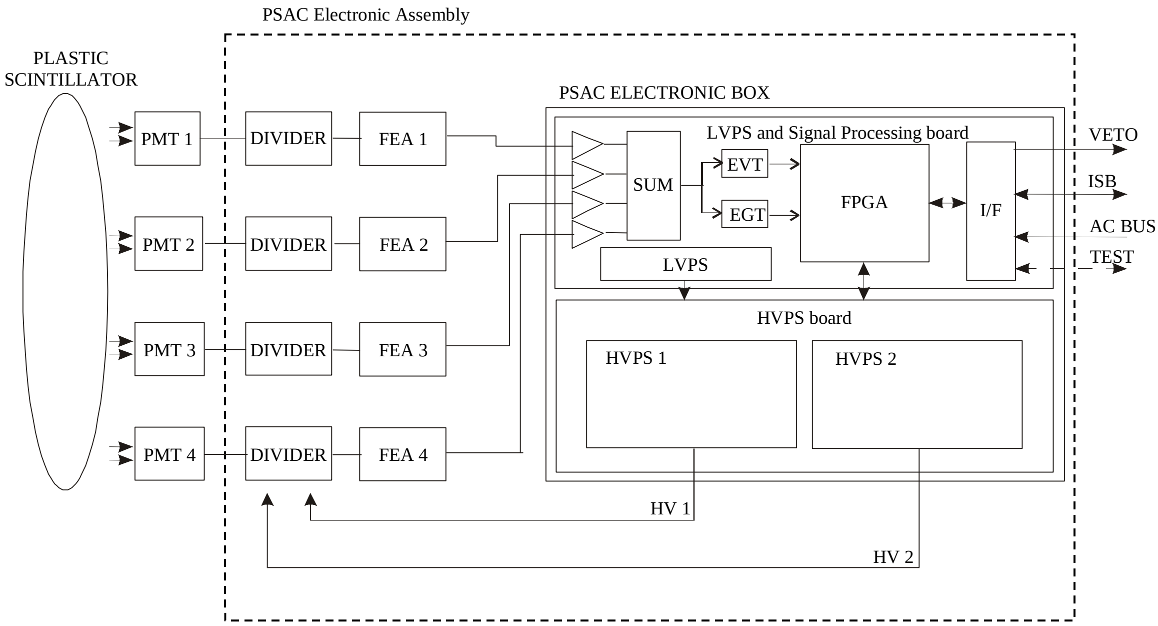
Photomultipliers tubes convert the light flashes into electrical pulses which are processed through the PSAC electronic assembly (PEA). The PEA sends a synchronous veto signal associated to the detected events and compatible to the ACS FEE veto signal to the VCU of the ACS.

The PSAC has a central hole to allow the alignment of the mask with the cryostat.

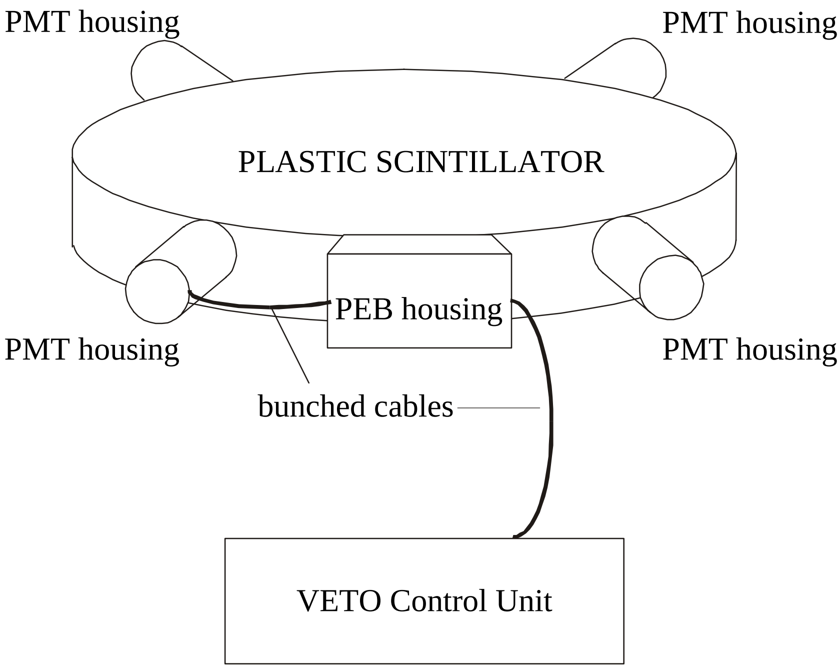
The PSAC elements are the following:

- The PSAC mechanical assembly (PMA) which consists of the plastic scintillator, the scintillator housing and the carbon fiber windows. 4 photomultiplier tubes (PMTs) and their electronic are located on the scintillator housing in dedicated boxes with their electronics: the divider electronics (Div) and the Front End Amplifiers (FEA)
- The PSAC electronic assembly (PEA) which main task is to supply and control the 4 PMTs, to produce the veto pulse for coincident data retention, to test the veto system and produce the veto HK data packet, to interface the PSAC system with the SPI.

The functional block diagram of the PEA is shown below:



The physical arrangement of the PSAC components is outlined in the following drawing



1.3.3.5. DFEE

1.3.3.5.1. Description

The Digital Front End Electronics sub-system (DFEE) is in charge of the real time acquisition, assembly, time stamping and intermediate storage of the various pieces of information carried by the signals coming from the SPI front-end sub-systems. Events are classified and formatted into several digital record blocks which are delivered at regular intervals to the DPE.

- **Input**

  The DFEE handles the following information:

  - Time of occurrence, energy measurement, channel occupancy and saturation conditions of Ge events, as produced by the corresponding independent Analogue Front End Electronics units (AFEE);
  - Time of occurrence and time uncertainty of BGO shield events, as produced by the Anti Coincidence Sub-assembly (ACS);
  - Time of occurrence and identification of a qualified subset of Ge events, as produced by the Pulse Shape Discriminator unit (PSD).

- **Output**

  The DFEE produces the following classes of information:

  - The list of *single non vetoed AFEE events*, including their time of occurrence and associated energy;

  - The list of *non vetoed AFEE-PSD events*, for which the PSD unit provided additional information to DPE;

  - The list of *multiple non vetoed Ge events*, for which several Ge detectors where observed active within a predefined signal analysis time window;

  - The list of *overall event energies*, separately arranged for each Ge detector, and intended to populate individual energy spectra within the DPE;

  - A block of *system monitoring statistics*, giving signal counts, dead time measurements and other system activity values.

- **Timing**

  Global timing reference is provided by the satellite base clocks (8 Hz signals).

  Fine timing information is provided by a local, high speed clock, which is also used to synchronise the input signals and schedule the overall internal operation of the DFEE. The current baseline for synchronous system operation frequency is 20 MHz.

- **Time frame sequence**

  The DFEE uses the 8 Hz reference signal to define successive 125 ms interval *time frames*. The overall operation runs in a 2-stage pipeline scheduled at time frame boundaries:

  - During stage 1, the real time input information is analysed and processed;

  - During stage 2, the corresponding results are passed to the DPE on a fast dedicated data output link.

Statistics are passed at 1 s intervals on the general purpose DPE communication link, which is also used to prepare, initialise and supervise the DFEE.

1.3.3.5.2. Implementation

The DFEE is implemented as a synchronous digital unit which runs under control of a programmable micro-controller unit.

- *Synchronous digital unit*

  The *real time unit* takes care of input signal detection, association and classification. The AFEE energy and PSD event identifier are collected, and the various classes of events are formatted and stored for the duration of the time frame.

  The *intermediate storage unit* receives the various classes of single and multiple event aggregate objects corresponding to a time frame interval.

  The *counting unit* maintains signal activity counts and measures the various dead time values.

  The *dialogue unit* takes data from intermediate storage and passes them to the DPE according to the high speed link protocol.

  - **ASIC**

    The synchronous digital circuit logic is implemented in an Application Specific Integrated Circuit (ASIC). The MG-RT family of sea of gates CMOS gate arrays from MHS-Temic has been selected as the preferred technology.

  - **Storage**

    The intermediate storage is implemented as separate First In First Out memories. The corresponding circuits are dimensioned to cope with the expected maximum rate for each event class.

- *Supervision unit*

  System supervision is handled by an independent controller unit, which receives commands from the DPE low speed link. The controller unit initialises and controls the DFEE hardware circuitry, and returns housekeeping information at regular intervals.

  - **Micro-controller**

    The micro-controller sub-system serves as the interface between the DPE low speed link and the ASIC circuit. The interface with the DPE is provided by a compatible USART, and the ASIC control function is directly provided by the micro-controller port signals, in accordance with the ASIC serial configuration and readout protocol.

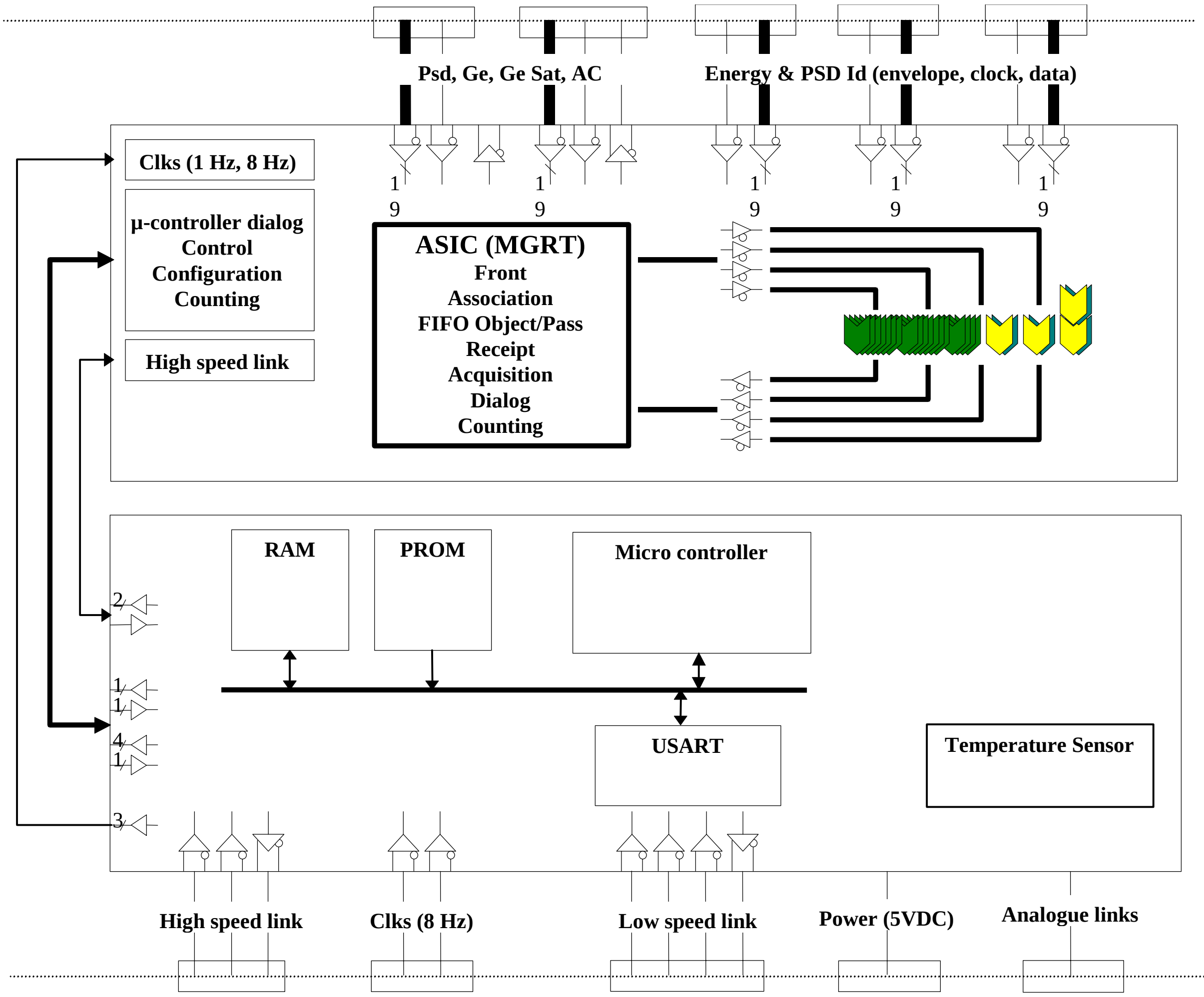


Figure 1.21 - DFEE Overview

1.3.3.6. DPE

The Data Processing Electronics (DPE) represents an interface unit dedicated to the instrument. It forms part of the OBDH equipment. The DPE provides the TC and TM interfaces with the instrument. Furthermore, it provides the environment for instrument dedicated software called Instrument Application Software (IASW).

The DPE is not internally redundant; therefore, two DPE units are assigned to the instrument. The DPE includes the following functional modules:

- *DC/DC Converter Board*
  - for internal DPE power supply

- *Processor Board*
  - based upon the MIL-Std61750A microprocessor command set with 1 Mword RAM protected by SECDED (Single Error Correction and Double bit Error Detection), the DPE allows for Memory keep-alive when other DPE functions are powered Off.
  - internal CPU functions of Built-In-Self-Test and watchdog.
- *ROM board*
  - with ROM for Common Services S/W,
  - with ROM of 48 kword for Instrument Application S/W.
- *DBI/RBI board*
  - includes the bi-directional standard interfaces (Litton/NRZ-L) to the OBDH Interrogation Bus (IB) and Response Bus (RB), and the Data Bus Interface (DBI),
  - implements the protocol layer by the Remote Bus Interface (RBI).
- *Monitoring Board*
  - provides Analogue Channels which are configured as Analogue TM channels. Additionally, thermistor channel and PT-500 Resistance Thermometer channels are provided.
- *mRTU Core and CMD Board*
  - provides Relay Status Channels and On/Off Command Lines.
- *RS-422 Interface Board*
  - provides bi-directional serial data lines with the instrument units. These data lines are according to the balanced transmission line standard RS-422-A (point-to-point, differential voltage, twisted pair). The serial links are operated one-at-a-time i.e. they are sequentially multiplexed onto the DPE internal data bus. The max. transmission rate is 64 kbit/sec. Additional data lines are one-directional high-speed links which are sequentially multiplexed inside the DPE and support transmission rates up to 5 Mbit/sec.

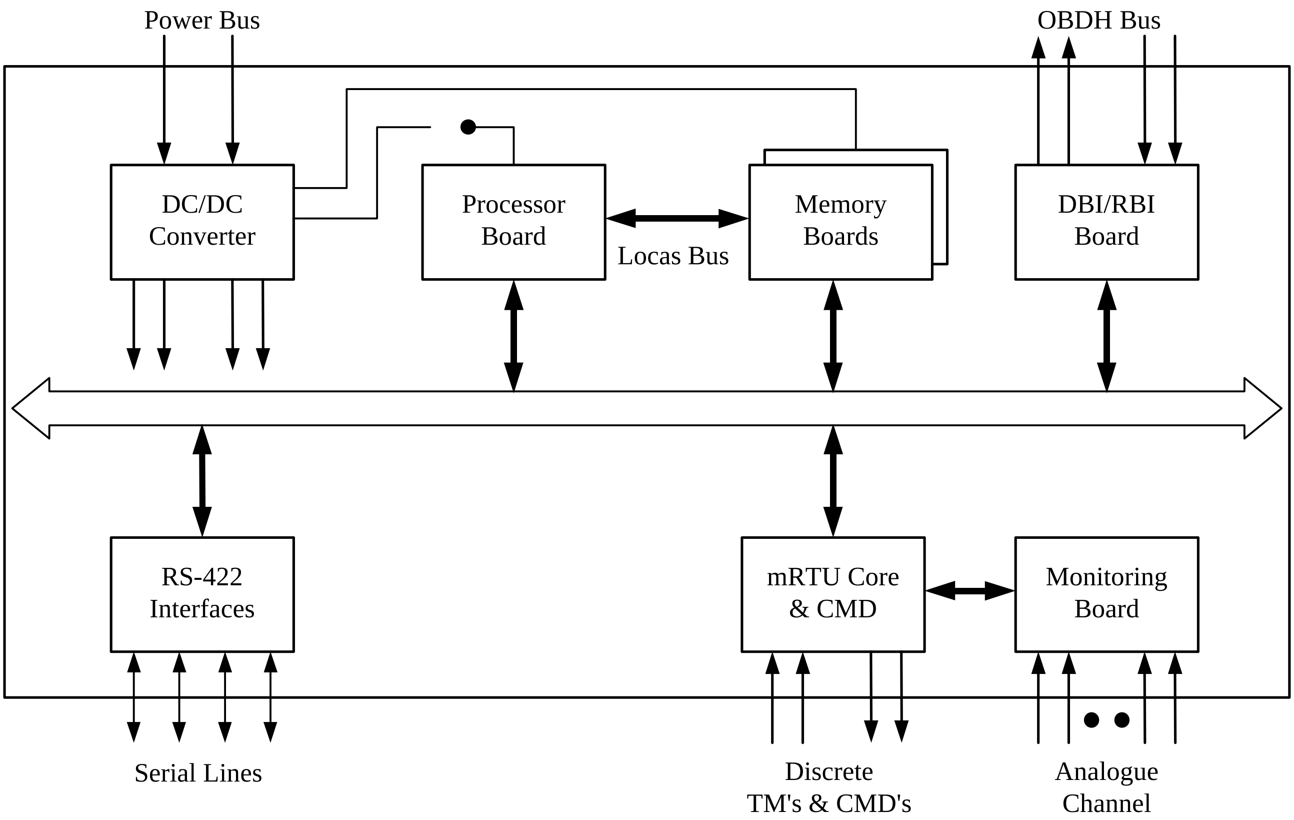


Figure 1.22 - DPE Functional and Hardware Architecture

1.3.4. Software description

Unit	Software	Software functions	Microprocessor foreseen	Issues / Comments	RAM/ROM
AFEE	YES: C language	Communication with DPE	µ-Controller 80C32	No orbit maintenance	32 Kbytes/8 Kbytes
DFEE	YES: C language	Communication with DPE Event signal processing	Microcontroller used to manage I/0. 80C52	Orbit maintenance	40 Kbytes/16 Kbytes
PSD	YES	Load calibration matrices. Manage I/0. Event signal processing	ATT DSP 32C	Rad Hard status TBD. Orbit maintenance	Internal RAM: 5x2 Kbytes External RAM: 512 Kbytes EEPROM: 512 Kbytes ROM: 32 Kbytes
VCU (ACS)	C language	ACS + I/0 Management Event signal processing	80C32	Orbit maintenance	32 Kbytes/16 Kbytes

Table 1.1 - Software, Software Functions & Microprocessor in SPI Electronic Units Other than DPE

1.3.4.1. Anticoincidence sub-assembly

The VCU software provides the following functions:

- Control and command
  - performs auto-test,
  - receives/interprets commands from the DPE and sends corresponding responses,
  - performs configuration of the VCU and FEE's,
  - performs software loading and memory dumping,
  - manages mode changes,
  - stores parameters.
- HK data acquisition/distribution
  - acquires HK data from the FEE's, the PSAC and the VCU,
  - formats and sends HK data to the DPE.
- Veto signal generation
  - enable/disable VETO output signal to the DFEE.

- Overall veto counter
  - provides the services read/clear/enable/disable for the overall veto counter.
- Gamma ray burst detection
  - acquires overall-counter value (overall anticoincidence rate) all 50 ms,
  - stores overall-counter values for a time interval of 8 seconds in history buffer including timing information,
  - provides synchronisation capability of ACS time with DPE on-board time.
- ACS energy calibration
  - acquires and stores energy calibration data (64 energy threshold steps for all 91 FEE's and 1 PEB).
- Error handling
  - watchdog surveillance.
- Software maintenance
  - able to reload SW-patches in code and data via a special reload SW module.

See also table 1.1.

1.3.4.2. DFEE

The DFEE software provides the following functions:

- Control and command
  - performs auto-test,
  - receives/interprets commands from the DPE,
  - performs configuration of I/F, ASIC and supervisor boards,
  - performs software loading and memory dumping,
  - manages mode changes,
  - stores parameters.
- HK data acquisition/distribution
  - acquires HK data,
  - formats and sends HK data to the DPE.

- Events processing
  - the reception and the time association of the signals coming from the AFEE, PSD and ACS,
  - the events generation at instrument level by gathering the signals from the AFEE and the PSD,
  - the ACS events anticoincidence processing,
  - the events classification in three groups:
    - Simple Events (SE),
    - Multiple Events (ME),
    - PSD Events (PE),
  - precise time measurement of each event,
  - BGO and GE events counting,
  - satured events counting,
  - dead time processing detector by detector,
  - data arrangement according to the events types and DPE transmission.
- Error handling
  - watchdog surveillance

See also table 1.1.

1.3.4.3. PSD

The PSD on-board software consists of two major packages:

The functional or engineering software provides all codes that handles PSD interfaces such as:

- Control and command
  - performs auto-test,
  - receives/interprets commands from the DPE and sends corresponding reponses,
  - performs analysis process configuration,
  - performs software loading and memory dumping,
  - manages modes changes,

- stores parameters.

• HK data acquisition/distribution

- acquires HK data,
- formats and sends HK data to the DPE.

• Error handling

- watchdog surveillance (TBC).

• Makes available the information needed for events discrimination

- identifies the detector signals to be analysed,
- accumulates detector pulse shapes and schedules them.

• Makes available the information to be sent to the DPE

- gathers scientific analysis results and puts them into telemetry,
- collects statistics on the PSD performances.

The scientific software provides all codes that:

• analyse a measured pulse shape in order to discriminate single-site interactions from multiple-site events,

• handle the uploadable library templates and the writing of the EEPROM's.

See also table 1.1.

1.3.4.4. AFEE

The AFEE software provides the following functions:

• Control and command

- performs auto-test,
- receives/interprets commands from the DPE and sends corresponding responses,
- performs configuration analogue chains and TM/TC I/F,
- manages mode changes,
- stores parameters.

- HK data acquisition/distribution
  - acquires HK data from AFEE's, cold plate,
  - formats and sends HK data to the DPE.
- Signal energy processing
  - encodes analog signal and sends it to the DFEE.
- Error handling
  - watchdog surveillance.

See also table 1.1.

1.3.4.5. DPE

The DPE on-board software is a payload management software. It is responsible for the following main functions:

- SPI scientific data management
- SPI monitoring
- SPI commanding

In order to execute these functions, a set of basic software services and standard software services are necessary.

The DPE software is structured into layers:

- Common Services Software (CSSW)
- Instrument Application Software (IASW)

The CSSW constitutes the software layer between the IASW and the DPE hardware.

1.3.4.5.1. CSSW services overview

- DPE initialisation including IASW initialisation
- DPE interrupt processing
- OBDH interface management
- Time synchronisation

- TC packets handling
- TM packets handling
- Instrument time management
- Communication with IASW management
- Expanded memory management
- Task handling and synchronisation
- I/O handling
- Patch/Dump management
- DPE hardware and software monitoring

1.3.4.5.2. IASW functions overview

The IASW is responsible for:

- SPI commanding
  - SPI initialisation,
  - SPI configuration management,
  - SPI operational sub-modes management,
  - SPI TC interpretation,
  - SPI TC distribution,
  - SPI TC execution.
- SPI scientific data management
  - Scientific data acquisition,
  - Spectra events processing: the main goal of this function is to process the amount of scientific data in order to make them fit with the telemetry data rate, while maximising the scientific return. It consists for example of spectra building, data correlation, data compressing,
  - Scientific data datation,
  - Scientific data formatting for TM transmission.

- SPI monitoring
  - SPI units analogue housekeeping parameters acquisition,
  - SPI units digital housekeeping parameters acquisition,
  - SPI data handling digital housekeeping parameters generation,
  - SPI on-board housekeeping parameters processing,
  - SPI housekeeping parameters datation,
  - SPI housekeeping parameters formatting for telemetry transmission.

1.4. INSTRUMENT OPERATIONS

1.4.1. Spectrometer modes

Each mode corresponds to a particular life phase of the instrument.
During the orbit life the OFF mode should not exist. It shall be shorter as possible.

1.4.1.1. Mode 0: Launch mode

This mode corresponds to the launch, orbit acquisition in this mode corresponds to the Spectrometer status during the boost phase of the launch. The compressors are is locked and the 2 CDE are powered by 2 LCLs. The S/A heaters are ON.

1.4.1.2. Mode 1: Inactive phase

This mode is activated in two cases:

- When the satellite is acquiring its operational attitude.

  As soon as possible, the satellite switches ON the RTU for monitoring measurement (RTU Telemetry), and the CDE main heater. Then the spectrometer will be put on outgassing mode through a stand-by mode.
- After a satellite bus undervoltage corresponding to the PLM: contingency mode (survival mode of the satellite) or in case of SPI anomaly.

The RTU telemetry is available in this mode for SPI monitoring.

1.4.1.3. Mode 2: Heat pipe thaw

After an inactive phase, or emergency phase, or following the orbit acquisition, depending on the heat-pipes temperatures, a heat pipe thawing operation may be commanded from the ground.

The RTU telemetry is available in this mode for SPI monitoring.

1.4.1.4. Mode 3: Cooling phase

The DPE is ON as well as the AFEE TM/TC and S/A in order to measure the detectors temperature with a sufficient accuracy. RTU, DPE channels and AFEE housekeeping data are used for SPI monitoring during this mode and all the following modes.

This is the detection array active cooling phase.

This operating mode is commanded from the ground as soon as possible after the outgassing mode and after annealing.

In any case, this mode is preceded by temperature monitoring of the heat pipes and by heat pipe thaw mode when necessary.

The ground control center will set the two cryocoolers in operational mode via the SVM RTU. (After that a stabilisation phase would be necessary in order to check the stability of detector temperature. It will be made in Configuration mode. The transition to Operational mode should be possible only after this stabilization).

1.4.1.5. Mode 4: Stand-by mode

The electrical on/off state of the instrument is set only in this mode (except for the heaters and for the ACS, PSAC and detectors high voltages). Indeed, before to set SPI in Cooling, Outgassing, Annealing, Operational, Calibration or Diagnostic mode, we have to define the instrument electrical state in Stand-by mode (see the sub-assembly modes, table 1.2 Volume 2).

The ACS, AFEE, DFEE and PSD perform their auto-tests at the beginning of this mode. The ACS and detectors high voltages are automatically switched OFF when entering this mode.

After Inactive mode (only heaters are powered on), the spectrometer will be set in Stand-by mode by switching on the required subassemblies. The DPE is switched on for the first time (a Stand-by telecommand is not required).

After the subassemblies switching on by the satellite payload module or ground TC, the IASW will receive the configuration of the Spectrometer on/off status (except after the Eclipse mode). By this way, it knows which subassemblies are powered on. The cryocoolers and the CDE states are not transmitted to the IASW.

The electrical on/off state can be changed again in this mode. That will be done by sending to the IASW a new ON/OFF status configuration, after switching on or before switching off some sub-systems, depending on the new required state (a new Stand-by telecommand is not required if SPI is already in Stand-by mode).

In the other modes, after reception of the Stand-by telecommand, the IASW will set the instrument in Stand-by mode, by sending to the powered sub-system Stand-by commands. A new configuration of the ON/OFF status is not necessary (except if the electrical status is changed after the Stand-by telecommand).

The IASW performs the analogue housekeeping acquisitions, manages the TM/TC, the configuration and data handling modes.

The transfer to this mode is commanded by ground, satellite time tag command or by the instrument on broadcast packet information, in accordance with the intermode transitions diagram.

In case of overradiation (radiation belts or high count rate background), IASW can put the instrument in Stand-by mode (or in Configuration mode, see § 1.4.1.6) according to the mode radiation configuration parameter. The overradiation status is defined by using the following broadcast packet data: either the OBT of radiations belts crossing start, or/and the radiation monitor count rates. Both are enabled by telecommand.

In this mode, the available maximum power is nominal. It should be possible to return to operational mode in less than 30 minutes.

This mode requires the minimum TM rate to monitor the instrument. Maximum TM rate is 3 kb/s.

1.4.1.6. Mode 5: Configuration mode

The configuration for the other scientific modes (operational, calibration, diagnostic) is sent in this mode. Therefore, we have to go in this mode to change the configuration. The high detectors voltages could be switched on only in this mode. The PMT high voltages could be switched on in this mode, but also in outgassing, cooling, annealing which are specific servicing configuration mode. All the sub-system parameters needed for the operational detector modes are set in this mode.

The configuration can be changed again. It's one of the reasons why the high voltage could be already on at the entrance.

This mode will be used also as a safe mode, in case of loss of satellite attitude control (ESAM), overradiation condition (except after telecommand to choose Stand-by mode in accordance with overradiation parameter). These cases are identified from the broadcast packet information. If this mode is set for radiation reason, the DPE will send to the ACS its configuration with ACS and PSAC photomultipliers high voltages OFF. The Ge detector high voltages will remain ON.

As in Stand-by mode, the TM rate is minimum. Maximum TM rate is 3 kb/s (HK only).

1.4.1.7. Mode 6: Operational mode

This is the active mode of the Spectrometer. It corresponds to the operational phase. The IASW send a START command to all the powered sub-system to start the observation.

There are two different sub-operational modes. SPI working is the same for these two sub-modes but the data process is different and leads to two different values of the TM rate.

- **Mode 6.1:** Nominal mode, is a photon / photon mode with high temporal resolution.
  - This mode is the more complete one. It gives per each photon the scientific data.
- **Mode 6.2:** TM Emergency (minimal scientific TM mode)
  - This mode is the minimum scientific TM mode. This mode induces a strong reduction of the scientific performances and shall be used only in case of SPI TM overflow. This mode is commanded by the ground.

1.4.1.8. Mode 7: Eclipse mode

This mode is dedicated to the Eclipse phase of the Satellite and the ground non-visibility following the penumbra if any. The Eclipse mode is shared out in 2 sub-modes: the Low Power Eclipse Mode and the Nominal Power Eclipse Mode corresponding to 2 different electrical status (see table 1.2 Volume 2) with therefore 2 different sets of design constraints.

The Low Power Eclipse sub-mode is defined to cross the penumbra. In order to minimize the power consumption during this phase, the cryocoolers power consumption is reduced, the other sub-assemblies and their nominal heaters are off. To avoid freezing the heat pipe, the antifreeze 1 and 2 are on. The nominal cryocoolers heaters and the redundant sub-assemblies heaters are enable.

Because of the decreasing of the cryocooler temperature, the duration of the phase with reduced power for the compressor shall be minimized and shall be less than 1.8 hour.

The Nominal Power Eclipse sub-mode is used after the penumbra, before the ground station acquisition. In order to avoid the risk of over-consumption in the penumbra induced by the using of Time Tag Commands to power autonomously the SPI units, the sub-assemblies will be powered on only by ground commands. Therefore they are still off in this sub-mode. Because we shall minimise the temperature decreasing of the cryocooler, the strokes of these machines shall be set again to the nominal values as soon as possible. The nominal heaters of the sub-assemblies shall be powered again to optimise the thermal balance of the spectrometer.

1.4.1.9. Mode 8: Annealing phase

In order to ensure their efficient performance, it is necessary to regenerate the detectors, by reheating, normally once a year. This period depends on the detectors temperature and the radiation level.

The reheating temperature will be set at telecommand at 103°C ± 3°C. The maximum temperature of detectors will be 106°C. The annealing temperature will be maintained for 24 hours typically at 103 ± 3°C.

This operation is telecommanded from the ground via the satellite.

The detector temperature shall be controlled by a spacecraft on-board monitoring.

After annealing, telecommands are sent from the ground to perform the transfer to the cooling mode by passing through Stand-by mode in accordance with the inter-mode transitions.

1.4.1.10. Mode 9: PSD calibration mode

This mode is dedicated to the PSD calibration mode.

From time to time, typically after an annealing mode, PSD library has to be changed. In order to redefine on ground the new libraries, board information from PSD are requested. This mode will last 3 days (TBC).

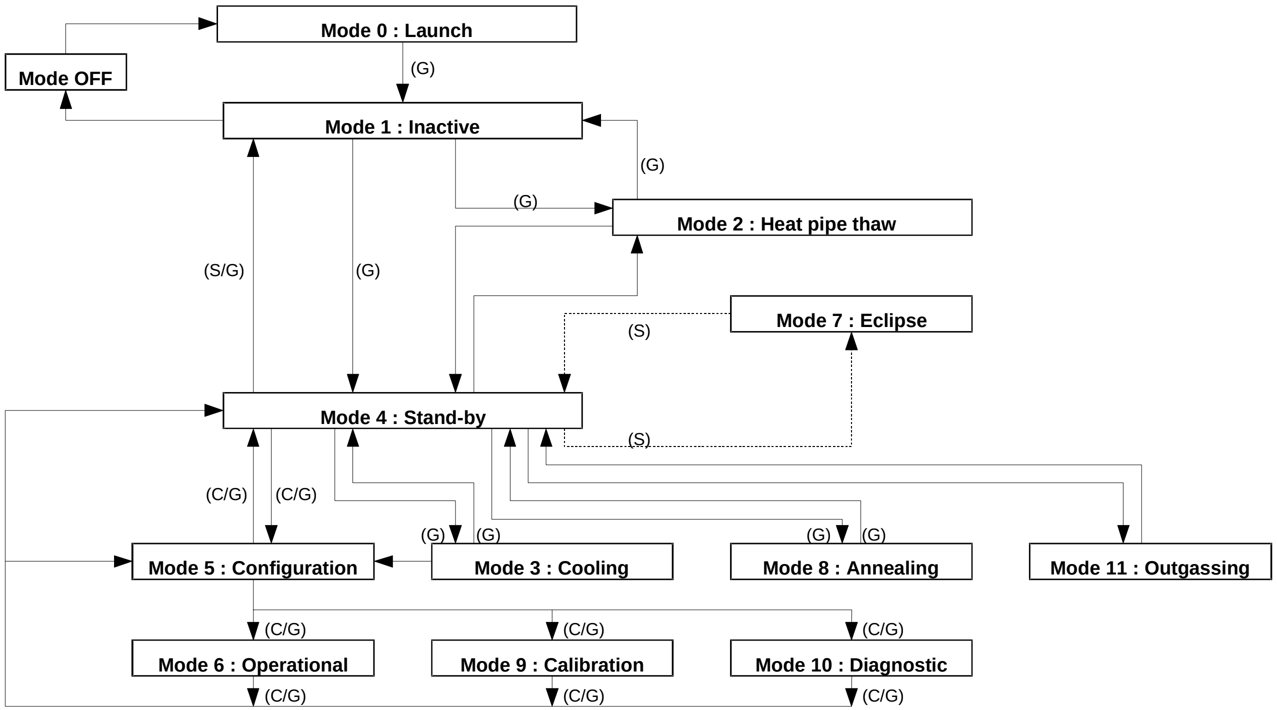
1.4.1.11. Mode 10: Diagnostic mode

This mode is dedicated to the diagnostic analysis after an anomaly. In this mode the electrical status of each sub-assembly are free taking into account the thermal condition.

1.4.1.12. Mode 11: Outgassing mode

After the acquisition of the operational attitude of the satellite, the spectrometer shall be put as soon as possible in outgassing mode during a week (TBC) in order to obtain a good MLI outgassing, in particular inside the cryostat. The detector temperature is set at 37°C ± 3°C.

INTER MODE TRANSITIONS



Anomalies :

ESAM : SPI stays in the current mode except for Diagnostic, Operational or Calibration mode, for which it will be put in Configuration mode.

DPE watchdog activation : In case of CSSW or IASW watchdog activation, information is sent to ground via TM and SPI waits for ground intervention.

Figure 1.23 – Inter-Mode Transitions

1.4.2. Sub-assemblies modes

The sub-assemblies can be operated in the following modes:

- Off mode
- Stand-by mode
- Configuration mode
- Operational mode
- Diagnostic mode
- Calibration mode (PSD only).

1.4.2.1 Off mode

In this mode, the subassemblies are powered off.

1.4.2.2. Stand-by mode

Entry conditions:

Subassemblies are in STAND BY mode in the following cases:

- After a power ON.

  In this case, the sub-assembly performs a self-test. Then S/A must be ready to respond to HK acquisitions and commands. As an example, a typical sequence can be:

  At the early 8 sec after Power-On, the IASW sends a <STBY> command to S/As, then the Status acquisition command will be sent.

  In case of a successful self-test, IASW requests for HK acquisition which occurs in a fixed cyclic way as long as the sub-assembly replies and will be the same during all the various modes (in Diagnostic mode HK cyclic acquisition sequence is not different, but others cyclic acquisitions can be done at a period comprised between 250 ms and 24 sec).

  Scientific HK acquisition is stopped in STAND BY mode.

- After reception of the STAND BY command (STBY), which can occur in the following cases:
  - before radiation belts crossing,
  - before eclipse,
  - in case of loss of attitude,
  - in case of STBY Telecommand from ground received by IASW,
  - After S/A switch ON.

  STAND BY command reception by ACS and/or AFEE TM/TC I/F leads to switch off high voltages.

  STAND BY mode exit is performed:

  Exit conditions:
  - Switch off,
  - Configuration mode command <CONF>.

  All other commands are not allowed. In STAND BY mode, the <STBY> command is not allowed.

1.4.2.3. Configuration mode

Entry conditions:

Sub-assemblies go to CONFIGURATION mode in the following cases:

- After reception of a configuration command <CONF>.

  When in configuration mode, the S/As accept configuration commands.

  A CONFIGURATION command contains the values of settable parameters of the sub-assembly. These values are stored in the DPE memory and are updated according to received ground telecommands.

  The IASW can check by reading the bit 7 of STATUS byte if S/A SW has initiated all the configuration commands it has received or if some are not yet achieved.

- In CONFIGURATION mode, S/As accept also commands to enter and exit SW maintenance sub-mode and dump commands.

  The mode transition to CONFIGURATION does not affect settable parameter values (High Voltages remain in their previous state as well as other settable parameters).

A new functional mode (with START, CAL, DIAG commands) can be started either with a new configuration re loading or without.

Exit conditions:

On reception of one of the following commands: <STBY>, <START>, <DIAG>, <CAL> (PSD only). All other commands are not allowed (e.g.: In CONFIGURATION mode, the <CONF> command is not allowed). When in configuration mode, if a TC configuration mode is sent then IASW put automatically SPI in stand-by 2 mode.

1.4.2.3.1. S/A S/W maintenance

While in Configuration mode it is possible to maintain the entire S/A S/Ws (Load, Dump and Init). The S/A S/W maintenance is a CONFIGURATION sub-mode.

Entry condition:

While in CONFIGURATION mode, this sub-mode is entered at reception of the command <SW MAINT>.

Exit conditions:

At reception of the command <RESTART SW>, when exiting this sub-mode, the S/A return to CONFIGURATION mode.

1.4.2.4. Operational mode

Entry conditions:

It starts with the <START> command issued from the DPE. In that mode IASW acquires science data from PSD and DFEE on HSL.

Exit conditions:

Reception of one of the following commands: <CONF>
<STBY>.

All other commands are not allowed (e.g.: In OPERATIONAL mode, the <START> command is not allowed).

1.4.2.5. Diagnostic mode

Entry condition:

This mode starts by a < DIAG > command sent by the IASW.

This mode is essentially dedicated for HK parameters checking. The number of acquired parameters can be higher than in operational mode.

The format size of HK blocks are defined in Volume 4 for each S/A as well as specific DIAG HK blocks that are acquired only in DIAG mode. This supplementary set of acquisitions is done by means of a DIAG HK table with a pooling sequence of 250 ms, which is uploaded in IASW and can be filled with HK blocks and specific DIAG HK from any sub-assembly. The size of this table induces the maximum time between two identical DIAG acquisitions (96 entries → 24 sec), while the minimum time between DIAG acquisitions is 250 ms.

In DIAG mode, all technological HK are still acquired, scientific data and scientific HK also.

Dump commands are allowed in DIAGNOSTIC mode.

In that mode IASW acquires science data from PSD and DFEE on HSL

Exit conditions:

Reception of one of the following commands: <CONF>
<STBY>.

All other mode commands are not allowed (e.g.: In DIAGNOSTIC mode, the <DIAG> command is not allowed).

1.4.2.6. Calibration mode

Entry condition:

This mode is selected by the < CAL > command. It is specific to PSD, other S/A do not implement this mode.

When SPI is in this mode, PSD will be in CALIBRATION mode , and other S/A in OPERATIONAL mode. In that mode IASW acquires science data from PSD and DFEE on HSL

Exit conditions:

Reception of one of the following commands: <CONF>
<STBY>.

All other mode commands are not allowed (e.g.: In CALIBRATION mode, the <CAL> command is not allowed).

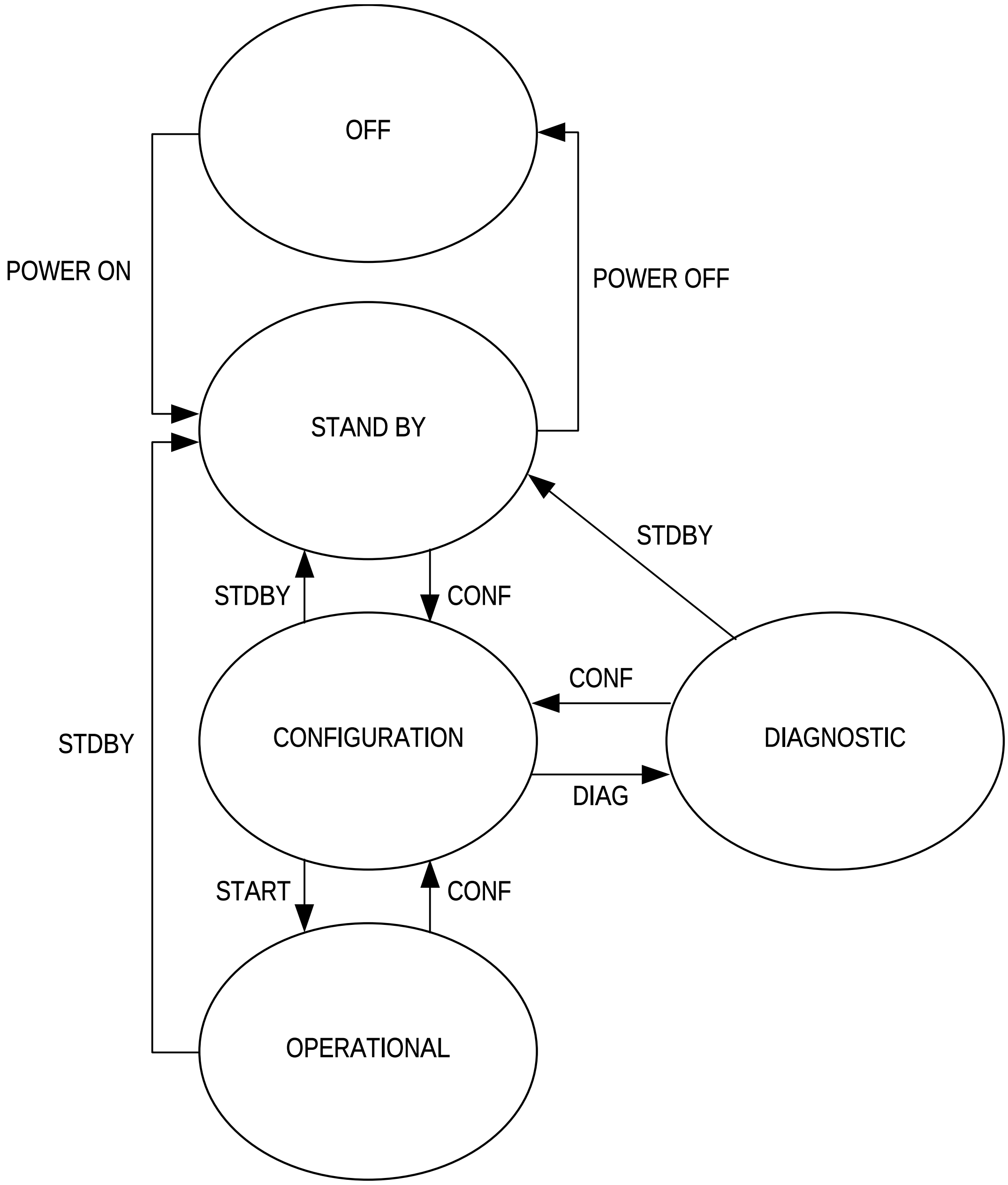


Figure 1.24 - ACS, AFEE, DFEE Operating Modes

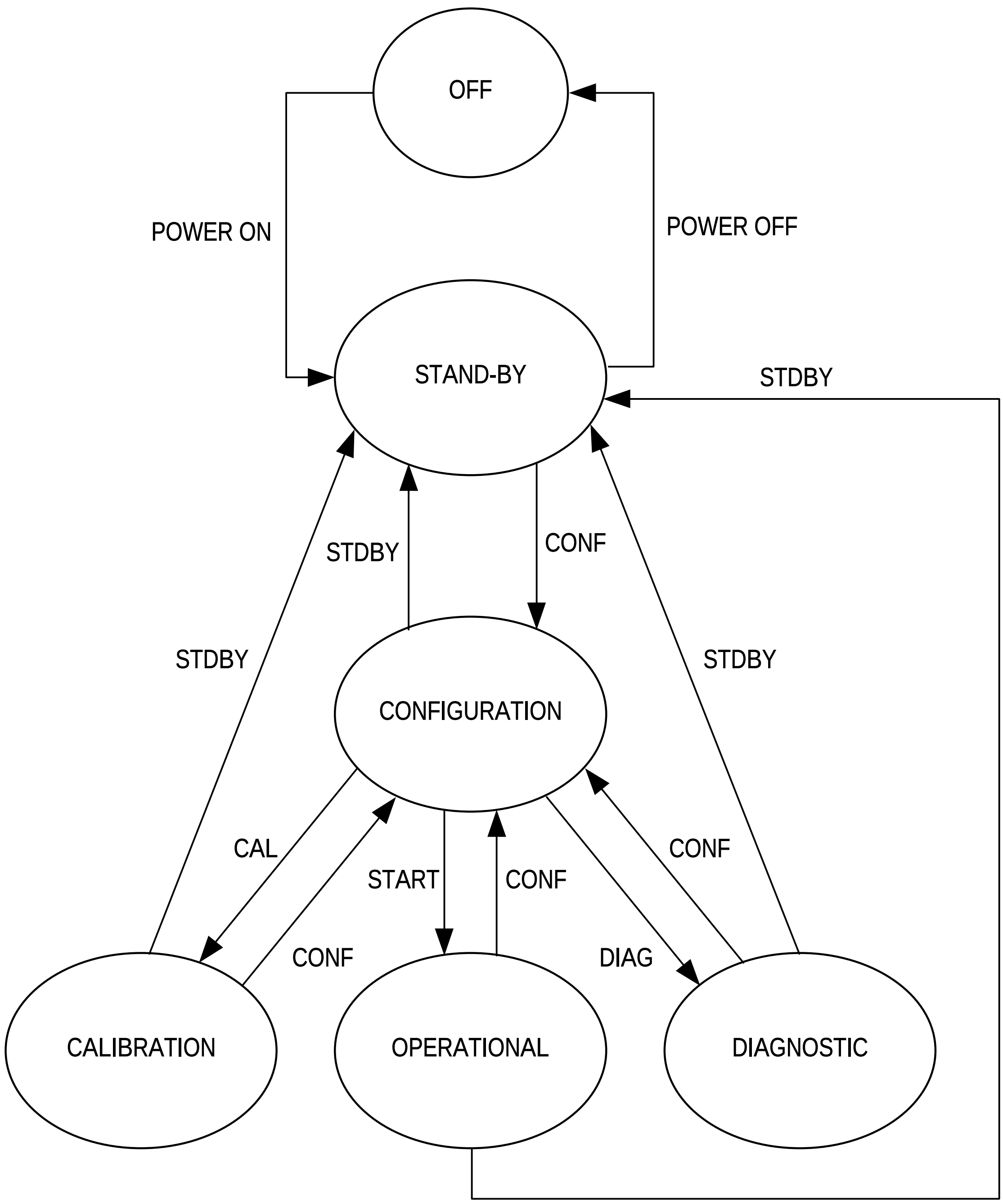


Figure 1.25 - PSD Operating Modes

2. SYSTEM CHARACTERISTICS AND CONSTRAINTS

2.1. INSTRUMENT SYSTEM BUDGETS

2.1.1. Mass budget

MASS (kg)	**23/03/2001** Measured mass		
ANTICOIN. SUBSYS.			**813.2**
BGO		*504*	
REAR SHIELD			
SIDE SHIELD			
LOWER COL. RING			
UPPER COL. RING			
PMT, HOUSING STR.			
ANTICOIN. ELECTR.			
EXTERNAL STRUC.			
Plastic Scintillator PSAC			22.2
CAMERA			**157.3**
DETECTION		*68.5*	
GE + PREELECT.	30.15		
AFEE1	14.9		
AFEE2	14.9		
PSD	8.67		
CRYOSTAT		*87.1*	
COLD BOX	29.36		
ACTIVE COOLING	39.4		
CDE	10		
PASSIVE COOLING	8.4		
INSTRUMENTATION		*1.65*	
THERMAL CONTROL			**8.5**
HARNESS			**31.26**
DFEE			**8.76**
LOWER STRUCTURE			**55.8**
MASK			**131.6**
Tungsten		107	
Structure		24.6	
TOTAL SPECTRO WITH CDE			**1228.6**
TOTAL SPECTRO WITHOUT CDE			**1218.6**

2.1.2. Power budget

See paragraph 3.4.5.

2.1.3. Telemetry budget

For further details, see RD 22.

2.1.3.1. Housekeeping data telemetry

The detailed contents of the HK data is presented in Volume 4.

2.1.3.1.1. Technological housekeeping data

There are analogue technological HK data (digitised by the mini RTU in DPE) and digital technological HK data. The detailed budget is presented in paragraph 3.6.1.2.1.

The technological HK data represent 3 packets per polling cycle (8s) at maximum, including 1 packet for CSSW.

2.1.3.1.2. Science housekeeping data

The science HK data require 5 packets per pooling cycle: TPN 60000, 60001, 60002, 60003, 60004.

See paragraph 3.6.3.2.

2.1.3.2. Science telemetry budget

The detailed contents of the science data telemetry is presented in § 1.4.9 Volume 4.

2.1.3.2.1. Science telemetry for photon/photon data

- **Counting rate specification:**

Solar min: **20,0** events/s/detector
Solar max: **8,0** events/s/detector

Distribution:

Single	**PSD**	**Multiple**
45,60 %	**42,30 %**	**12,10 %**

- **Single-detector events out of PSD range:**

Number of events/s/detector:

Solar min: 9,12 events/s/detector
Solar max: 3,648 events/s/detector

Word structure:

32 bits

<table>
<tr><td>Time (11 bits)</td><td>@ (5 bits)</td></tr>
<tr><td colspan="2">Energy (16 bits)</td></tr>
</table>

Number of bits needed:

Solar min: **5544,96 bits/s**
Solar max: **2217,984 bits/s**

- **Single-detector events in PSD range:**

Number of events/s/detector:

Solar min: 8,46 events/s/detector
Solar max: 3,38 events/s/detector

Word structure:

48 bits

<table>
<tr><td colspan="2">Time (11 bits)</td><td>@ (5 bits)</td></tr>
<tr><td colspan="3">Energy (16 bits)</td></tr>
<tr><td>Flag
(2 bits)</td><td>Pulse Height
(8 bits)</td><td>Time to Peak
(6 bits)</td></tr>
</table>

In addition every 4 s, a PSD curve of 80 samples of 9 bits + 48 bits (event identification) ⇒ 192,0 bits/s

Number of bits needed:

Solar min: **7907,52 bits/s**
Solar max: **3278,208 bits/s**

- **Multiple-detector events:**

Only, multiple-detectors events of the second order are considered, because the other orders are marginal.

Number of events/s/detector:

Solar min: 2,42 events/s/detector
Solar max: 0,97 events/s/detector

Word structure:

	Time (11 bits)	Nb (5 bits)
	Energy (16 bits)	
80 bits	Δt (11 bits)	@ (5 bits)
	Energy (16 bits)	
	Δt (11 bits)	@ (5 bits)

Number of bits needed:

Solar min: **3678,4 bits/s**
Solar max: **1471,36 bits/s**

- **Total photon/photon scientific telemetry:**

	Solar min	Solar max	
Single (out PSD range)	5544,96	2217,984	
PSD	7907,52	3278,208	
Multiple	3678,4	1471,36	
Total (bits/s)	**17130,88**	**6967,552**	
Total packets*	**40,1**	**16,3**	**per polling cycle (8 s)**
	41	**17**	**per polling cycle (8 s)**

(*) One packet has 427 bytes available for data

- **Number of packet reduction in solar min by increase of the energy threshold:**

In nominal TM mode the scientific photon/photon data required 41 packets in solar min and 17 packets in solar max with the maximum evaluation. The increase of the threshold can allow us to save 11 packets in solar min with a threshold of 100 keV, but induces an important scientific loss (see figure 2.1).

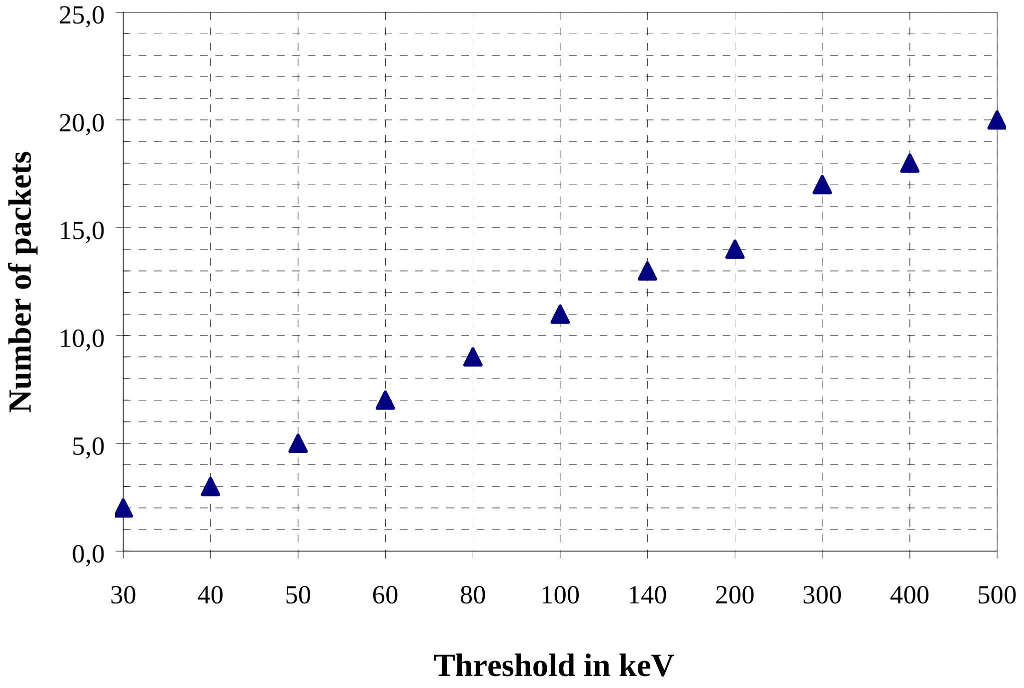


Figure 2.1 - Packets Reduction

2.1.3.2.2. Science telemetry for spectra

The compressed spectra size is 11 kwords (2 bytes) x 19 detectors = 3424256 bits.

The nominal time for transmission is 30 min and the corresponding TM rate is 1902,36 bits/s i.e. **5 Packets per polling cycle**.

If the spectra accumulation is the same as the dithering observation time for each point defined in the Core Program (965 s), the TM rate becomes 9 packets per polling cycle.

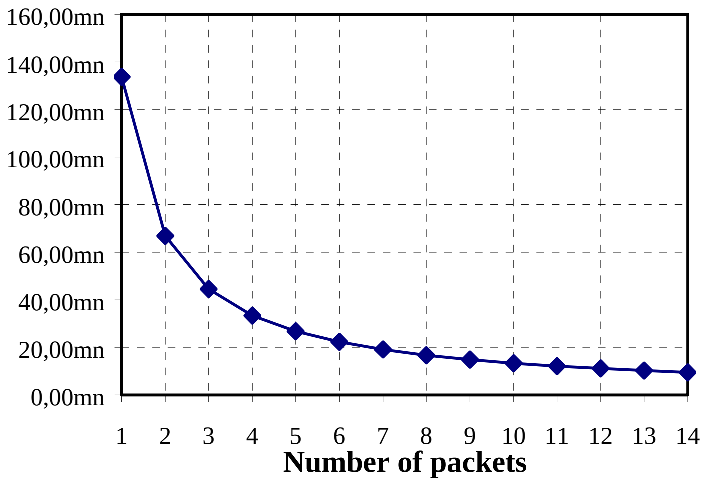


Figure: 2.2 - Transmission Duration in mn for Full Packets

It can be saved 2 packets with a transmission time of 45 mn and 3 packets with 67 mn. Over this time, the win is very poor, and after 134 mn the reduction is nil (see figure 2.2).

2.1.3.3. Telemetry budget synthesis in TM emergency mode

In this mode only the spectra and the multiple detectors events compose the telemetry. The budget as follows:

Nominal values	Solar min
Scientific Telemetry	9
Spectra	5
Scientific HK data	5
Technological HK	3
Total packets	**22**

This mode allows a margin greater than 3 on the background level at the end of the mission in solar minimum, but timing performances are very bad (125 ms) and therefore the science performances will be extremely decreased.

2.1.3.4. Telemetry budget synthesis in photon/photon mode

The budget is as follows:

Nominal values	Solar min	Solar max
Scientific Telemetry	41	17
Spectra	5	5
Scientific HK data	5	5
Technological HK	3	3
Total packets (*)	**54**	**30**

This budget is obtained with 20 keV for the AFEE energy threshold and 27 mn for spectra accumulation. The useful data rate is 20.9 kb/s at the solar minimum.

2.1.3.5. Telemetry budget synthesis in PSD calibration mode

In this mode the DPE will transmit 40 curves per second. The Science TM rate is 90 packets per polling cycle (~ 38.7 kb/s). The total TM rate is 103 packets per polling cycle.

2.1.3.6. Telemetry budget in mode with no science data acquisition

During the Stand-by, Configuration, Cooling, Annealing and Outgassing modes, only the technological data is transmitted. The TM rate is 3 packets per polling cycle (~1.29 kb/s).

2.1.3.7. Burst case

To take in account burst event, a 3 Mbits buffer is used. Two ways are proposed for burst event transmission:

- With the current SPI PST (Polling Sequence Table), the transmission of this buffer will be done with the TM rate margin, if any. 7 packets per polling cycle (~ 3 Kb/s) of TM rate margin, the transmission of this buffer will last less than 18 min.

- With an increase of the SPI PST in order to empty the 3 Mb buffer, the transmission could last about more than 2.5 min with 50 packets per polling cycle.

2.2. INSTRUMENT CHARACTERISTICS

2.2.1. Calibration

TBW

2.2.2. Pointing and stability

See paragraph 3.2.4.1.

2.2.3. Radiation susceptibility

The instrument is fully compliant with the specifications and robust vis-à-vis of radiations levels.

2.2.4. Lifetime limited items

TBW

2.2.5. Degradation of instrument

(performance analysis)

TBW

3. INTERFACE DEFINITION

3.1. DEFINITION OF COORDINATE SYSTEM

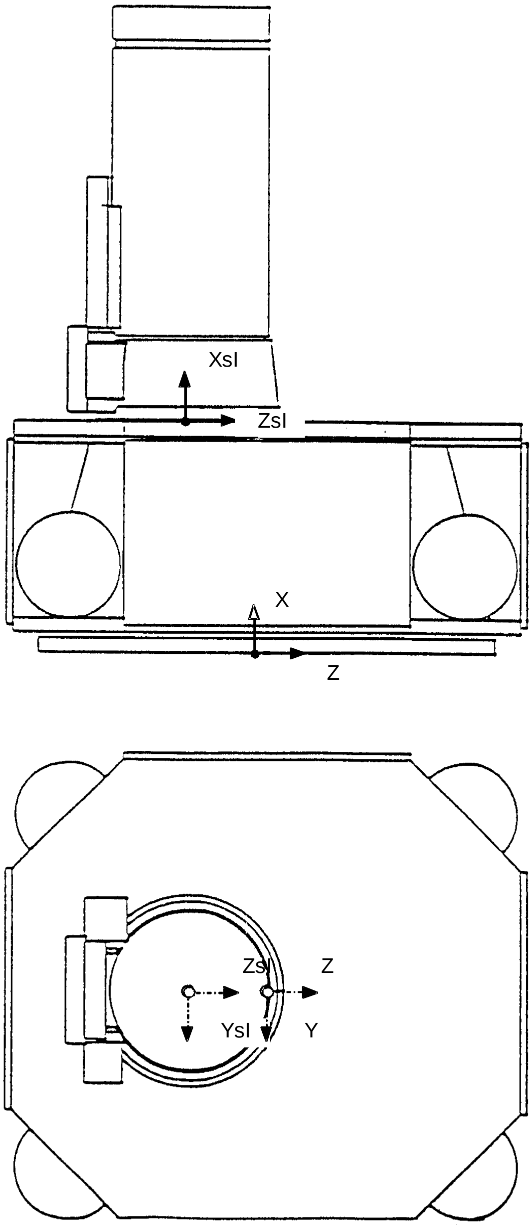


Figure 3.1 - Instrument Reference

3.2. MECHANICAL INTERFACES

3.2.1. Instrument mechanical description

- **Mechanical architecture description**

The architecture has been driven by the following criteria.

a) To guarantee the absolute and relative positioning in referential satellite axis of scientific elements like mask, detection plan, collimator shield.

b) To minimise presence of material inside the anticoincidence sub-assembly.

c) To manage the load paths and the dynamic behaviour in order to minimise fluxes and local accelerations, during handling and launch phase.

d) To minimise the mass which is a critical factor.

e) To define the best architectural compromise, around the detection plan, between the background leakage through the shield and the necessary functional paths to the outside (tubing, harness).

f) To define a general layout which uncouple as much as possible the different sub-assemblies with several criterias like:

- development autonomy,
- integration and functional tests logic,
- no multiple or crossed interfaces.

This point is applicable for the whole spectrometer towards the satellite.

In accordance to these criteria the mechanical architecture is shown on the figure 3.1. Starting from, surfaces, distance and field of view defined for the mask and the detection plan which froze a minimum size of the spectrometer, it has been defined a cylindrical external structure. This structure is bolted at its base on the satellite, and supports on its length, all the instrument elements.

This configuration allows:

a) To fix all the spectrometer components.

b) To avoid material presence inside the veto shield.

c) To keep all freedom to define the diameter of this cylinder, to manage the shield plates inside cantilever, to determine the global stiffness and the hard-mounted loads at base, and this, in respect with the best structural mass ratio, as much as possible.

The diameter of the cylinder is 0.85 m and 1.09 m at its base. With this configuration, the autonomy of the whole instrument is guaranteed. The total length of the instrument depends only on two dimensions:

a) The distance between the mask and the detection plan which has been fixed at 1,71 m by scientists.

b) The height of the detection plan above the satellite Interface plane. This height is fixed at 0,55 m due to a compromise between a minimisation of the Centre Of Mass height above fixation plane, to reduce hard mounting fluxes and a maximisation of this distance to limit the background onto the Ge detectors coming from the satellite.

Figure 3.2 shows the main dimensions of the instrument.

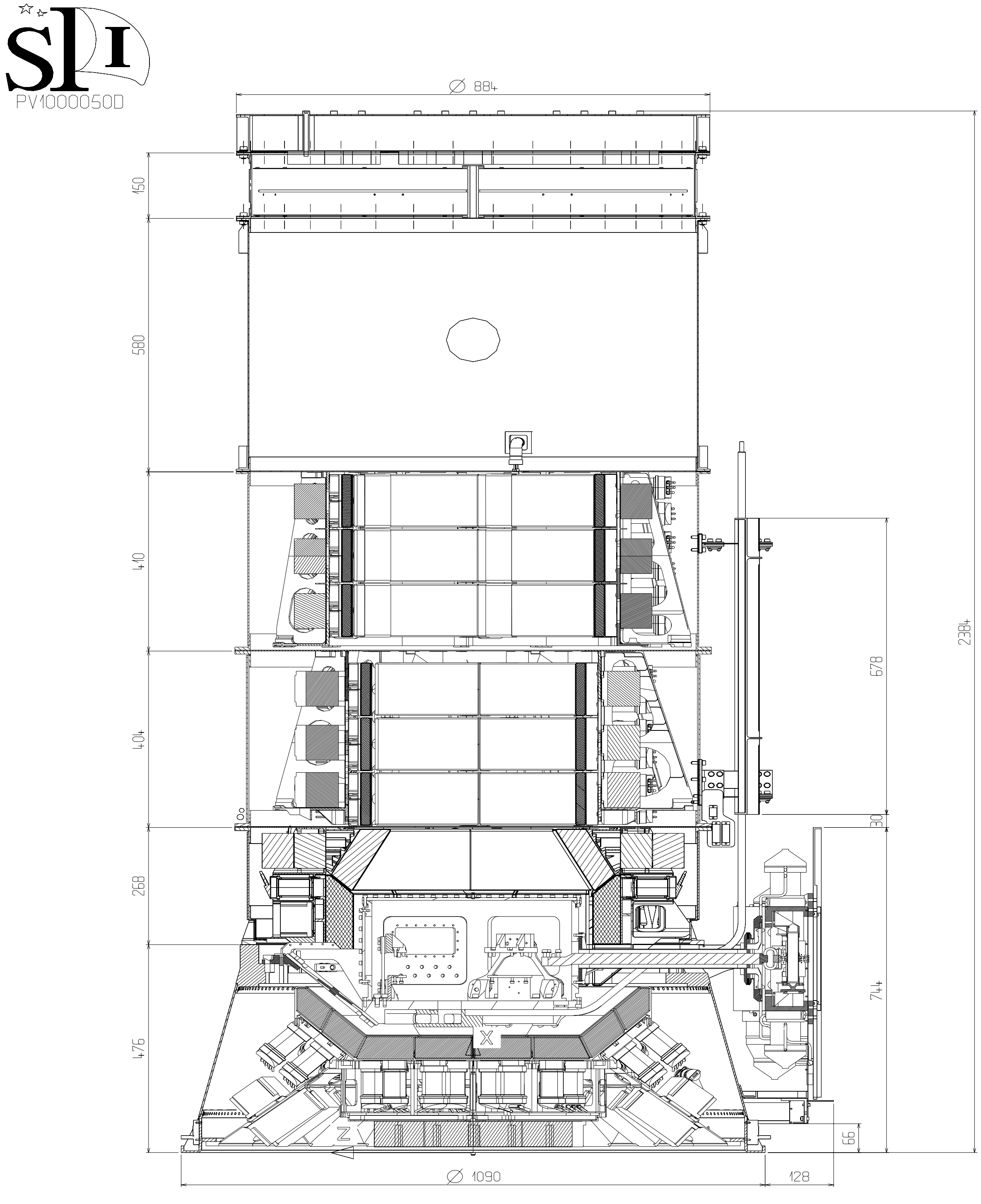


Figure 3.2 - Integral Spectrometer: Main Dimensions

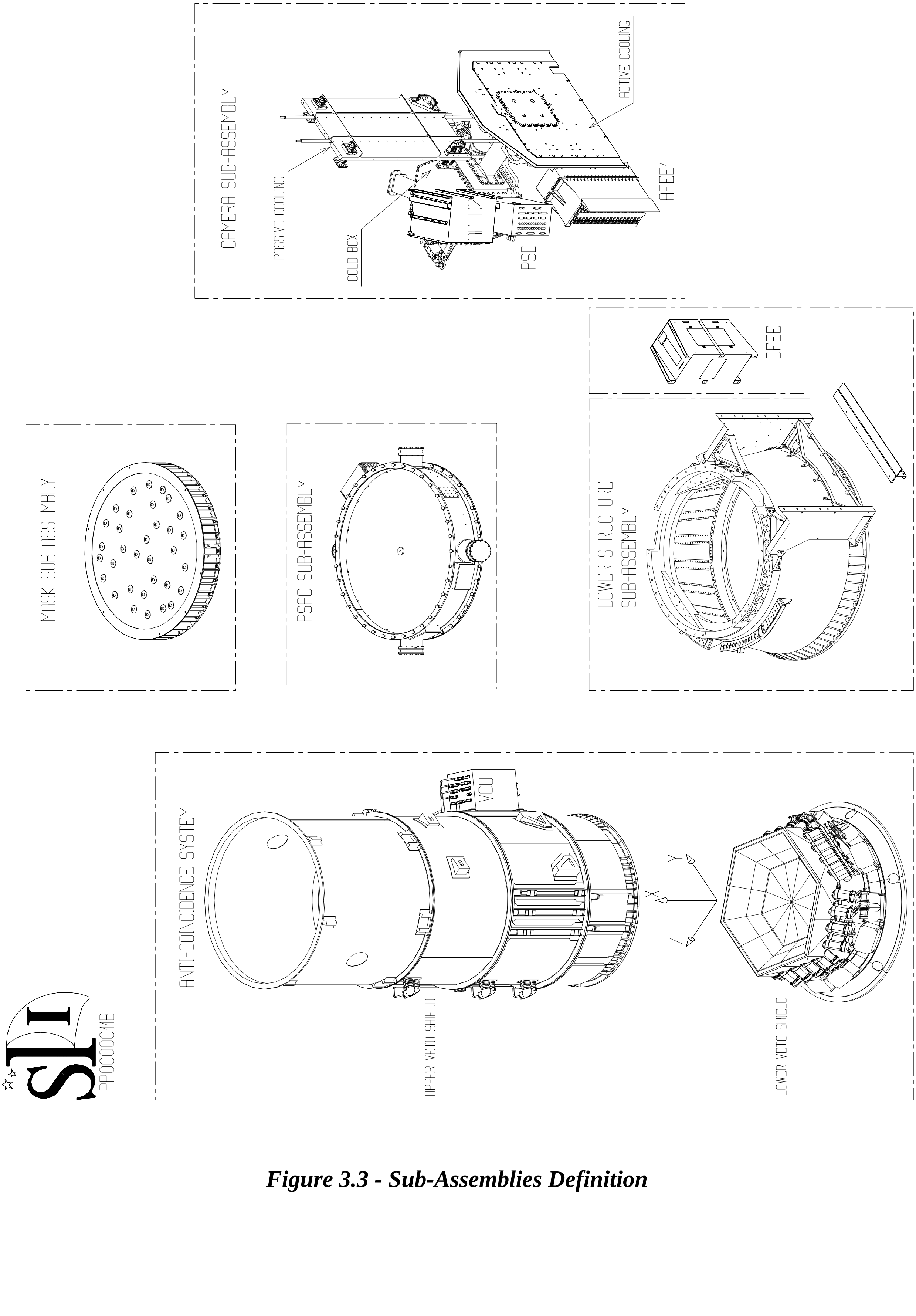


Figure 3.3 - Sub-Assemblies Definition

3.2.2. Mounting concept

Figure 3.3 shows the cutting logic of the sub-assemblies.

- autonomy of each sub-assembly,
- single interface by sub-assembly (except for camera sub-assembly),
- architectural independence between sub-assemblies,
- no crossing interfaces between them. Each of them is connected on a basic structure which is the lower structure fixed on the satellite (except for the mask fixed on plastic scintillator which is fixed on the veto-shield sub-assembly structure and for the 200 K radiator of the camera sub-assembly fixed on the veto-shield sub-assembly structure).

This logic is used to simplify the project management and development, the lower structure being directly under the project team control.

Each sub-assembly is integrated, tested independently from the others and then integrated and tested step by step at SPI system level.

At satellite level, SPI is mounted like a complete unit on the PLM only by the bolted bottom flange.

3.2.3. Mechanisms

The only mechanisms foreseen in the SPI are two sets of cryocoolers compressors, which have no direct interfaces with PLM.

During operations, the vibrations environment is (TBD).

3.2.4. System alignment budget

3.2.4.1. Alignment and stability requirements

See RD 24 for more details.

The integral spectrometer uses a mask equipped with a set of tungsten blocks, which allow to obtain a shadowgram on the detectors array in order to determine the location of the gamma sources. The sensitivity of the instrument depends on the quality of the projection of the mask shadowgram on the detectors, that is to say the registration accuracy of the mask shadowgram with the detection grid.

Therefore, the SPI detection axis shall be pointed with a maximum angle of 8' with the source direction.

In addition, the mask grid and the detection grid shall:

- have a maximum angle θx less than 5', with a measurement accuracy of 3';
- be parallel with a maximum angle of 20', with a measurement accuracy of 5'.

This alignment shall have a stability better than 2'.

3.2.4.2. Synthesis of SPI system geometrical budget

Before that all the terms of the budget are detailed, it can be noticed that there are two possibilities for the pointing of the spectrometer:

- either SPI is considered as the prime instrument for the observation: all the measured offsets between the SPI detection reference frame and the AOCS reference frame are taken into account for the orientation of the PLM,
- either SPI is not considered as the prime instrument for the observation and then the initial offsets of SPI with AOCS and the offset between the prime instrument and the AOCS are to taken into account for the offsets valuation with the gamma source.

3.2.4.2.1. Budget with SPI offsets correction

The budget is constituted by: APE, Δθ2, εθ1, εθ3, Δθ4 (see figure 3.4).

3.2.4.2.1.1. Offsets errors

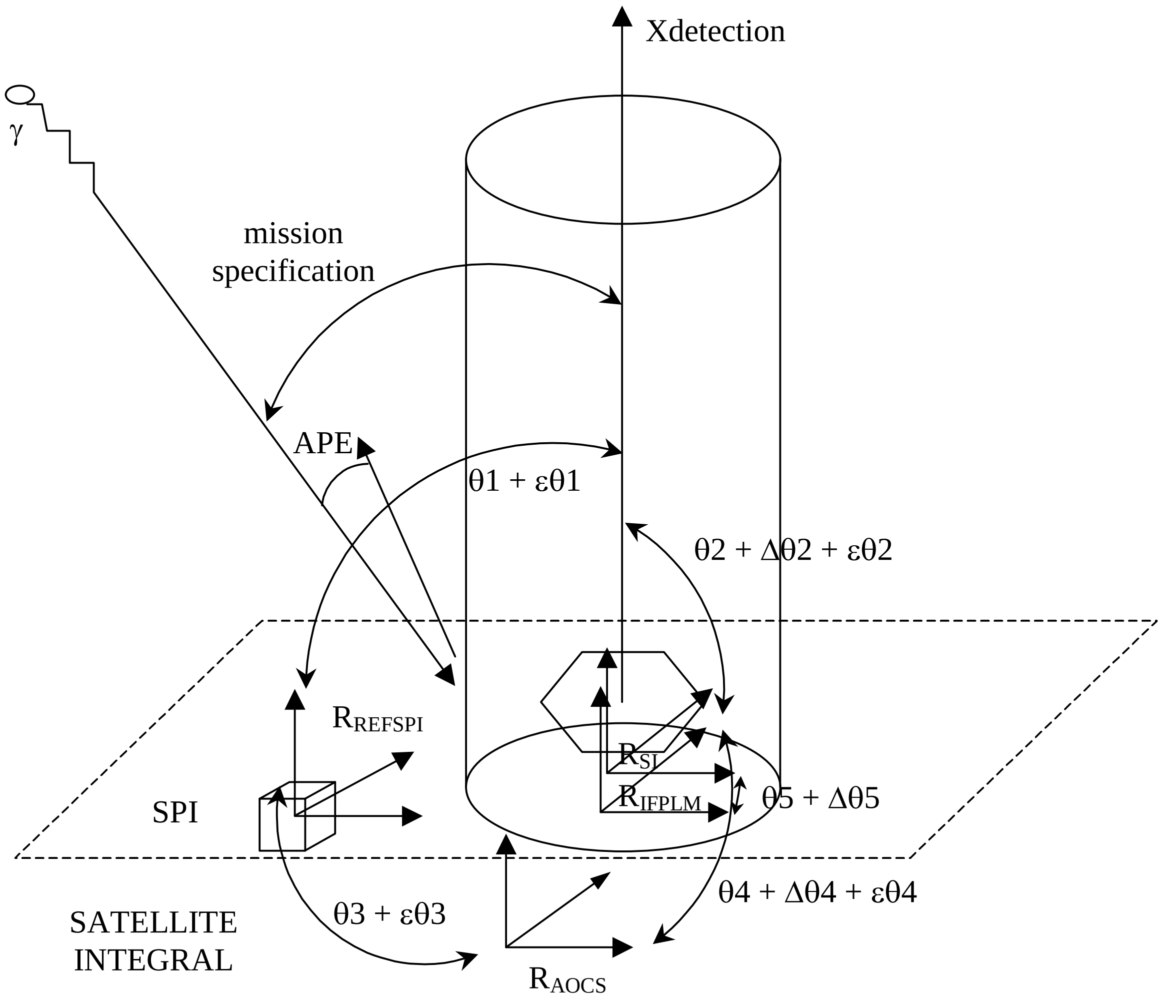
εθ1 errors	θX	θY	θZ
R_{Ge} / R_{CP}	1,50'	0,00'	0,00'
Variation R_{Ge} / R_{CP}	1,70'	0,00'	0,00'
R_{CP} / R_{SI}	1,00'	1,00'	1,00'
Mask integration	0,30'	0,22'	0,22'
R_{REFSPI} / R_{SI}	0,12'	0,12'	0,12'
Ground / orbit SPI offsets variation	0,00'	0,70'	0,00'

εθ3 errors: Measurement accuracy of SPI in RAOCS	0,25'	0,25'	0,25'

Δθ4: Ground / orbit Satellite offsets variation	0,00'	0,00'	0,30'

APE: Absolute Pointing Error	2,82'	2,48'	0,82'

Total of the offsets errors	**3,78'**	**2,79'**	**1,37'**



Note: The terms θ represent the offsets (misalignment), εθ the offsets errors and Δθ the variations of the offsets (periodic, random and drift)

Figure 3.4 - Main Reference Axes for SPI on the PLM

3.2.4.2.1.2. Ageing errors

Δθ2: Thermoelastic effects	0,00'	1,50'	0,00'

3.2.4.2.1.3. Periodic errors

Δθ2: Orbital variation	0,00'	0,30'	0,00'

3.2.4.2.1.4. Total errors

TE max: maximum Total Error	**3,78'**	**4,11'**	**1,37'**
TE rms: rms Total Error	**3,78'**	**3,17'**	**1,37'**

3.2.4.2.1.5. Errors of the SPI detection axis orientation

	θX	X DSPI/ Source
TE max: maximum Total Error	**3,78'**	**4,33'**
TE rms: rms Total Error	**3,78'**	**3,46'**
Specification	**-**	**8,00'**

3.2.4.2.2. Budget with another instrument offsets correction

The budget is constituted by: APE, for SPI: θ2, θ4 and θ5, Δθ2, Δθ4 and for the prime instrument offsets Detection axis (ILS) / R_{AOCS}.

3.2.4.2.2.1. Offsets

	θX	θY	θZ
θ2: Mask integration offsets R_{DSPI} / R_{SI}	0,50'	0,33'	0,33'
θ2: Offsets R_{Ge} / R_{CP} *	5,00'	0,00'	0,00'
θ2: Variation R_{Ge} / R_{CP} *	1,70'	0,00'	0,00'
θ2: R_{CP} / R_{SI} *	2,50'	0,00'	0,00'
θ5: R_{SI} / RIF_{PLM}	1,30'	0,00'	0,00'
θ4: RIF_{PLM} / R_{AOCS}	0,30'	0,22'	0,22'
Prime Instrument / R_{AOCS}	15,00'	5,00'	5,00'
Total Offsets	**16,16'**	**5,02'**	**5,02'**

* These offsets around Y and Z have no impact on θ2.

3.2.4.2.2.2. Offsets errors

Δθ2: Ground / orbit SPI offsets variation	0,00'	0,70'	0,00'
Δθ4: Ground / orbit Satellite offsets variation	0,00'	0,00'	0,30'
APE: Absolute Pointing Error	2,82'	2,48'	0,82'
Total of the offsets errors	**2,82'**	**2,58'**	**0,87'**

3.2.4.2.2.3. Ageing errors

Δθ2: Thermoelastic effect	0,00'	1,50'	0,00'

3.2.4.2.2.4. Periodic errors

Δθ2: Orbital variation	0,00'	0,30'	0,00'

3.2.4.2.2.5. Total errors

TE max: max Total Error	**16,40'**	**6,51'**	**5,09'**
TE rms: rms Total Error	**16,40'**	**5,84'**	**5,09'**

3.2.4.2.2.6. Errors of the SPI detection axis orientation

	θX	X DSPI/ Source
TE max: max Total Error	**16,40'**	**8,26'**
TE rms: rms Total Error	**16,40'**	**7,75'**
Specification	**-**	**8,00'**

The spectrometer sensitivity during the pinpoint sources will be better when SPI is the prime.

3.2.5. Structural math model

See RD 19.

3.2.6. Mechanical interface control drawing

See RD 21.

3.3. THERMAL INTERFACES

3.3.1. Definition of thermal requirements and design drivers

The following modes are defined for thermal control:

THERMAL CONTROL MODES	INSTRUMENT MODES	PLM STATUS
STORAGE	Storage	Ground
LAUNCH	Launch (mode 0)	OFF
INACTIVE (PLM OFF)	Inactive (mode 1)	OFF
INACTIVE (PLM ON)	Inactive (mode 1)	ON
HEAT PIPES THAW	Heat pipes thaw (mode 2)	ON
COOLING PHASE	Cooling phase (mode 3)	ON
STAND-BY	Stand-By mode (mode 4)	ON
OPERATIONAL	Configuration (mode 5) Operational (mode 6) Calibration (mode 9) Diagnostic (mode 10)	ON
ECLIPSE	Eclipse (mode 7)	OFF / ON
ANNEALING	Annealing (mode 8)	ON
OUTGASSING	Outgassing (mode 11)	ON

Table 3.1 - PLM Status w.r.t. SPI Modes

DESIGN DRIVERS:

During SPI nominal operational modes (SPI modes 4, 5, 6, 9 and 10), the thermal control is fully passive (no heater power consumption is allowed) exception made of the heat pipes antifreeze safety system.

During other modes except ECLIPSE, the thermal control is active and heater power consumption is permitted.

During ECLIPSE, redundant thermal control lines are enable but no heater power consumption is allowed.

3.3.2. Instrument thermal control description

3.3.2.1. Thermal design description

The thermal control of the Spectrometer is based on Multi Layer Insulation blankets (15 layers), associated to radiators used respectively as thermal sinks for the cryostat (PAC and ACC) and for electronic modules located outside the instrument (AFEE1, AFEE2, PSD, DFEE and VCU).

The cryostat is thermally decoupled from the instrument, and controlled by cryocoolers and ammonia heat pipes linked to their dedicated external radiators (PAC and ACC radiators).

The cavities between the primary structure, the ACC and PAC radiators are closed by a MLI blanket. Electronic modules (AFEE1, AFEE2, PSD) are conductively decoupled from their structural support by means of insulating washers.

Mask, ACS and LSA sub-assemblies are conductively coupled, fitted together by means of bolts, without any insulating washer. The VCU is coupled to the ACS structure (no insulating washer).

The Spectrometer is fitted on the PLM platform by means of bolts, at the baseplate between LSA and PLM. **Therefore, the instrument is conductively coupled with the PLM baseplate.**

PLM MLI covers all I/F between PLM platform and PLM panels all around the SPI. In particular, a blanket lays on the internal radiative I/F between SPI and PLM (inside the LSA cone). PLM MLI is fixed on the SPI MLI by means of velcros and stands-off.

3.3.2.2. Thermal control lines description

Electrical lines dedicated to SPI thermal control are the following ones:

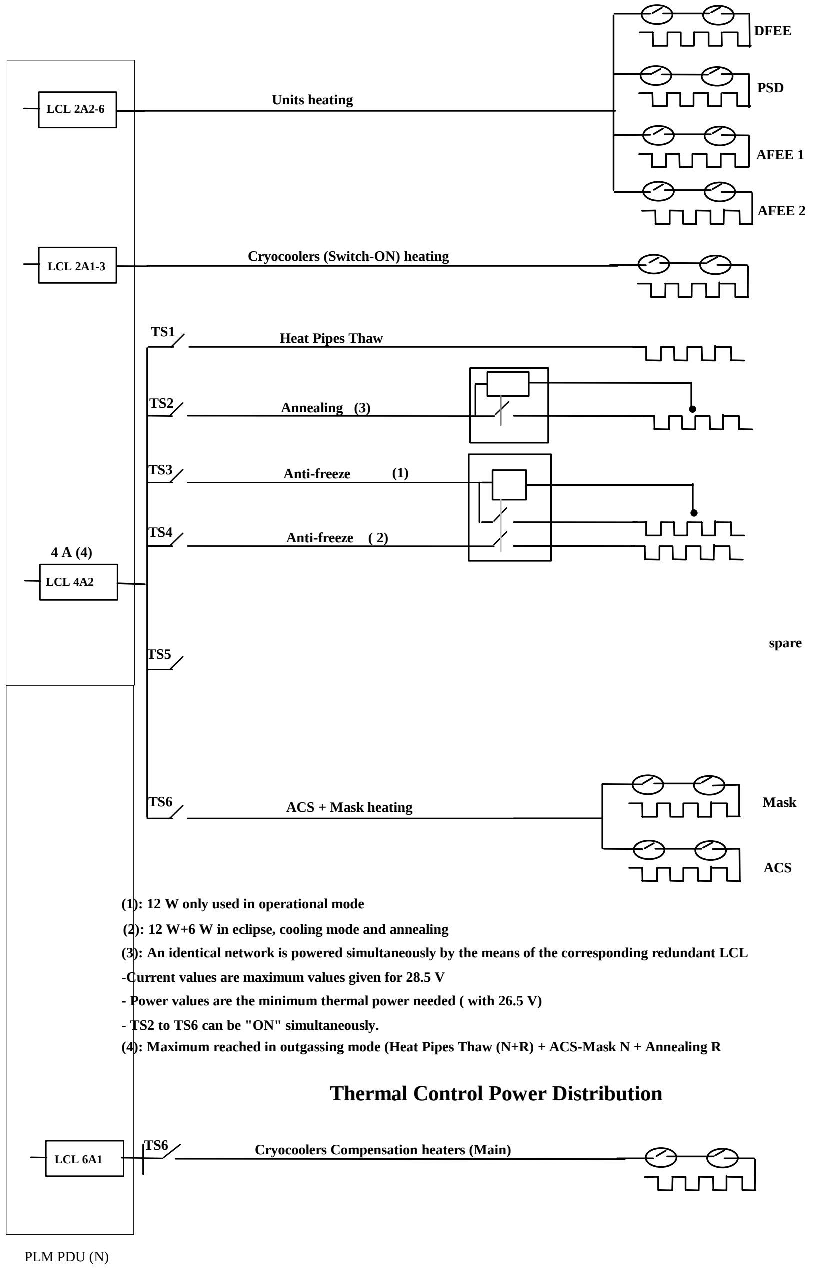
Main lines:

- 2A2-6: AFEE1, AFEE2, DFEE, PSD heater circuits
- 4A2: Heat pipes thaw, annealing, antifreeze 1 and 2, cryocooler compensation, ACS and MASK heater circuits
- 2A1-3: Cryocoolers survival/switch-on heater circuit

Redundant lines:

- 2B2-6: AFEE1, AFEE2, DFEE, PSD heater circuits
- 4B2: Heat pipes thaw, annealing, antifreeze 1 and 2, cryocooler compensation, ACS and MASK heater circuits
- 2B1-3: Cryocoolers survival/switch-on heater circuit

All heater circuits are independent from one and other.



(1): 12 W only used in operational mode
(2): 12 W+6 W in eclipse, cooling mode and annealing
(3): An identical network is powered simultaneously by the means of the corresponding redundant LCL
-Current values are maximum values given for 28.5 V
- Power values are the minimum thermal power needed (with 26.5 V)
- TS2 to TS6 can be "ON" simultaneously.
(4): Maximum reached in outgassing mode (Heat Pipes Thaw (N+R) + ACS-Mask N + Annealing R

Thermal Control Power Distribution

One heater circuit is constituted by several heaters (in parallel) thermostatically controlled (two thermostats in serial per heater circuit). Main lines are equipped with High Temperature Protection thermostats (HTP), redundant lines are equipped with Low Temperature Protection thermostats (LTP):

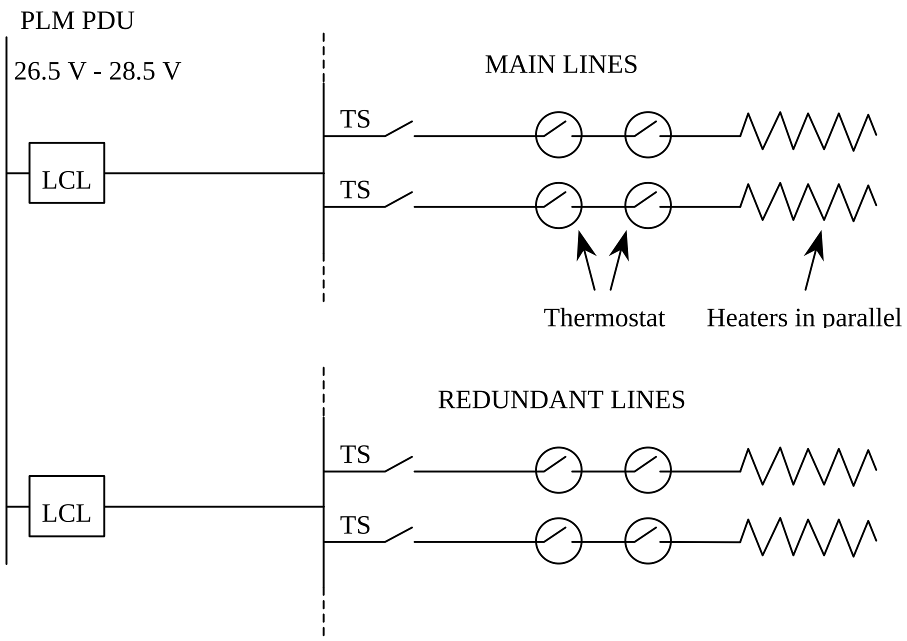


Figure 3.5 - Main and Redundant Thermal Control Lines

The two following tables give first the closing and opening thresholds for each heater circuits (tolerances and drifts excluded) and secondly the equivalent resistance of each heater circuits (tolerance excluded) and associated installed power under 26.5V and 28.5 V.

	HTP thresholds			**LTP thresholds**		
	closing	**opening**	**ΔT**	**closing**	**opening**	**ΔT**
PSD	- 23,3	- 18,7	4,7	- 31,3	- 26,3	5,0
AFEE1	- 14,7	- 11,3	3,5	- 31,5	- 26,7	4,7
AFEE2	- 15,3	- 11,3	4,0	- 31,5	- 25,9	5,6
DFEE	- 20,2	- 15,1	5,0	- 30,7	- 26,4	4,3
ACC cryocoolers	- 19,5	- 15,5	4,0	- 18,0	- 13,0	5,0
PAC thaw	NO THERMOSTAT					
PAC antifreeze	207 (*)	207 (*)	0,25	208 (*)	208 (*)	0,25
ACC compensation	- 8,5	- 2,5	6,0	- 6,5	- 2,5	4,0
ACS	- 14,3	- 8,5	5,8	- 21,4	- 16,1	5,2
MASK	- 14,3	- 9,2	- 5,1	- 21,1	- 16,5	4,6

(*) electronic device regulation

Table 3.2 - Thermostats Thresholds

Remark: the thresholds values given in this table correspond to the values measured by the manufacturer before delivery (mean of three measurements).

	Main R Ohms	Red. R Ohms	Installed power 26,5 V		Installed power 28,5 V	
			Main R	**Red. R**	**Main R**	**Red. R**
DFEE	69,1	69,4	10,2	10,1	11,8	11,7
AFEE1	26,5	26,5	26,5	26,5	30,7	30,7
AFEE2	26,4	26,4	26,6	26,6	30,8	30,8
PSD	69,3	69,3	10,1	10,1	11,7	11,7
ACS	15,3	15,3	46,2	46,2	53,4	53,4
MASK	66,3	66,5	10,6	10,6	12,3	12,2
ACC (survival) cryocoolers	R - 2 % 7,7	R + 2 % 8,1	90,5	90,5	104,7	104,7
PAC antifreeze 1 + 2	R - 2 % 35,8	R + 2 % 37,4	19,5	19,5	22,6	22,6
PAC thaw	R - 2 % 18,1	R + 2 % 18,9	37,2	37,2	44,8	44,8
ACC (compensation) cryocoolers	R - 2 % 18,6	R + 2 % 19,4	36,2	36,2	43,6	43,6
TOTAL			**313,6**	**313,5**	**366,4**	**366,2**

Table 3.3 - Thermal Control Equivalent Resistances and Corresponding Heater Power

Remark: the resistances values given in this table correspond to the values measured by the heaters manufacturer before delivery.

3.3.2.3. Thermal control functioning

In general, when a SPI unit (or sub-assembly) is ON (with full electrical power), it is maintained within its in-orbit operating temperatures range thanks to its electrical dissipation. Radiators and SPI MLI are sized to reject the exceeding power.

This allows to avoid heater power during SPI nominal operating modes (modes 4, 5, 6, 9 and 10).

During all other modes, when sub-assemblies are switched off, thermal control lines are used to maintain units within their in-orbit non-operating temperature ranges (above their minimum start-up temperatures).

During Annealing mode (mode 8), AFEE1 and AFEE2 are partially ON but their lower electrical dissipations (a few watts) do not permit to keep them within their in-orbit operating temperatures range. Then their thermal control lines are activated to achieve that. All other units are OFF and regulated by their thermal control lines.

During Eclipse mode, thermal control redundant lines are enable but no heater power consumption is allowed, except on antifreeze lines.

Cryogenic ammonia heat pipes are used to transfer the "cryostat 200K stage" heat loads towards a dedicated radiative plate.

The heat pipes network needs an active thermal control during SPI nominal operational mode: an antifreeze safety system is used to keep ammonia above its frost temperature: (power ON only if $T_{hp} < 205K$).

After non-operating phases, a heater system is used to thaw the heat pipes and thus to allow the start-up of the instrument.

3.3.3. Temperature and energy budgets

3.3.3.1. Unit temperature reference point

- TRP for the spectrometer is defined at the mounting interface between the lower ring of LSA primary structure and the PLM platform ring. Precise location is given in the SPI I/F specifications.
- For all SPI units, the TRP between two sub-assemblies is precised in the SPI I/F specifications. These TRPs are defined at the mechanical I/F between sub-assemblies.

3.3.3.2. Temperature ranges

For all SPI sub-assemblies, two types of temperature ranges are defined:

- Interface radiative temperature range guaranteed by the SPI thermal control. They must be considered as mean surface temperatures for equipment (skin temperatures of the equipment, when the skin interfaces directly either with the SPI external MLI or with an other sub-assembly unit).

  For AFEE1, AFEE2, DFEE, PSD, VCU and ACC radiator, the radiative temperature has been calculated on their radiators.

- Interface conductive temperature ranges guaranteed by the SPI thermal control. They are defined and calculated at the TRP between two SPI sub-assemblies and must be taken as conductive sink temperatures for sub-assemblies thermal analyses. The SPI sub-assemblies in-orbit temperature ranges are given hereafter:

SUB-SYSTEMS and UNITS	TEMPERATURE LIMITS (°C)				
	operating		non-operating		start-up
	min	max	min	max	min
EXTERNAL ELECTRONIC UNITS					
AFEE1	- 20	45	- 35	45	- 35
AFEE2	- 20	45	- 35	45	- 35
DFEE	- 15	40	- 35	40	- 35
PSD	3	41	- 35	41	- 35
VCU	5	42	- 35	42	- 35
SPECTROMETER					
PSAC	- 10	35	- 25	35	- 25
ACS					
ACS shields	- 8	44	- 30	44	- 30
Structural rings UVS, LVS	- 12	40	- 30	40	- 30
LVS cone	- 12	44	- 30	44	- 30
LSA	- 13	40	- 30	40	- 30
MASK	- 13	30	- 25	30	- 25
CRYOSTAT					
ACC radiator	- 20	40	- 20	40	- 20
PAC	N.A.	N.A.	N.A.	N.A.	N.A.

Table 3.4 - SPI Units Limit Temperature Ranges

3.3.3.3. Heater power budget

This paragraph gives first the installed heater power on each regulated SPI units (except power for annealing mode), and secondly the SPI modes for which thermal control heater power consumption is allowed (except power for annealing mode). Tables 1.6 to 1.8 Volume 2 complete this information for SPI survey.

Equipment	Mask	ACS	DFEE	AFFE1	AFEE2	PSD	ACC	Antifreeze 1+2	Thaw
Installed heater power under 26.5 V	10.6W	46.2W	10.2W	26.5W	26.6W	10.1W	86.9W	19.1W	38W
Installed heater power under 28.5 V	12.3W	53.4W	11.8W	30.7W	30.8W	11.7W	104.7W	22.6W	44.8W
Total installed (26.5V / 28.5 V)	274.2W / 322.8W								

Table 3.5 - SPI Installed Heater Power under 26.5 V and 28.5 V

For Mask, ACS, AFEE1, AFEE2, DFEE and PSD, the heater power are calculated considering the resistances values measured by the heaters manufacturer.

For ACC, antifreeze and thaw, the heater power are calculated considering heater resistances R with a tolerance of ± 2 %:

Pmin (26.5 V) = $U^2/R_{+2\%}$ where U = 26.5 V

Pmax (28.5 V) = $U^2/R_{-2\%}$ where U = 28.5 V

THERMAL CONTROL MODES	INSTRUMENT MODES	THERMAL CONTROL HEATER POWER
STORAGE	Storage	Not allowed
LAUNCH	Launch (mode 0)	Not allowed
INACTIVE (PLM OFF)	Inactive (mode 1)	Allowed
INACTIVE (PLM ON)	Inactive (mode 1)	Allowed
HEAT PIPES THAW	Heat pipes thaw (mode 2)	Allowed
COOLING PHASE	Cooling phase (mode 3)	Allowed
STAND-BY	Stand-By (mode 4)	Not allowed (except antifreeze and compensation heaters)
OPERATIONAL	Configuration (mode 5) Operational (mode 6) Calibration (mode 9) Diagnostic (mode 10)	Not allowed (except antifreeze and compensation heaters)
ECLIPSE	Eclipse (mode 7)	Not allowed (except antifreeze)
ANNEALING	Annealing (mode 8)	Allowed
OUTGASSING	Outgassing (mode 11)	Allowed

Table 3.6 - Thermal Control Heater Power Consumption w.r.t. SPI Modes

3.3.4. Thermal hardware

The main thermal components and coatings are:

- MLI (blankets + velcros + stand-off) for insulation (Zodiac International, France)
- aluminium brackets, pins + clips (CAMERIN, COMAT, France) for MLI fixation
- SG 120 FD white paint (manufacturer: MAP France) for radiative areas
- flexible heaters (manufacturer NICOLITCH, France)
- thermostats for warming-up (manufacturer COMEPA, France)
- temperature sensors (YSI and PT100, PT500)
- miscellaneous (aluminium, kapton tapes...)

COMPONENTS CHARACTERISTICS

- Materials are amagnetic.
- Electrostatic protection: MLI exposed to space environment on external surfaces is grounded to the structure (2 points for each blanket).
  External radiative paint SG120 FD is compliant with ESA electrostatic requirement.
- Outgassing: Materials are compliant with the following outgassing criteria:
  Under tests conditions described by ESA PSS-01-702 (or ASTM e 595-77)
  Total Weight Loss < 1 %
  Collected Volatile Condensable Material < 0.1 %
- Thermal covers and insulating blankets incorporate features to insure adequate venting of volume enclosed by them.
- Heaters are generally used with a power density less than 0.1 W/cm^2
- Thermostats are qualified to support 100 000 switch-on/off cycles.

SG 120 FD thermo-optical properties:

Thermo-optical properties for SG 120 FD white paint are:

emissivity: $\varepsilon = 0.87 \pm 0.02$

solar absorptivity: $\alpha_s = 0.17 \pm 0.04$
$\alpha_s = 0.51$ after 2.5 years of irradiation in GEO (UV + p^+ + e^-)

MLI thermo-optical properties:

External MLI blankets: 15 layers (13 sheets of 6µ Mylar (aluminised on both sides) separated by Dacron sheets + internal and external sheet made of 25µ diffuse kapton).

Internal MLI blankets (cryostat): 10 to 20 layers identical to external MLI without Kapton sheets

Kapton thermo-optical properties: $\varepsilon = 0.63$ at beginning and end of life,
$\alpha_s = 0.36$ at beginning of life,
$\alpha_s = 0.46$ at end of life

THERMOSTATS:

THERMOPA class 47

Electrical: SPST opening contact, snap action
Nominal rating resistive: 4A / 30V DC resistive
Maximum rating resistive: 6A / 30V DC resistive (overload)
Contact resistance < 10 mΩ
Insulating resistance > 10 TΩ

Thermal: Storage temperature range: from - 65°C to + 175°C
Tolerance: ± 1°C
Drift < 1°C
Life test: 100000 cycles at nominal rate

FLEXIBLE HEATERS:

FLEXTHERM class 200, double layers heaters (nominal and redundant resistance on the same Kapton support).

Electrical: Ohmic density (see table paragraph 3.3.2.2.)
Tolerance on ohmic value: ± 2 %
Dielectric strength: 2000 V
Insulating resistance: 10^3 MΩ

Thermal: Insulating material: Kapton
Adhesive: high temperature
Temperature range: from - 200°C to + 200°C
Power density: stand up to 8 W/cm^2

3.4. ELECTRICAL POWER SUPPLY

3.4.1. Instrument power supply design definition

- **General rules**

In order to reduce electrical coupling and to lead to autonomous sub-assemblies, each equipment include as far as possible its own DC-DC converter powered by 28 Volts current limited and switched power lines provided by the S/C PDU.

There is no ON-OFF commands in the converters (except for AFEE's): each converter will be started by setting-up by S/C PDU of the 28 Volts on its own power line.

All power lines are redundant, and protected by LCL inside PDU.

- **Detectors and AFEE power supply**

For each of the 19 GeD is dedicated an analogue processing chain with its own Low and High Voltage DC-DC converter. The 19 low and high voltage DC-DC converters are powered by one nominal and one redundant power bus-line switched and protected by LCL inside the PDU.

As there is one common LCL for the 19 converters, each of them will be protected in their input stage by a circuit breaker, and can be switched separately by DPE commands.

HV values are set by DPE commands.

- **TM / TC AFEE's interface**

There is one nominal dedicated power bus line for the TM/TC AFEE's interface unit and one redundant power bus line for the redundant one.

- **PSD power supply**

There is one nominal and one redundant power bus line for the PSD unit.

- **DFEE power supply**

There is one nominal power bus line for the nominal DFEE and one redundant for the redundant one.

- **Veto-shield sub-assembly**

There is one nominal and one redundant power bus line, each of them protected by LCL inside PDU, for the ACS sub-assembly.

HV switching and setting and FEE's enabling/desabling can be performed with DPE digital commands, as part of configuration file.

- **Heaters power supply**

  - *Compressor heating*

    There is one nominal power bus line for the nominal power heating and one redundant for the redundant one protected by LCL inside PDU.

    Compressor's heating is controlled by thermo-switches.

  - *Other heating lines*

    Six heating lines are protected by one LCL. Each of them is switchable by transistor switches.

    Nominal and redundant power buses are powered simultaneously.

    All heating networks are controlled by thermo-switches, except for annealing and antifreeze which are controlled by electronic regulators directly powered by the primary bus line (see Figures 3.6 and 3.7).

    There is no regulation device for heat pipes thaw.

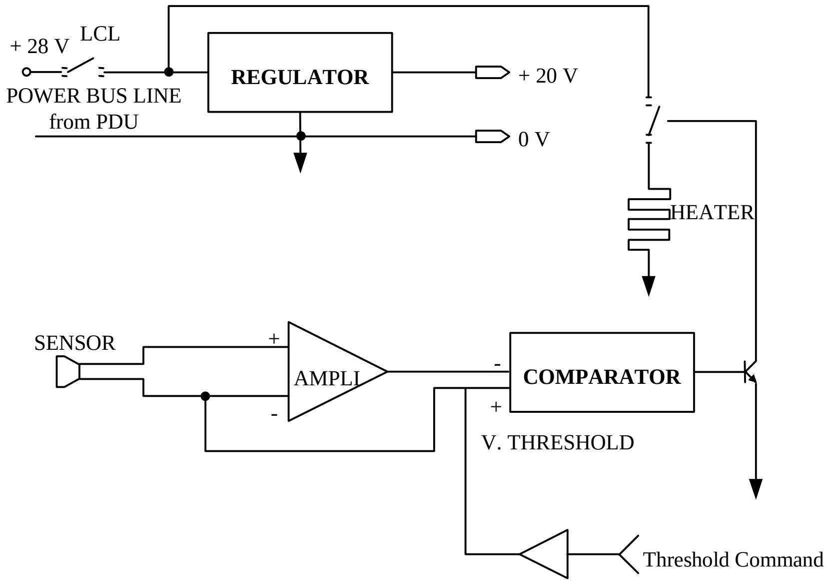


Figure 3.6 - Annealing Thermal Regulation

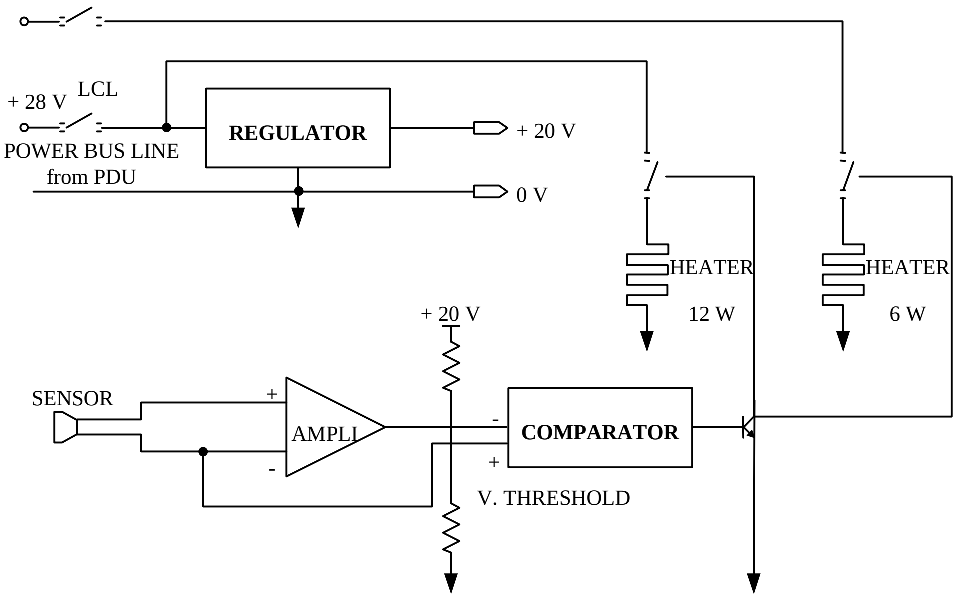


Figure 3.7 - Antifreeze Thermal Regulation

3.4.2. Instrument level block diagram

See SPI Electrical Diagram annex Volume 3.

Also see figures 3.8 and 3.9.

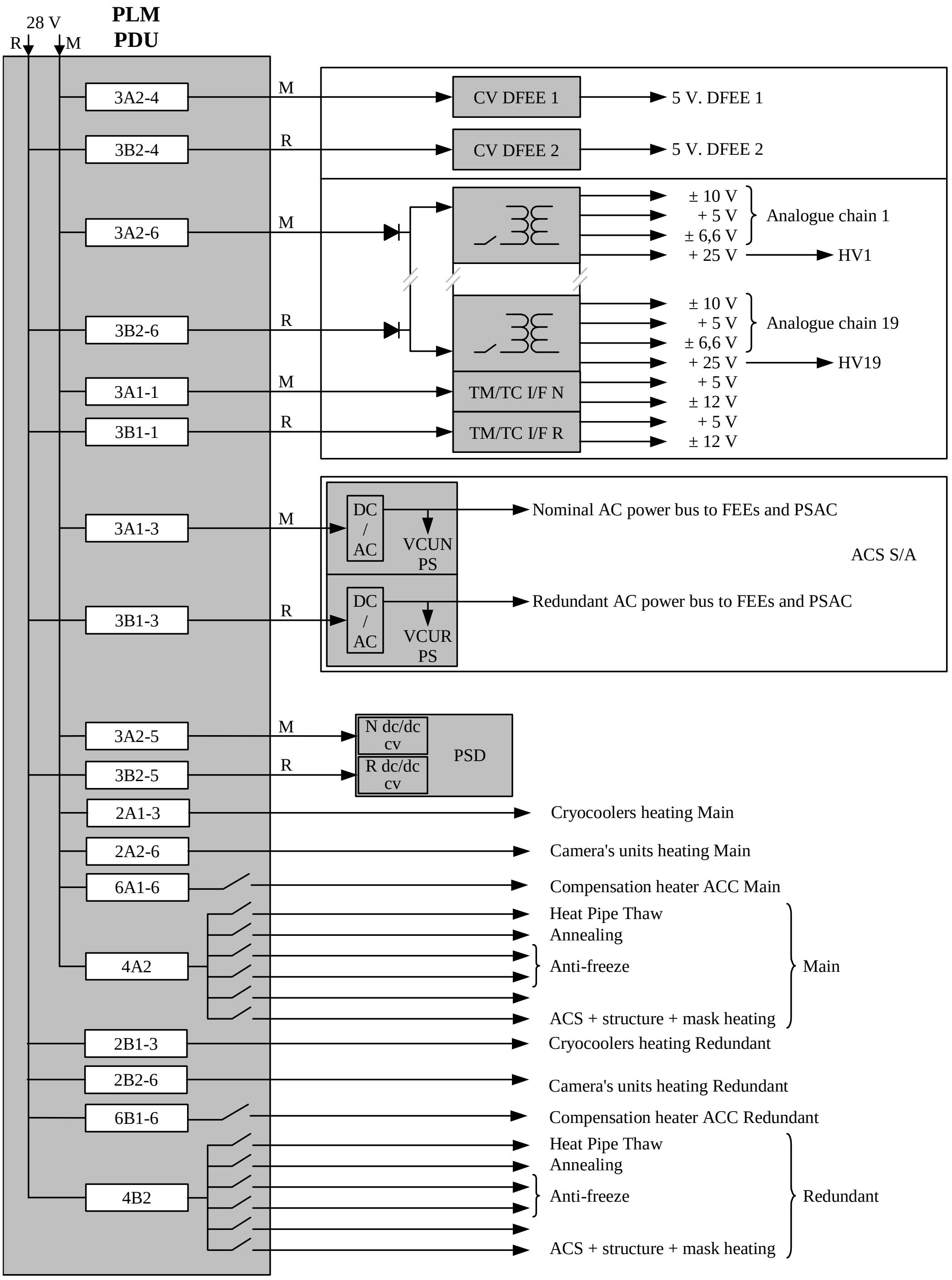


Figure 3.8 - Sub-Assembly Power Supply

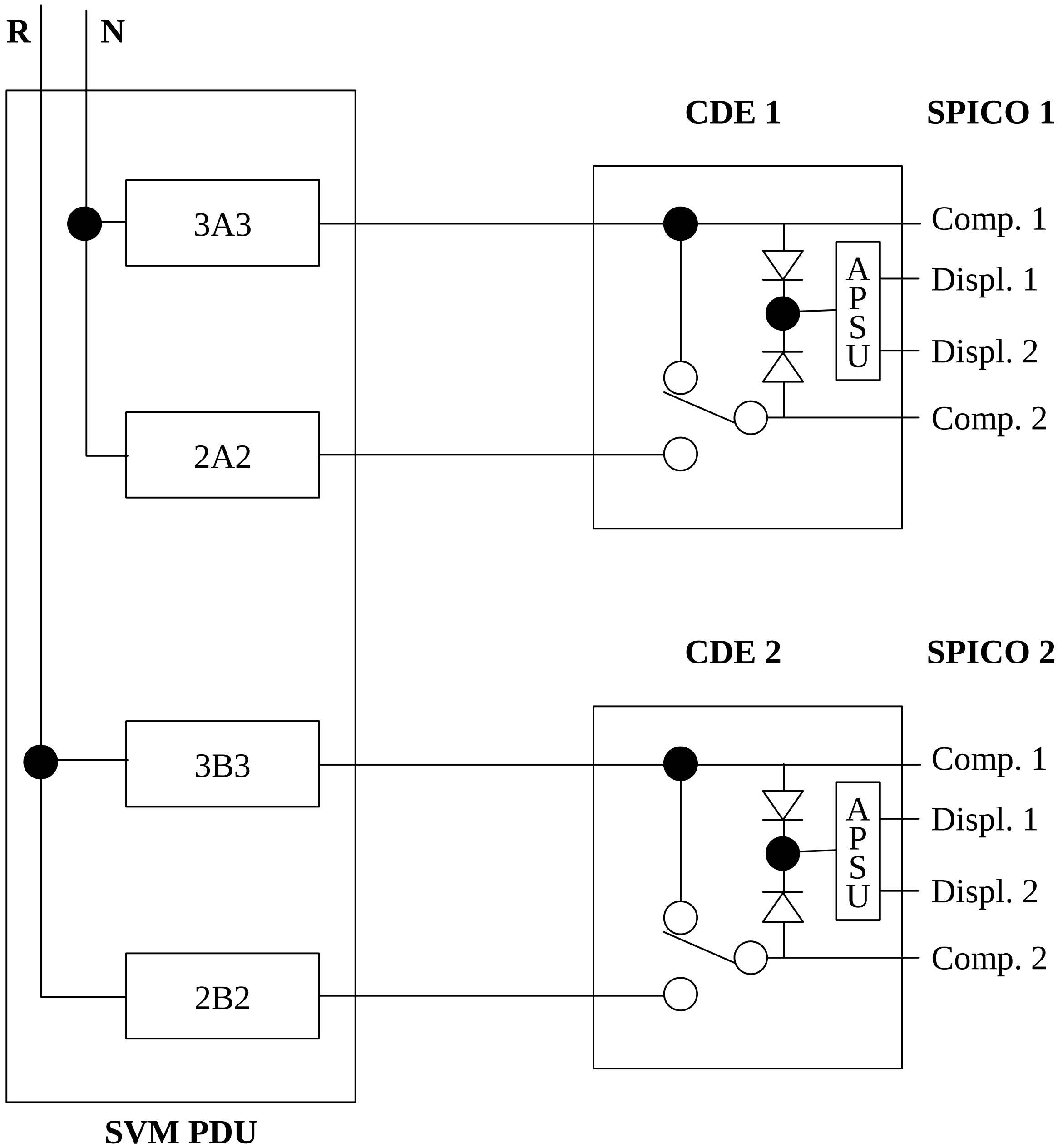


Figure 3.9 - SPICO Power Supply

3.4.3. Definition function and use of the required power lines

See paragraph 1.4 and the table 1.7 Volume 2.

3.4.4. Definition of required pyro lines

N.A.

3.4.5. Power profile of each operating mode

See table 1.7 Volume 2.

3.4.6. Redundancy concept

3.4.6.1. Sub-assemblies management

There are three categories of sub-assemblies w.r.t the redundancy:

- Fully redundancy:
  - DPE
  - DFEE
  - AFEE TM/TC Interfaces
- Partly redundancy:
  - ACS: only the VCU (Veto Control Unit) has a redundant part.
  - PSD: only two different low voltage power supplies.
- No redundancy:
  - AFEE: the 19 detector chains are not duplicated but they can be powered by two different primary power bus lines (N + R). They have also two different data interfaces with the DFEE's.

As the sub-assemblies are not cross-trapped, this design leads to switch all the sub-assemblies on the redundant way when a failure occurs in one of them except for GeD chains and ACS detectors chains.

This will be detailed in the contingency procedures.

See figure 3.10 and TM/TC diagram (Refer to SPI-MU-0-1062V3-CNES Annex 1).

3.4.6.2. Heaters management

The heaters management redundancy concept is completely different from the sub-assemblies. Each heater has two independent power bus lines (1 nominal + 1 redundant) which can be activated indifferently nominal or redundant.

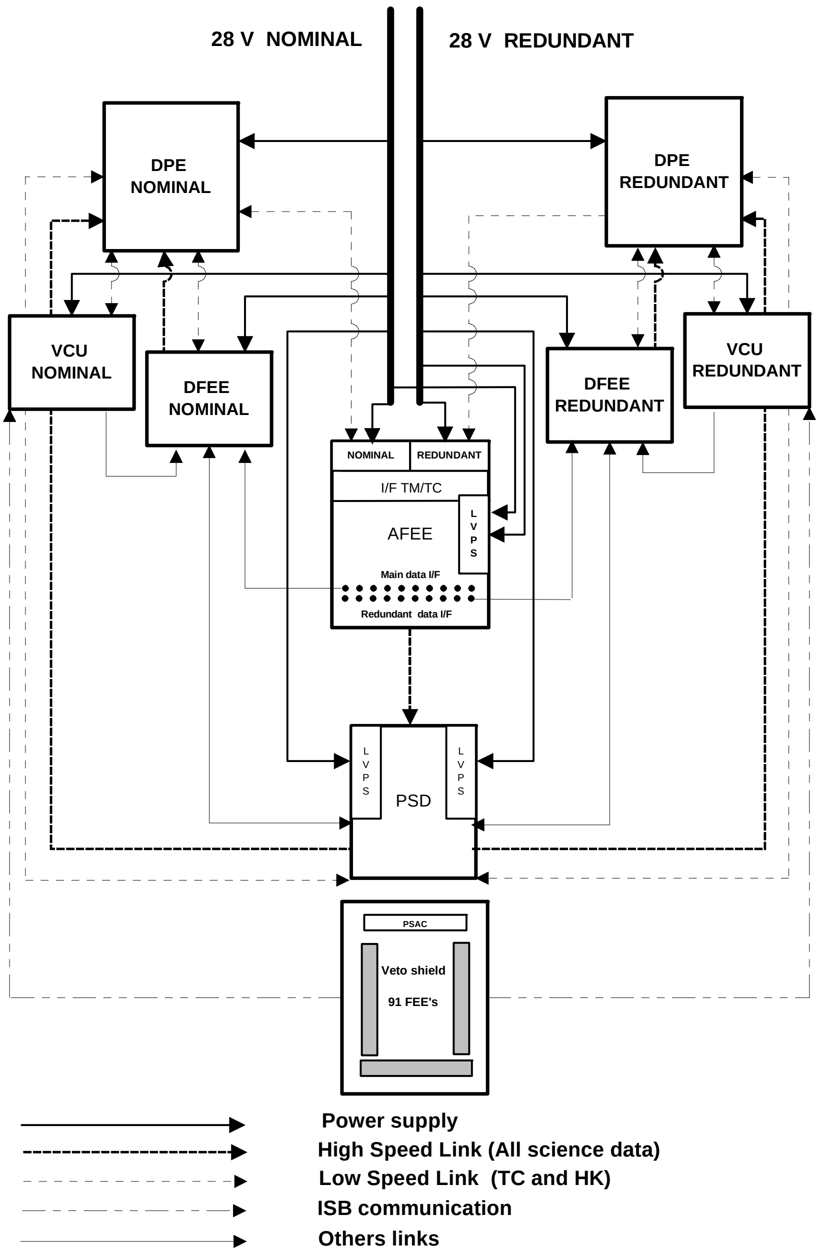


Figure 3.10 - Redundancy Concept

3.4.7. Electrical interface control drawing

Refer to SPI-MU-0-1062V3-CNES Annex 2.

3.5. EMC DESIGN

3.5.1. Instrument design concept

3.5.1.1. Electrical reference

- **Power grounding**

  - **Primary power**

    The primary DC power is grounded to structure in one point within the PLM power sub-system only. All return lines are isolated from structure.

  - **Secondary power**

    Each unit generates its own secondary power, isolated from the input power. The return of each secondary power is connected to its structure unit in one point through an as short as possible link. This point will be the signal reference ground for all the circuits fed by that secondary power.

  - **Signal grounding**

    Between electrical units, signal driver outputs are referenced to ground and signal receiver inputs are isolated from ground. The connection to ground is anyway made only on one side of electrical connections between units. Isolated receivers provide common mode rejection capability. Balance differential signals are preferred.

  - **Insulation**

    The galvanic insulation between any primary power supply pin and the structure in functional configuration are equivalent to a parallel combination of:

    a resistor ≥ 1 MΩ

    a capacitor ≤ 50 nF

    In addition, the primary power lines transformer is insulated from all secondary power. Insulation characteristics between primary and secondary lines is better than 50 nF in parallel with 1 MΩ (EID-A 4.4.3.1.)

    The use of a static shield between primary and secondary windings of transformers is recommended in order to reduce the capacitive coupling between primary and secondary side at very low values (less than 0.1 nF).

- **Electrical units grounding**

  All the units are grounded to the instrument structure, according to § 3.5.1.2.

- **Instrument grounding**

  A grounding stud near the interface with the PLM is foreseen in order to link the instrument and PLM mechanical grounds with a maximum resistivity of 10 mΩ.

  The boundstrap and its fixing points have to meet the grounding requirements § 3.5.1.2. They must remain accessible when spectrometer will be integrated with PLM.

  This grounding stud will be used during integration and tests (out of PLM) to connect the spectrometer to the ground.

3.5.1.2. Grounding description

- **Electrical units**

  All unit structures are made of electrical conductive material which is compatible with the instrument structure.

  Fixing points on the structure have been surfaced to prevent oxidation and are free of any non conductive coating in order to insure a maximum resistivity of 10 mΩ.

  In addition, all the units fit out with a grounding stud in order to boundstrap the unit to the instrument structure. The ratio length / wide of the boundstraps will be less than 5.

  The stud is M 4 x 6 mm (stainless steel) located near the unit mounting plane with at least 20 mm clearance. The stud is easily accessible when the unit is integrated, a torque of 3 Nm will be applied during integration.

- **Mechanical and thermal parts**

  - **Metallic parts**

    Electrical resistivity between each structure metallic part is less than 10 mΩ.

    The mechanical parts which cannot be in direct contact, are linked by bondstraps. Isolated metallic parts as small as they can be, are forbidden, if they are directly exposed to space. They are linked to the structure through any resistor.

    Areas which must make electrical continuity are protected from oxidation and be clear from any resistive surfacing.

- **Non metallic parts**

  Every unit, fixed on a non-metallic structure part, is linked with a near metallic structure part through a boundstrap in order to insure a maximum resistivity of 10 mΩ with the structure.

- **Thermal Multi Layers Insulation (MLI)**

  All conducting layers of metal coated MLI are electrically connected together.

  Each MLI set, as small it may be, is boundstrapped to the structure.

  Grounding is performed in two different points in order to:

  . provide redundancy,

  . make tests easier.

  If an MLI set is too small to allow bounding, design has to be modified.

  Serial MLI grounding is not allowed.

  Electrical resistivity between an MLI set and the main structure is ≤ 1 Ω.

  MLI inside the cryostat is considered separately.

3.5.1.3. Cable shielding and separation

Power and signal lines are grouped into the following EMC classes:

Class 1: Power lines

Class 2: Digital lines and high level analogue lines

Class 3: Pyro

Class 4: Low level sensitive lines

Class 5: RF

Lines of different EMC classes are separated by at least 5 cm and are routed through separate connectors. Where this is not possible, separation are implemented by a row of grounded pins.

Lines of Class 2 to Class 5 are shielded.

These rules will also be preferably applied within electrical units.

The active wire(s) is twisted with the return wire. The twisted wires are routed through a connector on adjacent pins to minimise the wire loop.

Cable shield is not used as the return path for signal or power.

Harness and connector layout permit the termination of cable shields at both ends.

Shields are terminated on metallic shell all-over 360 deg. For less sensitive signal lines only (i.e. Class 2) the pig-tail connection to connector metallic shell is allowed.

The pig-tail length is less than 5 cm. The ground connection of the shield via a connector pin is forbidden. The unshielded length of any single cable does not exceed 2.5 cm.

The resistance between any harness shield and its ground reference taken on the unit grounding point is less than 7,5 mΩ.

3.5.2. Grounding network block diagram

See Figure 3.11 showing the general grounding network without redundancies.

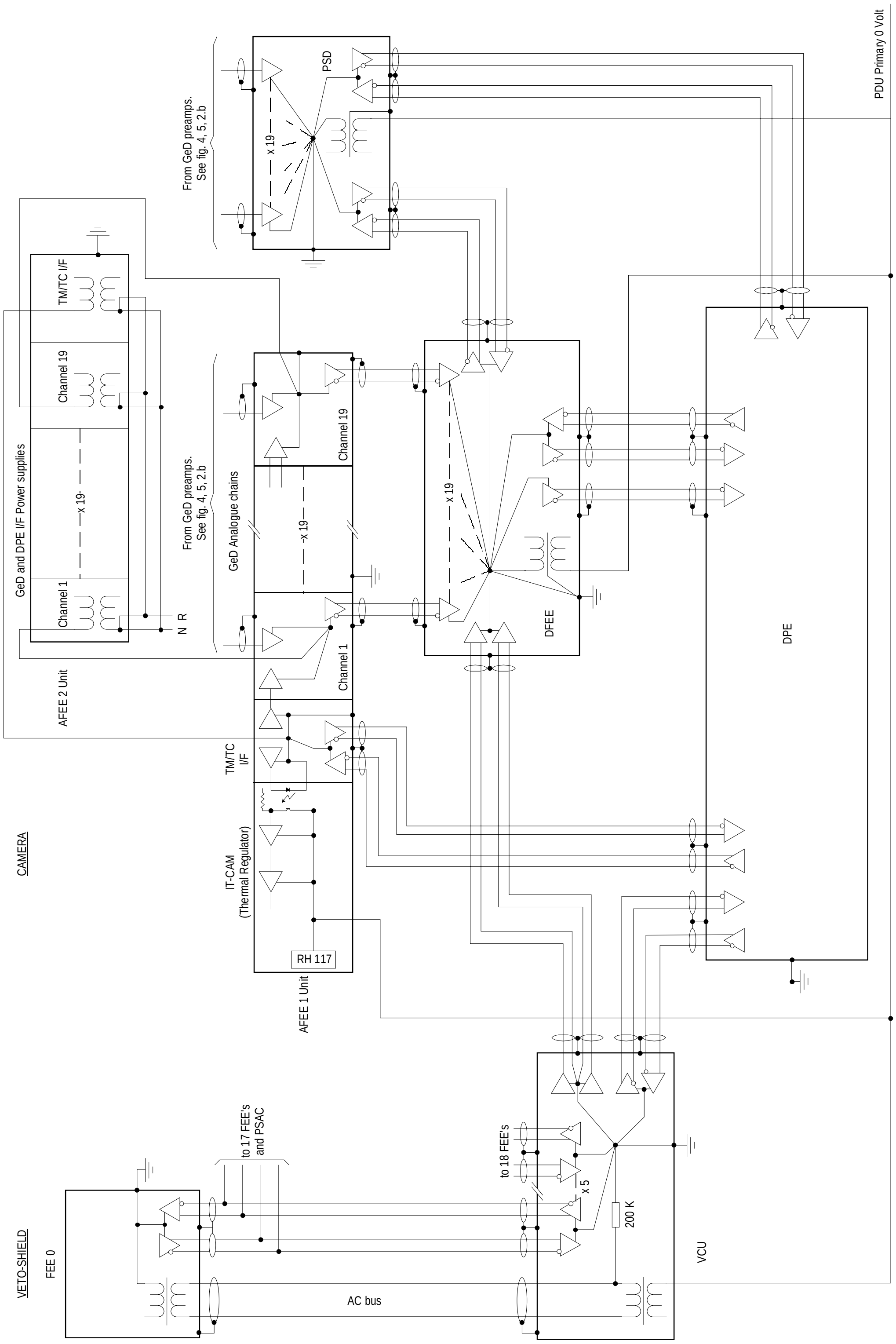


Figure 3.11 - General Grounding Network

3.6. DATA HANDLING INTERFACES

A Data Processing Electronics (DPE) is in charge of:

- data acquisition from spectrometer and transmission to SVM for telemetry,
- telecommands acquisition from SVM and dispatching towards the concerned spectrometer equipments.

3.6.1. Instrument data handling design

- Data are collected by DPE from the spectrometer equipments:
  - 2 multiplexed high-speed RS 422 link, for scientific data from DFEE and PSD,
  - 4 multiplexed low-speed bi-directional RS 422 links, for housekeeping data from AFEE, ACS, PSD and DFEE,
  - 17 analogue channels for voltage and temperature monitoring.
- Data are collected by RTU from spectrometer equipments:
  - 34 analogue channels for temperature monitoring when SPI is off.

3.6.1.1. Scientific data

These data concern each event detected by the Ge detector and processed by the camera electronics, the DFEE and the PSD.

Events are transmitted from DFEE and PSD to DPE by blocks through 2 multiplexed high speed RS 422 serial links (up to 5 Mb/s) as defined in EID-A.

Two blocks, one from DFEE and one from PSD (each of them enabled by a dedicated signal issuing from DPE) are transferred each 125 ms in synchronism with the 8 Hz clock provided by CDMU to DPE.

Transmission of each block inside a 125 ms period is continuous and its length is fixed by DPE for the whole working sequence.

Data are transmitted, MSB first.

DFEE block size (out of burst case)

The DFEE block contains:

- The good events (60 e/s/d, i.e. 1140 e/s) with:
  - The simple good events (45.6 %, encoded with 32 bits)
  - The multi-detector events (12.1 %, encoded with 80 bits)
  - The PSD flagged events (42.3 %, encoded with 48 bits)
- The spectrum events (1000 e/s/d: maximum number able to be processed by DPE).

The maximum DFEE block size for transmission to DPE each 125 ms is:

$$\left[\left(60\text{x}\frac{45.6}{100}\text{x}32\right)+\left(60\text{x}\frac{12.1}{100}\text{x}80\right)+\left(60\text{x}\frac{42.3}{100}\text{x}48\right)+\left(1000\text{x}16\right)\right]\text{x}\frac{19}{8} = 44\ \text{kbits (\~ 6 kbytes)}$$

(+ 270 bytes for header)

DFEE block size - Burst case

In case of burst, priority is given to good events transmission.

The limitation in this case is given by the maximum DFEE process capabilities which is design for 67000 events per second.

Consequently, the 22 DFEE output buffers are sized with 16 Kbytes each and are dedicated as following:

- 19 x 16 kbytes for the 19 spectra buffers,
- 3 x 16 kbytes for the good events.

In case of burst, it is foreseen to transmit to DPE at least the content of 3 x 16 kbytes buffers (+ 1 kbyte PSD data) in one 125 ms time frame. This represents a maximum of 49 kbytes per 125 ms i.e. 3.14 Mb/s.

PSD block size - (Normal mode)

The maximum event number which can be processed by PSD is 1000/s. So the maximum block size for 125ms period transmission is:

+ 250 x 16 bits words (processed events)

+ 45 x 16 bits (event curve sampling)

+ 3 x 16 bits words (curve header)

+ 1 x 16 bits word (bloc header)

i.e. ~ 598 bytes.

PSD block size - (Calibration mode)

The transmitted data concerns only the event sample curves, on the basis of

5 curves per 125 ms with:

45 words per curve + 3 words for the curve header

+ 2 words (processed event per curve)

+ 1 word (5 curves block header)

(i.e. 51 words per curve).

The block size for each 125ms period transmission from PSD to DPE is:

51 x 5 = 255 x 16 bits words

i.e. ~ 510 bytes.

For a maximum TM rate of 42 Kb/s, about 50 curves per second can be transmitted to ground.

- The enable duration is fixed to 308 words.

3.6.1.2. Digital housekeeping data and commands

Digital housekeeping data and commands are transmitted from / to 4 SPI units to / from DPE through multiplexed bi-directional low speed RS 422 serial links (up to 64 Kb/s).

These serial links are controlled by standard USART with internal double SYNC character processing, synchronous 8 bits characters and no parity, as defined in EID-A § 4.5.2.3.7.

- Housekeeping data are transmitted from each unit on DPE cyclic commands.
- Commands are issuing from DPE, they will be:
  - individual commands (e.g. housekeeping acquisition request...)
  - configuration files containing all setting parameters for each sub-system.

These configuration files will be sent to each sub-assembly, in one or several frames, before the beginning of the operational mode.

Each frame will be followed by an acknowledge from the receiver.

3.6.1.2.1. Digital housekeeping data contents and acquisition rate for each sub-assembly

All digital HK are downloaded through VCO channel except those acquired with 1sec. rate, from DFEE, which are science HK and are downloaded through VC1 channel.

- **FROM AFEE**

Acquisition rate: 640 s

		Size (Bytes) including CS & header
AFEE TM/TC temp.	(1)	16 (grouped)
Current source acq.	(1)	
Annealing 1 and 2 temperature	(2)	
Be bus bar temperature	(2)	
Cold plate temperature	(4)	
Thermal braid and H-bus temperature	(2)	
Pre-amp. temperature		22
DC output voltage from pream.		22
Detection threshold level		22
HV monitoring		22
ADC converters temperature		22
Analysis configuration		22
	Total	**148 bytes**

Acquisition rate: 8 s

		Size (Bytes)
AFEE DC-DC converters temperature*		22
LV monitoring*		22
Status word		6
** Downloaded with 640 s rate*	**Total**	**50 bytes**

Acquisition rate: 3840 s

HV settings		22
Low threshold settings		22
Chain parameters settings		22
On/Off configuration settings		12
	Total	**78 bytes**

- **FROM DFEE**

Acquisition rate: 1 second
(Science HK - VC1 channel)

		Size (Bytes)
GeD event counting rate above ULD		19 x 2
GeD event counting rate (all)		19 x 2
Non-vetoed GeD events c.r.		19 x 2
Veto pulse counting rate		6
AFEE Dead time		19 x 3
ACS Dead time		3
PSD events count		2
Clock monitoring		24
ASIC status		4
Time from start		2
ACS-AFEE gate count		3
PSD Gate dead time		3
PSD drop count		2
Headers and CS		25
	Total	**242 bytes**

Acquisition rate: 8 s

	Size (Bytes)
Status word	6

Acquisition rate: 3840 s

Current software parameters setting	30
Current ASIC parameters settings related to sub-unit activation, algorithm options, and HSL adjustment	20
Current ASIC parameters setting related to front end and signal alignment and veto gate adjustment	26
Total	**76 Bytes**

- **FROM PSD**

Acquisition rate: 8 s

	Size (Bytes)
Status word	6

Acquisition rate: 64 s

Requests A/O HK, command type and count, 8 Hz count, DFEE id.	28
Buffer contents, error status and channel rate	28
Channels statistics	56
Rate history	140
Total	**252 bytes**

Acquisition rate: 640 s

Library status	28
Soft and analogue control	28
Total	**56 bytes**

Acquisition rate: 3840 s

Detectors enable settings	12
Energy low threshold settings	48
Energy high threshold settings	48
ADC offsets settings	12
Library selection on control	90
Curve transmission rate	8
Total	**218 bytes**

- **FROM ACS**

Acquisition rate: 8 s

	Size (Bytes) including CS & header
FEE rate meter and status	22
Gamma burst start time	10
Overall counter	360
VCU status word	6
Total	**398 bytes**

Acquisition rate: 640 s

	Size (Bytes)
VCU voltage and current values	6
Segment temperatures	20
FEE's analogue status	208
Alert status	102
Total	**336 bytes**

Acquisition rate: 3840 s

	Size (Bytes)
System service and FEE configuration	102
Veto signal generation conditions	102
FEE's rate meter settings	102
FEE's veto signal delays	58
FEE's event trigger threshold settings	102
FEE's energy discriminator settings	102
HV settings	102
FEE's veto pulse width and veto mask	16
ISB communication status for each FEE	16
Total	**702 bytes**

- **FROM DPE**

1 reference channel for analogue acquisition (acquisition rate: 8 s).

1 reference channel for PT500 thermistors (acquisition rate: 10 mn).

1 reference channel for YSI thermistors (acquisition rate: 10 mn).

Sum up **Packets**

39	(1)	bytes in	8 s	1 packet CSSW
397	(3)	bytes in	8 s	1 packet (60011)
252		bytes in	64 s	1 packet (60060)
599	(3)	bytes in	640 s	2 packets (60601;60602)
1180		bytes in	3840 s	3 packets (63841;63842;63843)

per polling cycle	**2**	**packets max**
	1	**packet for CSSW**

Total	**3**	**packets**

The number of packets per pooling is 2 or 3 (including the CSSW packet) depending of the cycle number.

(1) in CSSW packet
(2) every 8 s for IASW processing and in HK packet every 640 s only
(3) because the number of byte is odd we add a byte filled with 0 to the packets 60011 and 60602

3.6.1.2.2. Digital commands

- Sub-systems mode commands:

	Size (Bytes)
. START	1
. STBY	1
. CONF	1
. DIAG	1
. CAL only for PSD	1
. EMCY	1

- Configuration commands

- Towards ACS

	Size (Bytes)
. System service	102
. High voltage setting	102
. Event trigger threshold setting	102
. Veto signal delay	58
. Veto signal generation condition	102
. Rate-meter setting	102
. Energy discriminator setting	102
. Veto pulse width and veto mask	16
. FEE's reset	16

- Towards AFEE

	Size (Bytes)
. High voltage setting	22
. Thresholds setting	22
. Chain parameter setting	22
. Chain 0/0 configuration	12

- Towards DFEE

	Size (Bytes)
. Software parameter	30
. ASIC parameters related to sub-unit activation processing options and HSL adjustment	20
. ASIC parameters related to front-end signal alignment and veto gate adjustment	26

• Towards PSD

		Size (Bytes)
. Configuration commands:	Detector enable	12
	Energy threshold	96
	A/D offset control	12
	Library selection and control	90
	Curves transmission rate	8
	Library description and control	226

. Library up-dating

PSD library is stored in PSD unit within EEPROMs.

The library is made of 40 sampled curves per detector with 64 samples per curve and 24 bits per sample which represent about 1,2 Mbits data.

Twice a year (TBC) this library will be up-dated from ground by telecommands through DPE and RS422 low speed link.

• Patch and dump commands

- for the following sub-assemblies: ACS, PSD, DFEE, protocol is described in RD21.

3.6.2. Internal timing concept

Events datation

A 8 Hz clock derived from OBDH clock is transmitted to DFEE by DPE.

This clock is synchronous with the DPE' S/W minor cycle.

Each event detected in the 20 keV - 8 MeV range is time-tagged in DFEE by the mean of a 11 bits counter with a resolution of 102,4 µs.

The content of this counter will be transmitted for each 8 Hz pulse occurrence in the housekeeping data (8 x 24 bits each second).

The on-board time of each 8Hz pulse is frozen in a dedicated DPE register with a resolution of 1.9 µs. This time, which is readable by the IASW, is associated by the IASW to the corresponding block received from the DFEE.

That means time information is available during 125 ms and is read by IASW within the 125ms period.

For more details see RD 25.

3.6.3. Instrument handling

On the ground, operation plans containing the necessary telecommands are defined for each mode and for each inter-mode transition. See chapter 1.2 Volume 2.

The instrument switches from one mode to another by:

- ground telecommand,
- time tag telecommand sent by the satellite,
- by the instrument itself on broadcast packet information (enable by ground).

Interruption of nominal mode for emergency reason shall be possible by on-board decision.

3.6.3.1. Ground telecommands overview

Most of ground telecommands are received and processed by the DPE, some of them are directly sent to the SVM or PLM in order to power the sub-assemblies and manage the cooling system.

- The different kinds of telecommands are:

Name	Type*	Sub-type*	Definition
Configuration	5	3	Load any parameters needed to set up the instrument and its sub-assemblies.
Reporting – On-request	5	4	Request parameters values loaded previously or processed from the instrument or its sub-assemblies.
Change mode	5	5	Change instrument functioning mode.
Load memory	6	1	Load a part of memory image of sub-assemblies memories.
Dump memory	6	2	Dump a part of memory image of sub-assemblies memories.
Tests Commands	13	1	TC acceptance test.
Broadcast Packet	15	1	Parameters for IASW configuration
Start Task	5	1	Process starting (ACS calibration; S/W maintenance)
Stop Task	5	2	Process stopping (S/W maintenance)

* PSD classification (AD3)

- Telecommands sent through SVM RTU for cooling system management

Type	Sub-assemblies involved	DB reference	Detailed description
Configuration	On/Off cryocoolers and CDE 1	P3030/P3031 P3060/P3061	See § 1.2.13 Volume 4
	On/Off cryocoolers and CDE 2	P3270/P3271 P3300/P3301	‘’
	Amplitude setting for compressors A+B n° 1	E9960 E9961 E9962 E9963 E9966 E9967	‘’
	Amplitude setting for compressors C+D n° 2	E9980 E9981 E9982 E9983 E9986 E9987	‘’
	CDE 1 relay configuration	E9968 E9969	
	CDE 2 relay configuration	E9988 E9989	

- Telecommands sent through PLM RTU for powering the sub-assemblies

Type	Sub-assemblies involved	DB reference	Detailed description
Configuration	On/Off camera unit’s heating Nominal	T5006/T5005	See § 1.1.1 & 1.1.2 Volume 4
	On/Off camera unit’s heating Redundant	T5106/T5105	
	On/Off thermal control Nominal	T4089/T4088	‘’
	On/Off thermal control Redundant	T4339/T4338	
	On/Off compressors 1 heating	T5001/T5000	‘’
	On/Off compressors 2 heating	T5101/T5100	‘’
	On/Off Heat pipe thaw Nominal	T5011/T5010	‘’
	On/Off Heat pipe thaw Redundant	T5111/T5110	
	On/Off annealing heating Nominal	T5016/T5015	‘’
	On/Off annealing heating Redundant	T5116/T5115	
	On/Off antifreeze 12w Nominal	T5021/T5020	‘’
	On/Off antifreeze 12w Redundant	T5121/T5120	
	On/Off antifreeze 6w Nominal	T5026/T5025	‘’
	On/Off antifreeze 6w Redundant	T5126/T5125	
	On/Off Mask + ACS heating Nominal	T5036/T5035	‘’

	On/Off Mask + ACS heating Redundant	T5136/T5135	See § 1.1.1 & 1.1.2 Volume 4
	On/Off AFEE I/F TM/TC Nominal	T4041/T4040	‘ ’
	On/Off AFEE I/F TM/TC Redundant	P4291/P4290	
	On/Off detections chains power supply Nom	T4061/T4060	‘ ’
	On/Off detections chains power supply Red	P4311/P4310	
	On/Off DFEE Nominal	T4053/T4052	‘ ’
	On/Off DFEE Redundant	P4303/P4302	
	On/Off ACS VCU Nominal	T4049/T4048	‘ ’
	On/Off ACS VCU Redundant	P4299/P4298	
	On/Off PSD Nominal	T4057/T4056	‘ ’
	On/Off PSD Redundant	P4307/P4306	
	On/Off DPE Nominal	T4045/T4044	‘ ’
	On/Off DPE Redundant	P4295/P4294	
	On/Off DPE Relay 0 Nominal	E9800/E9801	‘ ’
	On/Off DPE Relay 0 Redundant	F9800/F9801	
	On/Off DPE Relay 1 Nominal	E9805/E9806	‘ ’
	On/Off DPE Relay 1 Redundant	F9805/F9806	
	On/Off CDE 1 heaters Nominal	T5575/T5576	See § 1.2.13 Volume 4
	On/Off CDE 2 heaters Redundant	T5675/T5676	
	On/Off compensation heaters Redundant	P4459/P4458	‘ ’
	On/Off compensation heaters Main	P4209/P4208	‘ ’

- Telecommands sent through CDMU

  After sent by the ground, the telecommand is received by CDMU which dispatches to the related instrument DPE through the OBDH bus. The telecommand is processed by the CSSW, and put down into the RBI (Remote Bus Interface). Then, the application SW (IASW) can get the telecommand, process it and sends an adequate Command to the sub-assemblies. The telecommands listed below are intended for DPE (IASW).

Type	Sub-assemblies involved	DB reference	Detailed description
Configuration	Analogue chains	E0001-E0004	cf. § 1.2.1
	DFEE	E0101-E0103	cf. § 1.2.3
	ACS	E0201-E0222 E0224	cf. § 1.2.5
	PSD	E0300-E0316	cf. § 1.2.7
	DPE (IASW)	E0500 E0516 E0518 E0519 E0555	cf. § 1.2.9
	Diagnostic	E0581-E0586	cf. § 1.2.10

Type	Sub-assemblies involved	DB reference	Detailed description
Reporting – On-request	Analogue chains	E0011-E0014	cf. § 1.2.2
		E0020-E0031	
	DFEE	E0111-E0113	cf. § 1.2.4
	ACS	E0251-E0273	cf. § 1.2.6
		E0280-E0290	
	PSD	E0320-E0329	cf. § 1.2.8
		E0342-E0343	
	DPE (IASW)	E0523 E0524 E0525 E0567	cf. § 1.2.9
	Diagnostic	E0591-E0596	cf. § 1.2.11

Type	Sub-assemblies involved	DB reference	Detailed description
Change mode	DPE (IASW)	E0501-E0506 E0555 E9024	cf. § 1.2.9

Type	Sub-assemblies involved	DB reference	Detailed description
Load memory	DFEE	E0507-E0508	cf. § 1.2.9
	ACS	E0509-E0510	cf. § 1.2.9
	PSD	E0511-E0512	cf. § 1.2.9

Type	Sub-assemblies involved	DB reference	Detailed description
Dump memory	DFEE	E0513	cf. § 1.2.9
	ACS	E0514	cf. § 1.2.9
	PSD	E0515	cf. § 1.2.9

Type	Sub-assemblies involved	DB reference	Detailed description
Test commands	DPE (IASW)	E0517	cf. § 1.2.9

Type	Sub-assemblies involved	DB reference	Detailed description
Start and Stop Tasks	DFEE	E0565 E0575	cf. § 1.2.9
	ACS	E0563 E0566 E0573	cf. § 1.2.9
	PSD	E0564 E0574	cf. § 1.2.9

3.6.3.2. Telemetry overview

The Instrument Telemetry is made up:

- Housekeeping Telemetry
- Science telemetry

The HK telemetry is downlinked by two ways: via SVM RTU or PLM RTU and via Instrument DPE.

In the first case, telemetry parameters of an instrument are mixed with satellite ones. In second case, all the parameters are arranged in packets dedicated to the instrument and identified by specific APID's.

- **The different kinds of housekeeping telemetry packets are:**

Name	Type *	Sub-type *	Definition
Cyclical	1	8	CSSW parameters downlinked each polling cycle (8s)
	1	5-11	IASW parameters downlinked at different frequencies
			SRTU type 1 sub-type = 1
			PRTU type 1 sub-type = 5
	TBD	TBD	SRTU or PRTU parameters downlinked each 8s
On-Request	5	4	Report to configuration or measurement request TC
	6	2	Report to dump request TC
	13	TBD	Report to diagnostic purpose request TC

Type	Purpose	DB reference	Detailed description
Cyclical	SRTU - Cryocooler Temperatures (8 parameters)	200 000	cf. § 1.4.10
	PRTU – Instrument HK parameters (32 parameters)	200 500	cf. § 1.4.1.2 & 1.4.1.3
	CSSW HK	240108	cf. § 1.4.8
	IASW HK – one cycle acquisition (8 s)	60011	cf. § 1.4.1.2
	IASW HK – 8 cycles acquisition (64 s)	60060	cf. § 1.4.1.3
	IASW HK – 80 cycles acquisition (640 s)	60601-60602	cf. § 1.4.1.4
	IASW HK – 480 cycles acquisition (3840 s)	63841-63844	cf. § 1.4.1.5

Type	Purpose	DB reference	Detailed description
On-Request	Configuration request (memory re-reading)	64000-64041 64046	cf. § 1.4.2
	Housekeeping data request (measured parameters)	64640-64664	cf. § 1.4.2
	ACS calibration data	64700	cf. § 1.4.2.
	Memory Dump	64042-64044	cf. § 1.4.3
	Diagnostic	64901-64906	cf. § 1.4.6

- **The Science data are packetised as follows:**

These data are downlinked by VC1 channel which is not opened at MOC.

Type	Purpose	DB reference	Detailed description
Science Housekeeping Data	DFEE counters acquired every second. Downlinked each cycle (8s)	60000-60004	cf. § 1.4.1.1
Science Data	Photon/Photon acquisition	61000-61003	cf. § 1.4.9.1
	Spectra acquisition	61100-61101	cf. § 1.4.9.2
	Diagnostic	61136-61147	cf. 1.4.6

3.6.4. TM/TC diagram

See SPI-MU-0-1062V3-CNES Volume 3 Annex 1.

3.6.5. DPE and RTU channels

3.6.5.1. DPE channels

Acquisition rate: 640 s

Location		Number	Range °C	Accuracy °C	RESOLUTION °C
PSD temperature	E3988	1	- 40°C; + 70°C	± 3,1	< 1,24
DFEE temperature	E3986	1	- 40°C; + 70°C	± 3,1	< 1,24
AFEE I/F unit power supply	E3995	1	- 40°C; + 70°C	± 3,1	< 1,24
ACS temperature	E3991	1	- 40°C; + 70°C	± 3,1	< 1,24
Active cooling radiator temp.	E3994 E3997	2	- 40°C; + 70°C	± 3,1	< 1,24
Total		**6**			**< 0,5 in -28; + 40° range**

Table 3.7 - Thermistor Channels (6 Available)

Acquisition rate: 640 s

Location		Number	Range °C	Accuracy °C	RESOLUTION °C
200K stage	E3981-E3984	4	- 110; + 50	± 4,3	0,7
Heat pipes	E3992 E3996	2	- 110; + 50	± 4,3	0,7
Cold link tube	E3993	1	- 110; + 50	± 4,3	0,7
Total		**7**			

Table 3.8 - PT 500 Channels (10 Available)

Acquisition rate: 8 sec

Location		Number	Range	RESOLUTION °C
TM / TC I/F LVPS	E3985	1	0 - 5 V	20 mV
ACS –LVPS	E3990	1	0 - 5 V	20 mV
PSD – LVPS	E3989	1	0 - 5 V	20 mV
DFEE – LVPS	E3987	1	0 - 5 V	20 mV
Total		**4**		

Table 3.9 - Analogue Channels (16 Available)

In addition with the parameters listed above, one internal DPE references voltage for each of the three channel groups are downlinked.

3.6.5.1.1. DPE ON/OFF commands

Not used.

3.6.5.2. RTU channels

3.6.5.2.1. RTU analogue channels

34 analogue channels for cryostat, cryocoolers and structure temperature are needed to be monitored even when DPE is off.

Acquisition rate: 8 seconds.

Location		Number	Range °C	Accuracy °C	RESOLUTION °C
Compressor temperature	T5007 T5025 T5006 T5024	4	- 55; + 90	± 3	< 1 (TBC)
Displacers	T5008 T5026	2	- 55; + 90	± 3	< 1 (TBC)
Active cooling radiator temp.	T5009 T5027	2	- 55; + 90	± 3	< 1 (TBC)
Electronics (off) (AFEE1, AFEE2, PSD, DFEE) T5010 T5011 T5013 T5012		4	- 55; + 90	± 3	< 1 (TBC)
Structure (ACS + MSK +LSA) T5003-T5005 T5021-T5023 T5001 T5019 T5002 T5020		10	- 55; + 90	± 3	< 1 (TBC)
Total		**22**			

Table 3.10 - Thermistor Channels (22 Available)

Location		Nb	Range °C		Accuracy °C		Resolution °C
			Full	Effective	On full range	On effective range	
Cold plate transfer	T5107 T5114	2	- 200; + 200	- 193; + 63	± 6 (BOL) ± 23 (EOL)	± 3	< 1,6
Heat pipe evaporator	T5103 T5110	2	- 200; + 200	- 130; + 35		± 2	< 1,6
200 K stage	T5105 T5112	2	- 200; + 200	- 130; + 35		± 2	< 1,6
Heat pipes	T5106 T5113	2	- 200; + 200	- 130; + 35		± 2	< 1,6
Ammonia	T5102 T5109	2	- 200; + 200	- 130; + 35		± 2	< 1,6
Passive rad.	T5104 T5111	2	- 200; + 200	- 130; + 35		± 2	< 1,6
Total		**12**					

Table 3.11 - PT 500 Channels (15 Available)

3.6.5.2.2. RTU ON/OFF commands

None - Except for cryocooler - TBD -

3.6.5.2.3. RTU Serial digital commands

Two serial digital lines have to be foreseen for cryocoolers setting point temperature or compressors stroke commands - TBD -

3.6.5.3. Special channels

Deleted

3.6.6. Definition of telemetry packet rate per instrument mode

3.6.6.1. Telemetry packet rate

For further details, see RD 22.

3.6.6.2. TC packet rate

With a maximum TC rate of 1,2 Mbits (PSD need) and a TC packet size of 248 bytes (cf. CSSW URD § 3.1.3.1.2), the TC packet number will be: 605 which represents for a TCP rate of around 7 TCP from ground per 8 second telemetry cycle: 12 min (720 s) for up-loading 1,2 Mb (best case).

3.7. INSTRUMENT SOFTWARE AND INTERFACES

3.7.1. Instrument software architecture

The instrument on-board software includes the following distinct components:

- The DPE software composed of:
  - Bootstrap software
  - Common Services Software (CSSW)
  - Instrument Application Software (IASW)

The DPE CSSW provides all common low-level services required to support the processing of instrument applications.

- The sub-assemblies software for:
  - AFEE
  - DFEE
  - ACS
  - PSD

3.7.2. Common service software (CSSW)

The CSSW is made up of several components.

- The SW services are divided into:
  - ICB, which is the entity containing the interface provided by the Instrument Communication Buffer and used for DPE - ground communication as TC reception and TM transmission
  - RTX, is the interface provided by the CSSW RTX (Operating System) needed by IASW. It contains operations dealing with typical real-time features like task scheduling, inter-task communication
- The SW drivers provide services which allow the IASW to access the features of the following HW components:
  - serial lines, such as High Speed Lines and Low Speed Lines,
  - analog Channels used for reading instrument physical parameters such as temperatures,
  - relays for actuating instrument devices,
  - OBDH allowing the capture of the on-board time,

- microprocessor, providing services for using the 1750A timers, as well as interrupt related capabilities.

The following capabilities are implemented:

- Interrupt processing
- Packet TM/TC handling, dealing with the traffic between the CDMU and the DPE via OBDH bus
- I/O device drivers
- TM/TC exchanged between IASW and CSSW
- Task handling
- Time synchronization
- Error handling

The short above description corresponds to the standard CSSW definition used for IASW design without particular customization needs. However some specific features of the CSSW dynamic architecture have been taken into account when building the IASW architecture. See SPI User's Manual Volume 3: SIASW Dynamic architecture document.

3.7.3. Instrument specific application software (DPE IASW)

3.7.3.1. Introductory

SPIASW is responsible for the following functions:

- Instrument scientific data management including:
  - scientific data acquisition
  - scientific data processing
  - scientific datation
  - scientific data formatting for telemetry transmission
- Instrument monitoring including:
  - units analogue and digital parameters
  - data handling monitoring
- Instrument commanding including:

- configuration management
- modes management
- telecommand management

3.7.3.2. IASW architecture

The detailed description of the different tasks shown in the following diagrams can be found in SPI-MU-0-1062V3-CNES Volume 3.

A DPE memory map is also shown in the same volume.

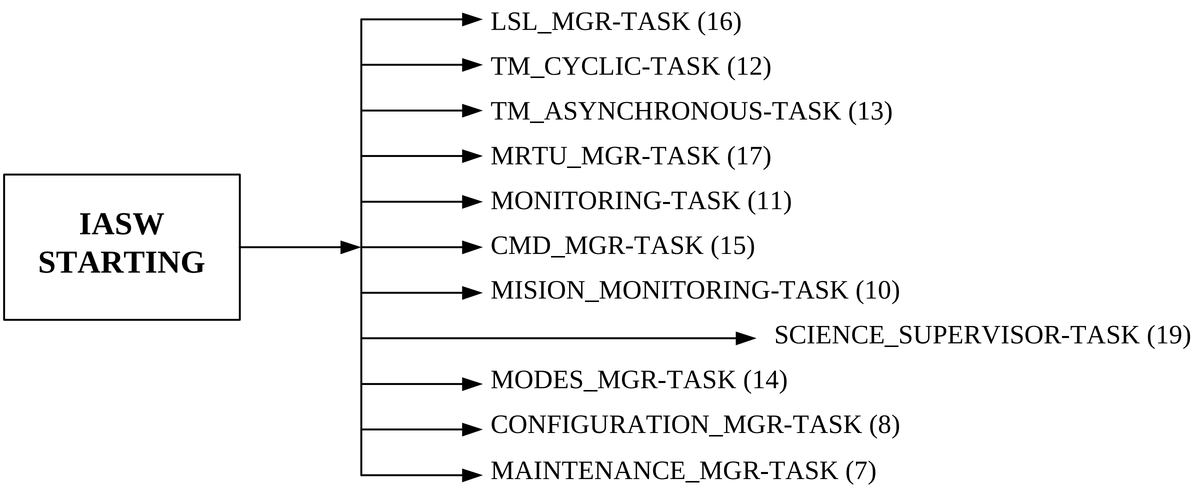


Figure 3.12 - Tasks Activated at IASW Starting

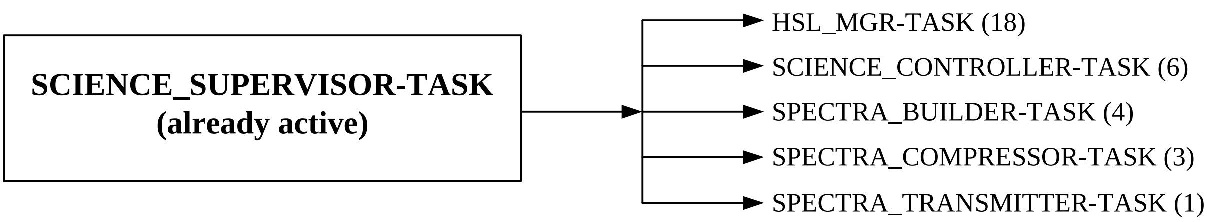


Figure 3.13 - Tasks Activated in Operational Mode

3.7.3.3. Data flow management

3.7.3.3.1. Data to be handled

- Science data

  - Events and data associated

When a photon reaching the detectors is coming in the field of view, it is called a good event.

When a photon reaching the detectors is coming out of the field of view, it is called a vetoed event.

Then these good events are sorted into three types:

- the single events, detected by one detector,
- the PSD flagged events; single events also processed by PSD,
- and the multidetector events, detected by several detectors.

The information related to each event are:

- energy deposed by the photon,
- relative time of the detection,
- address of the concerned detector,
- impulse analysis information,
- impulse digitalized curve.

According to the type of the event and the operating active mode, more or less information is associated to each event.

- Events blocks definition

  The information related to the detected photons are structured in blocks for the transmission from the sub-assemblies (DFEE and PSD) to the SPIASW. Each block contains the information acquired or processed during a time slot of 125 ms by the sub-assemblies. Three types of blocks are built:

  - Good events block

    Provided by the DPEE, it is made up of three sub-blocks: the single events sub-block, the PSD flagged events sub-block, and the multidetector events sub-block.

Except in case of transmission overflow, the all three sub-blocks are present in all modes. But they can be emptied according to some modes. They contain the complete DFEE processed information for each event including time, energy and detector address.

- PSD information block

  Obviously provided by PSD, there is only one sub-block containing both impulse analysis information and impulse digitalized curve if any.

- Spectrum data block

  Provided by DFEE, it is made up of 1 to 19 sub-blocks, each block related to a detector. Each sub-block contains the energy information of the spectrum acquired by the corresponding detector since the last sub-block acquisition by IASW.

- Science telemetry

  The above described information blocks are managed by SPIASW and put into telemetry packets. See User's Manual Volume 4 § 1.4.9.

• Housekeeping data

  - all the technological HK data acquired from the sub-assemblies, via the LSL and the mRTU management functions and necessary to monitor the instrument from the ground,

  - all the science HK data acquired from the DFEE, via LSL management function and necessary to assess the instrument performances and calibrate the returned science data on the ground.

3.7.3.3.2. Main data handling characteristics

• Scientific data acquisition

  - The scientific data are acquired on the HSL (by DMA) from the PSD and the DFEE, on a cyclic basis (125 ms).

• TC management

  - two sources of TC are considered: ground telecommand and the broadcast packet,

  - the telecommands are received in TC source packets in the instrument communication buffer,

  - a new TC is fetched once every cycle if no previously received TC is currently being executed,

  - the validity of the configuration telecommands (internal or w.r.t. to the units operating mode) is not verified on-board,

  - the validity of the telecommands is checked w.r.t. the current operational status,

- the execution of the telecommand is considered as completed (sucess or failure) only when all the SPIASW internal actions triggered by the telecommand have been completed but also when all the LSL exchanges induced have been completed.

• TM management

- TM packets categories

  . the CSSW HK packet (built by CSSW) includes an area reserved for SPIASW HK data and another area for on-event reports that is shared between the CSSW and the IASW,

  . the instruments packets totally reserved to the SPIASW. They are associated to a specific APID:

    - the technological HK packets including the HK data. They are dated by using the on-board time (resolution 1 s) of the 125 ms cycle of the acquisition in the packet,

    - the science HK packets including the science HK data. They are dated by using the on-board time (resolution 1 s) of the 125 ms cycle of the acquisition in the packet,

    - the photon/photon data packets including the photon/photon information acquired from the DFEE and the PSD, via LSL management function and digitalized curves provided by the PSD, if any. They are dated by using the on-board time (resolution 1 s) of the 125 ms cycle of the acquisition in the packet,

    - the diagnostic data packets including the information requested for diagnostic purposes, acquired via LSL management function. They are dated by using the on-board time (resolution 1 s) of the 125 ms cycle of the acquisition in the packet,

    - the spectra data packets including the compressed spectra information,

    - the on-request data packets including data specially requested by telecommand (i.e: S/A dump memory, SPIASW configuration table, diagnostic TC and so on).

• TM packets transmission

- They are acquired from the instrument by the CDMU according to a polling sequence table by a 8 s cycle. The CSSW provides the SPIASW with an instrument communication buffer which includes 3 specific areas to transfer the different categories of TM (SPIASW area in CSSW HK packet, on-event reports, instrument packets).

- The SPIASW is able to bufferise 64 on-events reports when the on-event report area in the ICB is full.

- In case of TM overflow the old data in the SPIASW area are replaced by the new ones.

- The SPIASW put the instrument data packets together with their respective APID, priority and sequence count in the instrument communication buffer. The priority associated to each category is as follows:

. Technological HK data packets : high

. On-request data packets : high

. Science data packets : high

. Photon/photon data packets : low

. Spectra data packets : medium

- In case of TM overflow:

  . new technological HK packets are kept and the old ones lost,

  . new science HK packets are kept and the old ones lost,

  . old spectra data packets are kept,

  . new photon/photon data packets are lost.

- Configuration
  - It is possible to modify the SPIASW configuration parameters in any modes.

3.7.3.3.3. DFEE SW/IF for scientific data

This paragraph defines the software interface for the scientific data exchanged through the HSL link. This interface is defined according to the joined figure.

The Start of Packets words (SOP) are defined as in the following table:

Type of Event	SOP (Hex)
SE (single events)	00 00
ME (multiple events)	01 00
PE (PSD events)	02 00
SPi (spectra for chain i)	03 ii*

** ii is the number of the detector chain ranging from 00 to 12 Hex.

The End of Packet words (EOP) have the following value:

Partial flag	Parity flag	Word Count
15	14	13 0

Word Count: Gives the number of words in the packet, SOP and EOP excluded. If it equals 8192 assume that an internal FIFO overflow has occured.

Parity flag: equals "1" when a parity error was detected in the ASIC, valid for SE, ME, PE only.

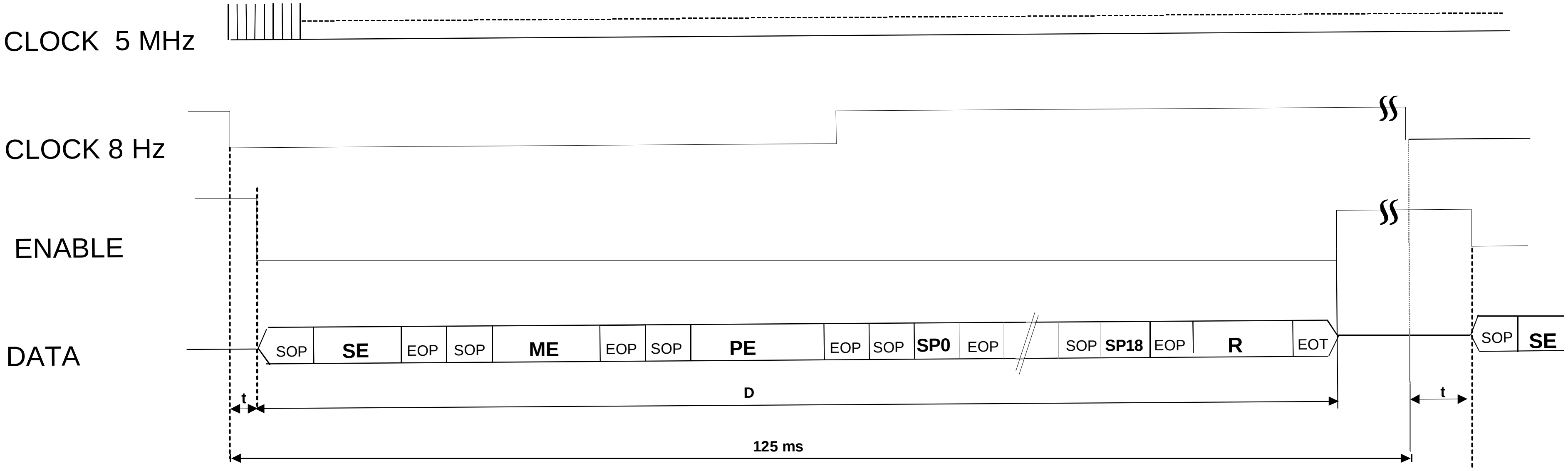
Partial flag: equals "1" when the current exchange was too short for ASIC to send all its data.

The End of Transfer (EOT) has the following value:

Word Count
15 ... 0

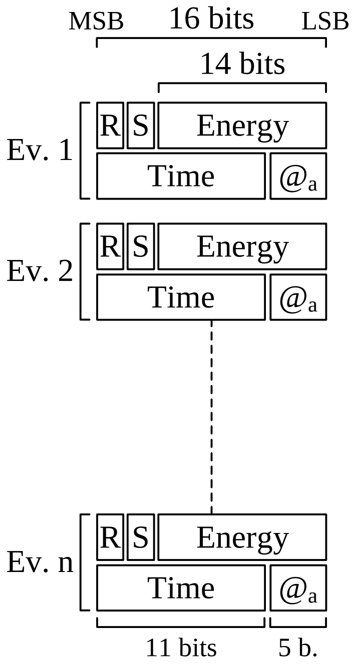
Word Count: Gives the number of words in the exchange from the 1st SOP to the last EOP included.

The structure definition of each sub-block for SE, ME, PE and SPi is given in the following figures.



SE **:** Single events
ME **:** Multiple events
PE **:** Single events PSD tagged
R **:** Dummy data
SP0 to SE18 : Spectra events
SOP **:** Start Of Packet x 3 = 3 words of 16 bits, each containing type of event of the packet, and detector address (for spectra)
EOP **:** End Of Packet x 3 = 3 words of 16 bits, each containing the number of 16 bits words of scientific data in the packet and flags
EOT **:** End of Transfert x 3 = 3 words of 16 bits, each containing the total number of the 16 bits words between the first SOP to the last EOP included
D **:** Transmission duration = enable duration (fixed) adjustable by TC in integer numbers of words
t **:** min 1 ms - This delay shall be insured by IASW

Figure 3.14 - Data Transmission on HSL



R: energy range bit (= 0 → 20 keV - 2 MeV; = 1 → 2 MeV - 8 MeV)
S: spare bit = 1
$@_a$: detector address from AFEE (0 to 18)

Time values are expressed in 2048 clock period units; time unit is 102.4 µsec.

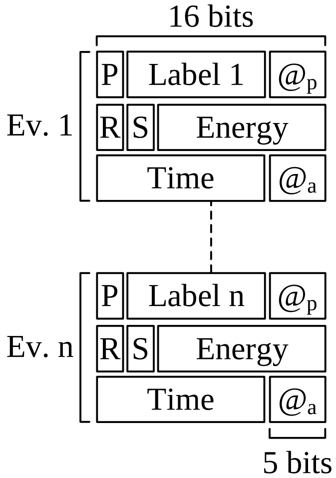
If a time out occurred on energy reception from AFEE, then the corresponding word is set to 0 (including R, S and Energy).

Figure 3.15 - Good Events Block (1/3)

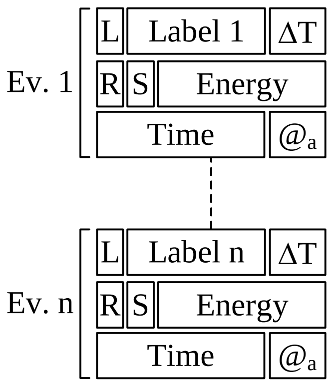
Single Events (SE) Sub-block

Depending of configuration parameter "EvtSetTimeFmtPE" of DFEE (configuration command 02 Hex), the PSD flagged events sub-block (PE) has two formats:

PSD flagged events sub-block normal mode (PE-NM)
(EvtSetTimeFmtPE = 0)



PSD flagged events sub-block time mode (PE-TM)
(EvtSetTimeFmtPE = 1)



P: process flag = 1 (processed by PSD)
$@_a$: detector address from AFEE (0 to 18)
$@_p$: detector address from PSD (0 to 18)
R: energy range bit (= 0 → 20 keV - 2 MeV; = 1 → 2 MeV - 8 MeV)
S: spare bit = 1
Label: as transmitted by the PSD to the DFEE in the identifier word after each time tag (10 bits)

Figure 3.16 - Good Events Block (2/3)

PSD Flagged Events (PE) Sub-block

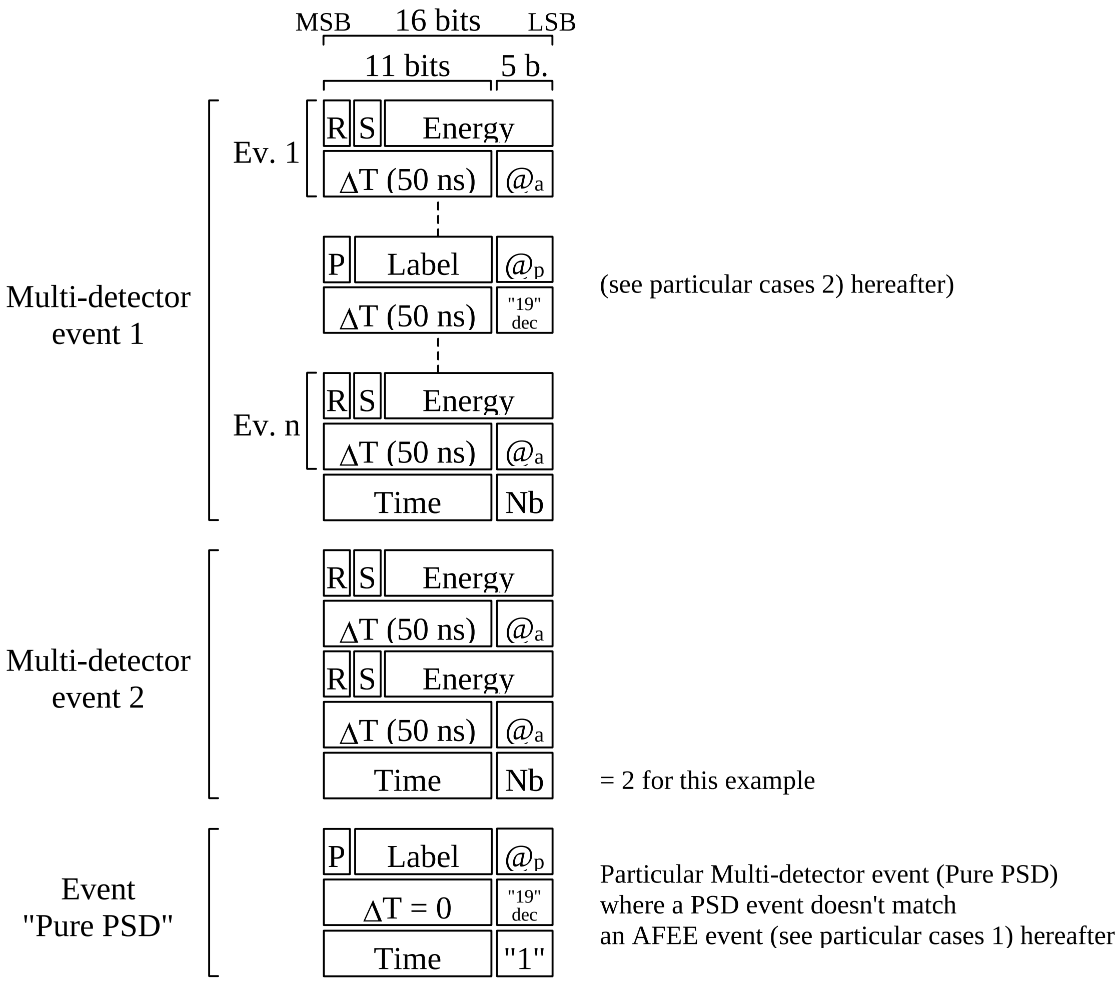
Energy: 14 bits for energy conversion value

L: sign of ΔT equals "0" if PSD TT anterior to AFEE TT

Time values are expressed in 2048 clock period units; time unit is 102.4 µsec.

ΔT: absolute value of duration elapsed between the PSD TT and the AFEE TT expressed in clock period unit (50 ns)

If a time out occurred on energy reception from AFEE, then the corresponding word is set to 0 (including R, S and Energy).



P: process flag (= 1 if processed by PSD)

R: energy range bit (= 0 → 20 keV - 2 MeV; = 1 → 2 MeV - 8 MeV)

S: spare bit = 1

Energy: 14 bits for energy conversion value

$@_p$: detector address from PSD

$@_a$: detector address from AFEE. When a PSD event matches an AFEE event which is part of a multi-detector event, the PSD event is inserted in the multi-detector event with @a = 19 dec and with its identifier word instead of R, S and Energy

Figure 3.17 - Good Events Block (3/3)

Multi-detectors Events (ME) Sub-block

Nb: number of events in the multi-detector event

In a multi-detector event, the components are stored in increasing time order, the TIME parameter is the time at occurrence of the event 1 of the multi-detector event.

Label: as transmitted by PSD to DFEE in the identifier word after each time tag (10 bits).

Time values are expressed in 2048 clock period units; time unit is 102.4 µsec.

ΔT: number of 50 nsec counts between events. ΔT can be either "0" or "1" for event n° 1; ΔT in event i gives the time elapsed between event i - 1 and event i. Useful bits are right justified.

If a time out occurred on energy reception from AFEE, then the corresponding word is set to 0 (including R, S and Energy).

Particular cases:

1) Pure PSD

If a PSD event doesn't match with an AFEE TT, if is included in the ME sub-block with the same structure than a multi-detector event.

In this case:

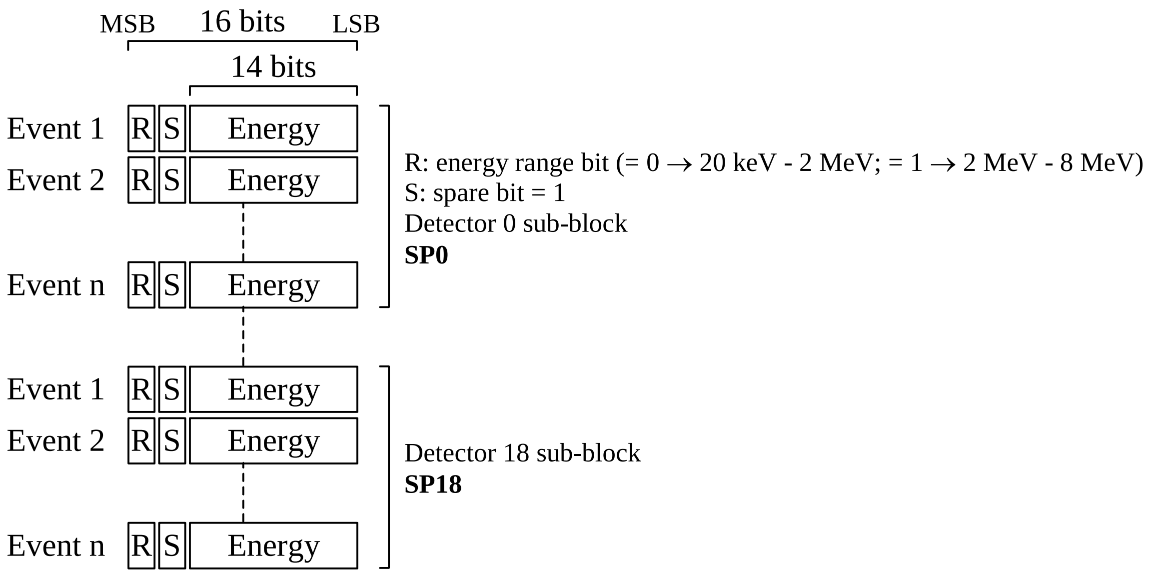
- In the first byte of the event, the "Energy + R + S" byte is replaced by the PSD identifier.
- In the second byte, ΔT = 0 if the Pure PSD event is alone (which will be generally the case). But ΔT ≠ 0 if there is 2 or more Pure PSD in the same multi-detector event. In this case ΔT = the time between the pure PSD and the previous one in the same multiple. And the address is set to 19 dec.
- In the third byte, Time and Nb are set as for a normal multi-detector event. If the Pure PSD is alone, the Nb = 1.

2) Multi-detectors event with one PSD flagged component

If one (or several) components of a multiple event is flagged as a PSD event, the component is described inside the multiple with both data from AFEE and PSD.

The data from PSD is included in the multiple with the same structure than for the AFEE component but the first byte (R + S + energy) is replaced by the PSD identifier and the address in the second byte is set to 19 dec.

Note: The first byte of each component of a multiple ("R + S + energy" or "identifier") is set to 0 if the time between the time tag and the energy (or identifier) delivery is too long. This time depends upon the DFEE configuration parameter "Time Out Miss Energy" value.



If a time out occurred on energy reception from AFEE, then the corresponding word is set to 0 (including R, S and Energy).

Figure 3.18 - Spectrum Events Block (SPi)

3.7.3.3.4. PSD SW/IF for scientific data

This paragraph defines the software interface for the scientific data exchanged through the HSL link. This interface is defined according to the joined figure.

The Start of Packets words (SOP) equals 0002 Hex.

The End of Packet words (EOP), repeated 3 times, are 16-bit Word Counts of the number of words in data field excluding SOP and EOP.

Dummy data are not defined.

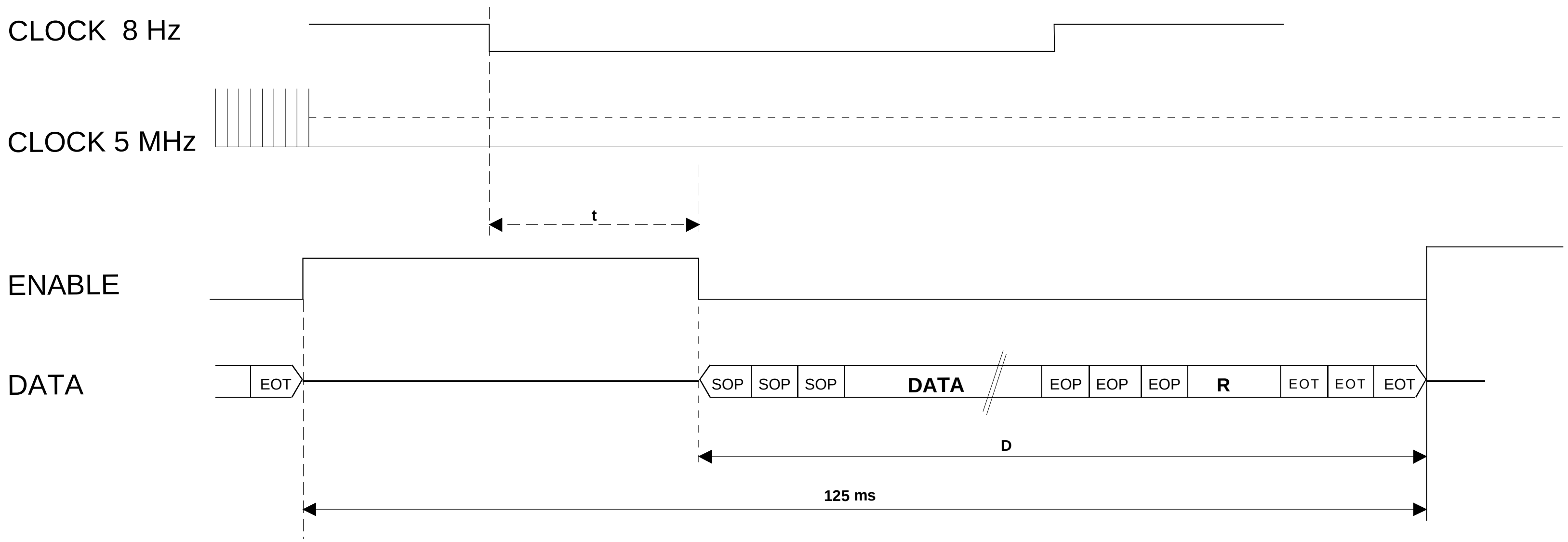
The End of Transfer words (EOT), repeated 3 times, are 16-bit Word Counts of the number of words from the 1st SOP to the last EOP.

The duration D of the Enable is sized for 308 words exchanges (all included).

The processing flag P equals "1" when the event has been processed by the PSD.

The simple/multiple flag S/M equals "1" when the event is multiple and "0" otherwise.

When no event is processed, PSD will send an "empty" format containing 3xSOP, 3xEOP, dummy data, 3xEOT up to 308 words.



8 Hz duty cycle: 50 %

$1 \geq 1$ mSec + 1 kW x 16/5 10^6 = 4 mSec (DFEE HSL is read first)

R **:** Dummy data for filling up till End Of Transfer
SOP **:** Start Of Packet = 16 bits including the data type
EOP **:** End Of Packet = 16 bits including the data words number in the transmission
EOT **:** End of Transfer = including the number of 16 bits words in the transmission, from the first SOP to the last EOP

D **:** Length of the transfer = Enable duration (Fixed and driven by DPE)

Figure 3.19 - PSD Data Transmission on the DPE High Speed Link BASIC FRAME

The format of the data sent on HSL is not dependent on the current mode of PSD: OPERATIONAL, CALIBRATION, or DIAGNOSTIC.

See the following schematic:

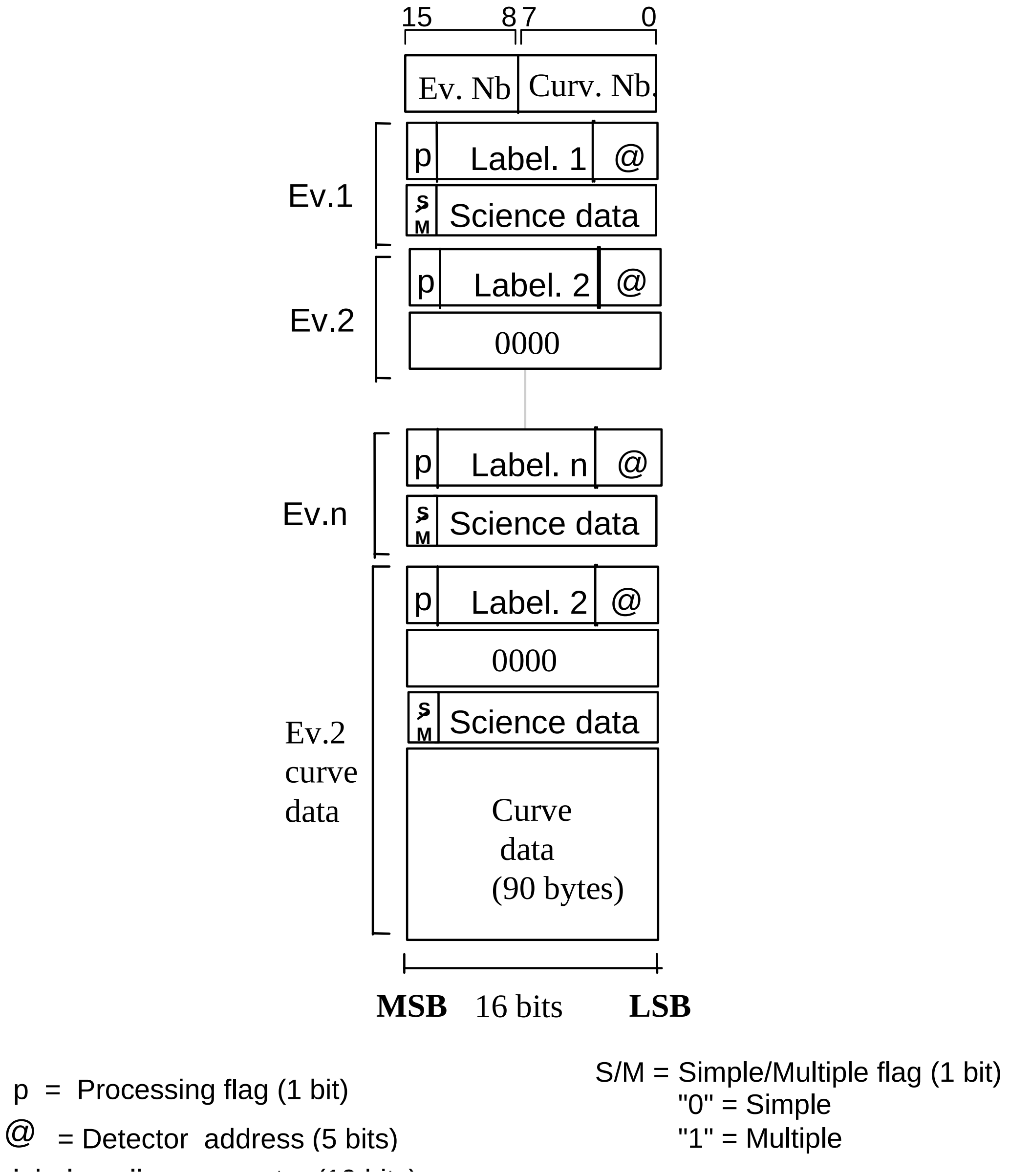
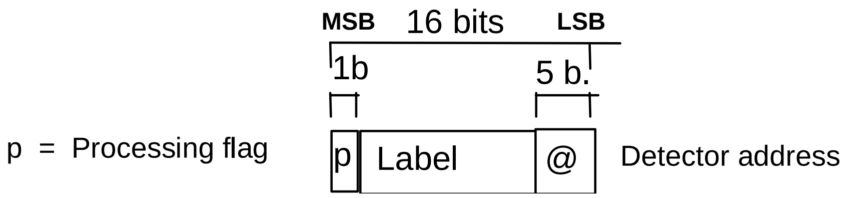


Figure 3.20 - PSD Data Organization

The number of event curve data depends on mode (OPER or DIAG/CAL) and on parameters of configuration command "curve transmission rates" (C 0AHex).

The events are provided by temporal order.

The PSD has a serial link with DFEE to exchange the identifiers of PSD tagged events. The format of this identifier is as follows:



The label (10 bits) is a roll-over counter.

3.7.4. IASW operational functioning

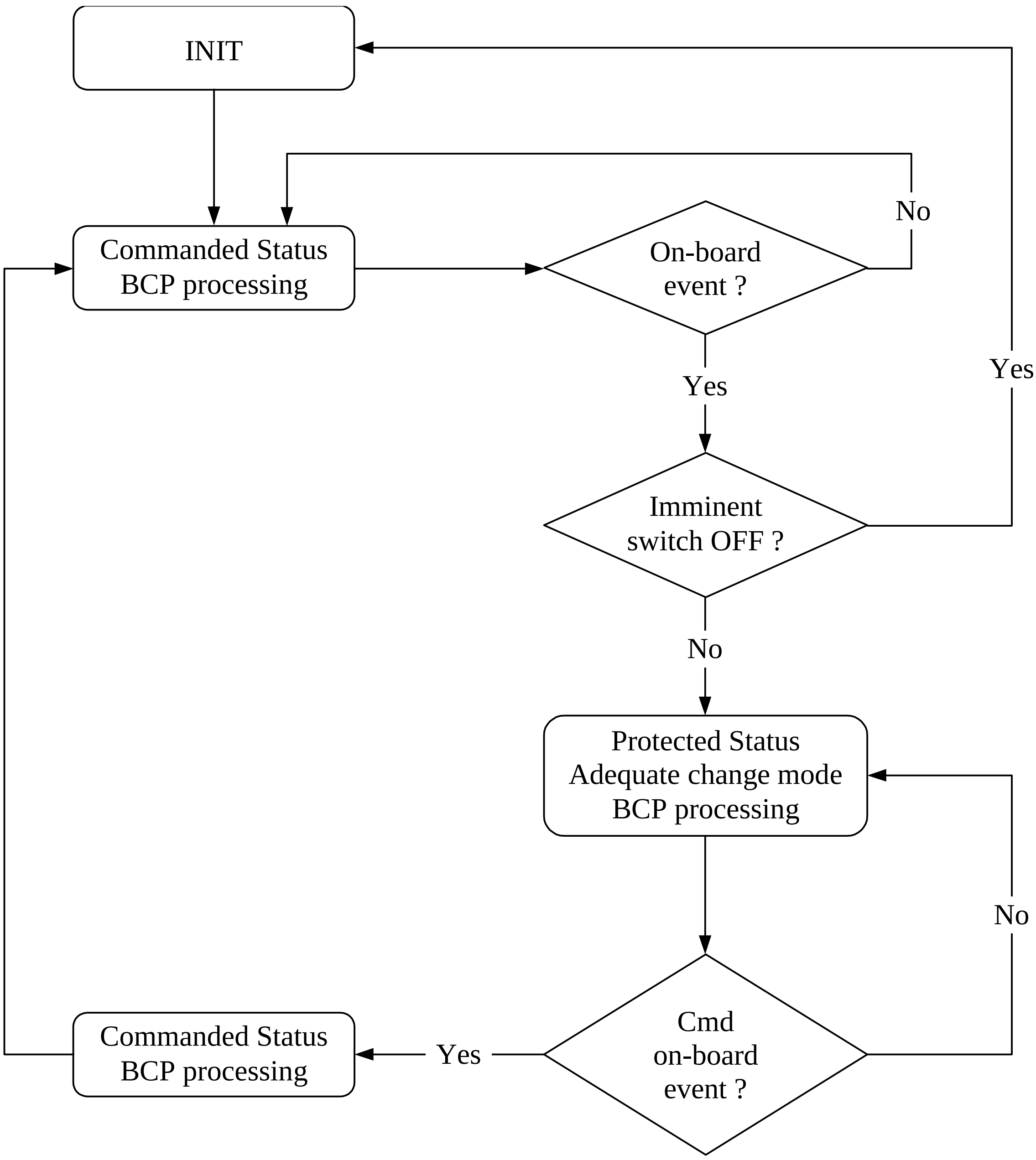


Figure 3.21 - IASW Functioning Principle w.r.t. On-board Events or BCP

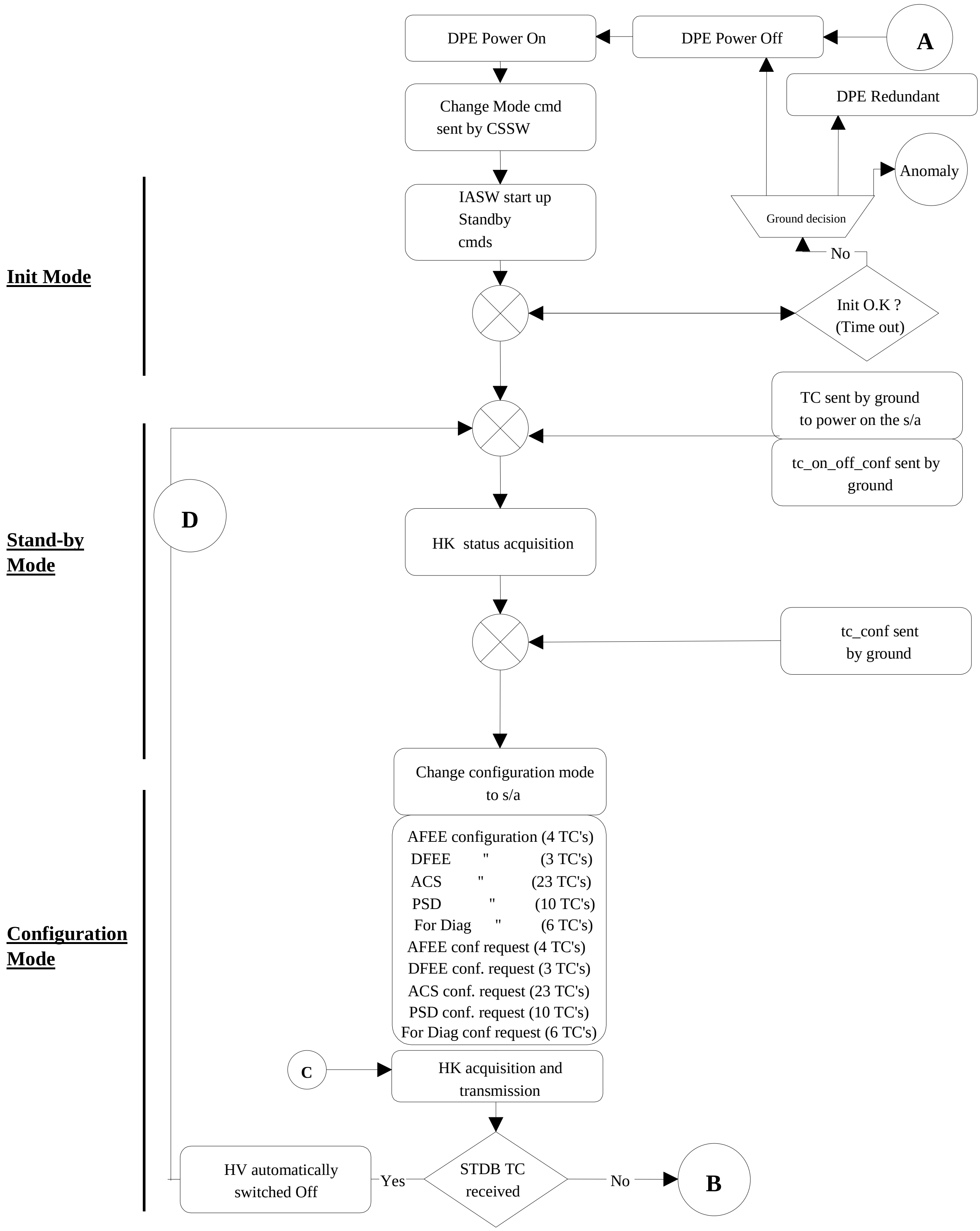


Figure 3.22 - IASW Functioning Principle w.r.t. Modes Management

Operational Mode

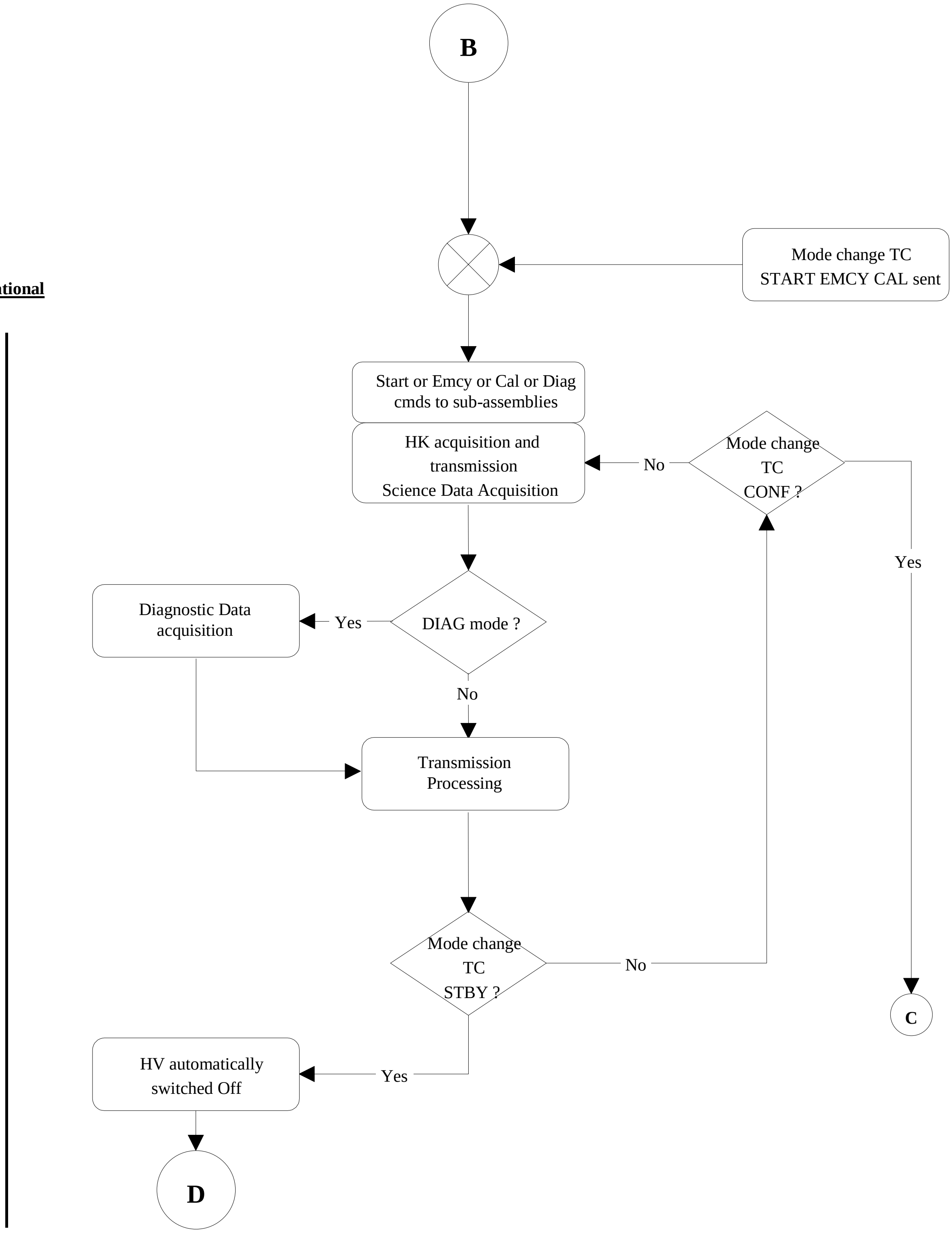


Figure 3.22 - IASW Functioning Principle w.r.t. Modes Management (cont'd)

3.7.4.1. Data handling modes definition

This chapter describes the application software (IASW) functioning w.r.t. the instrument and how it manages the data supplied by the sub-assemblies.

See also the SPIASW User's Manual in SPI UM Volume 3 Annex 6.

⇒ The following data handling modes are:

- init mode
- standby mode
- configuration mode
- active modes
  - Photon/photon mode
  - PSD calibration mode
  - Emergency_TM mode
  - Diagnostic mode

The first three modes may be considered as steps in the SPI initialisation and configuration process. Then one of the four last modes constitutes the fourth step of the process: the goal of the initialisation and configuration. The expression "active mode" may be used to designate in a generic way one of the four last modes, i.e. photon/photon mode, PSD calibration mode, emergency_TM mode and diagnostic mode.

The init mode is used for SPIASW initialisation purposes. When in this step, SPIASW is not ready to receive any telecommand and to send any telemetry. This mode is left automatically, when all the necessary initialisations have been completed.

The standby mode roughly corresponds to the SPI standby mode. When entering this mode after leaving the init mode, the SPIASW sends for the first time HK information by telemetry: this means that it is ready to process telecommands and to send telemetries. In this mode the ACS and AFEE high voltages are OFF. To be sure that it is the case, when entering this mode, the SPIASW will send a standby command to all units (without knowing whether they are ON). The units self-test acquisitions are performed in this mode. This mode is also considered as a safe mode used in case of imminent switch off, eclipse and possibly in case of flare.

The configuration mode roughly corresponds to the system configuration mode. The configuration and the patch are loaded to the units in this mode. This mode is used as a safe mode in case of loss of attitude and possibly in case of flare. It must be noted that when SPI is in cooling or annealing mode, the SPIASW remains simply in the configuration mode (except in some cases of flare, imminent off or eclipse).

One of the active modes is entered when scientific data handling or when diagnostic operations have to be performed. The occurrence of a flare or of a loss of attitude or the announce of an imminent eclipse or an imminent switch-off makes the SPIASW leave this mode.

The photon/photon mode and the emergency TM mode are respectively complete and reduced scientific modes.

The PSD calibration mode is used to be able to update the PSD curves libraries considering the detectors ageing.

The diagnostic mode is used for investigation purposes in case of problems and is as flexible as possible.

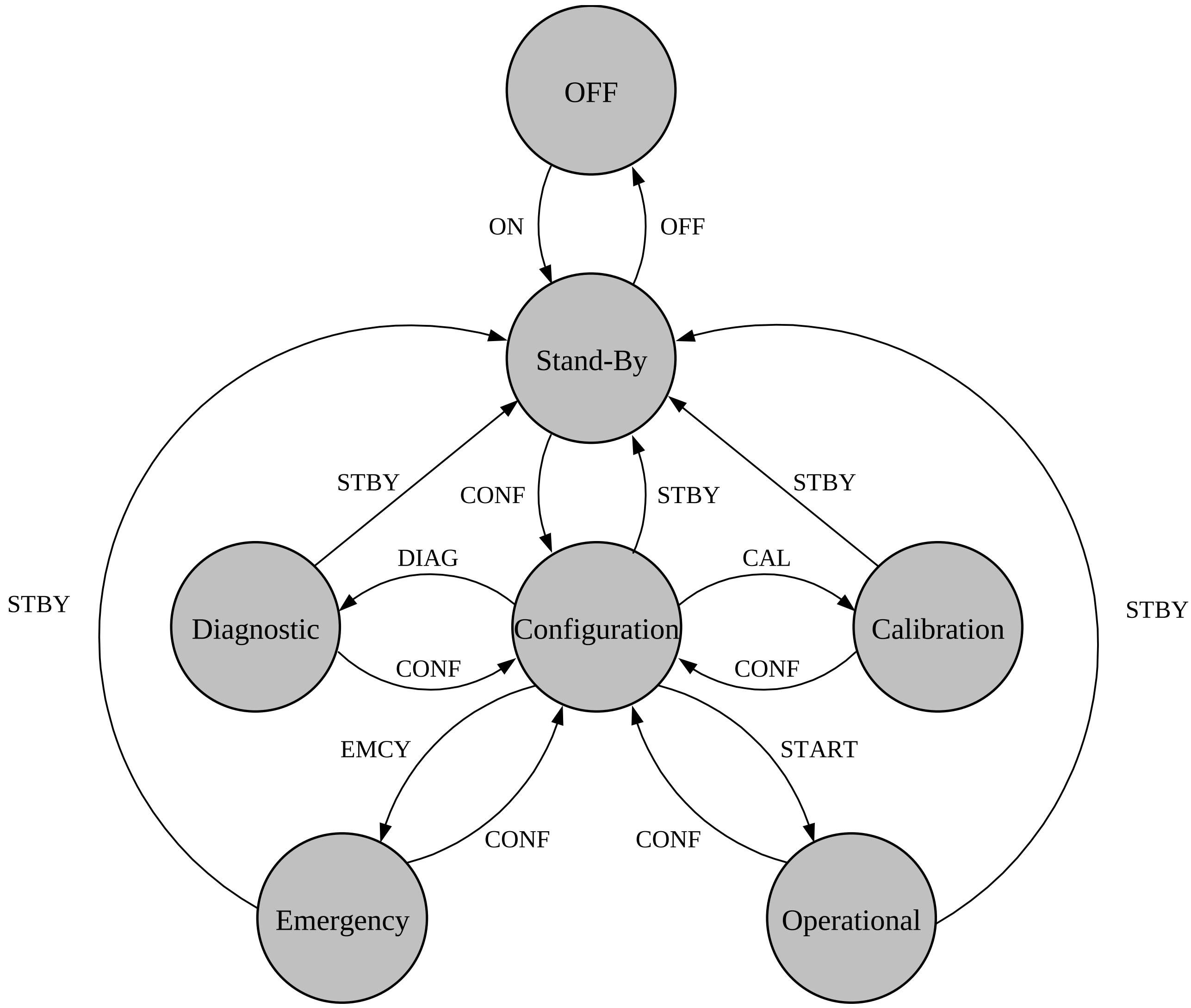


Figure 3.23 - IASW Modes (out of On-board Events with Automatic Transitions)

⇒ The standby mode is made up of two sub-modes:

- standby (1): in this mode the units on/off configuration is not known

This mode is used at initialisation and in eclipse.

- standby (2): in this mode the units on/off configuration is known

This is also used in case of imminent switch off.

⇒ The following information is taken into account at any time by the SPIASW for the mode and operational status management:

- the current mode which corresponds to the effective mode of the SPIASW and of the SPI instrument
- the commanded mode which is for particular use in case of on-board event (such a loss of attitude, a flare, an imminent eclipse and an imminent switch off) and represents the mode in which the SPI instrument should be put automatically on-board at the end of the on-board event

⇒ The following data handling operational stati should be considered for the acceptance of the received telecommands and the on-board generated triggering events:

- **init status**

  The init status corresponds to the case where the SPIASW is in init mode. In this case, the telecommands and the broadcast packet are not read by the SPIASW. They are bufferised in the ICB. This status is a transient one: it is left automatically when leaving the init mode.

- **commanded status**

  The commanded status corresponds to the status where the all the ground telecommands are accepted by the SPIASW, whichever the mode in which it is. While being in this status, the SPIASW may be in one of the following modes: standby, configuration, photon/photon, emergency_TM, PSD calibration or diagnostic.

- **automatic status**

  The automatic status is linked to the automatic reconfiguration process. An end of flow or end of ESAM or end of eclipse sent by the broadcast packet triggers the transition to the automatic status, which triggers also the automatic reconfiguration process if it is enable. At the end of the automatic reconfiguration the IASW becomes commanded (for more details, see SPIASW User's Manual § 2.2.2.3.3).

- **protected status**

  The protected status is entered in case of flare, eclipse and in case of loss of attitude. In this status, only the telecommands load parameter, report parameter, test and eclipse exit TC are executed. The instrument may be in the current mode configuration or standby. This mode is left when all three conditions (the flare, eclipse and loss of attitude) have been completed or when the corresponding monitoring are inhibited.

- **imminent off status**

  For a general description, it may be said that the imminent off status is entered in case of imminent switch off triggered by broadcast packet. In this status, the telecommands are not read from the ICB. Only the technological HK are still acquired and sent to the ground. The SPI instrument is in standby mode. In order to leave this status, the instrument shall be switched off. After the issue recovery which has triggered the imminent off status, the instrument shall be switched on again.

⇒ The correspondence between the data handling modes and operational stati are defined in the following table.

When the IASW is in one of the data handling status, the current mode can be only one of the modes defined in the column “Current mode”. After reception of allowed TC’s or on-board events the IASW is put automatically in a correspondant “Commanded mode”. For example, when protected status activated the current mode will be only stand-by or configuration mode, then an event appears on automatic process allows to leave the protected to the commanded status in which all IASW modes are authorized.

Data handling operational status	**Current mode**	**Commanded mode**
init	init	standby (1)
commanded (TC or on-board events accepted see paragraph 3.7.4.4)	standby (1)	standby (1)
	standby (2)	standby (2)
	configuration	configuration
	active	active
automatic (TC or on-board events accepted see paragraph 3.7.4.4)	standby (1)	standby (2)
	standby (1)	configuration
	standby (2)	
	configuration (in progress)	
	standby (1)	active
	standby (2)	
	conf	
protected (TC or on-board events accepted see paragraph 3.7.4.4)	standby (1)	standby (1) standby (2) configuration active
	standby (2)	standby (2)
		configuration
		active
	configuration	configuration
		active
imminent off (switch off)	standby (1 or 2)	standby (1 or 2)

Table 3.12 - Correspondence between Data Handling Modes and Operational Stati

⇒ The correspondence between the data handling modes and the units modes (for ON units) are defined in the following table.

SPIASW	**AFEE**	**DFEE**	**PSD**	**ACS**
init	-	-	-	-
standby	standby	standby	standby	standby
configuration	configuration	configuration	configuration	configuration
photon/photon	operational	operational	operational	operational
emergency TM	operational	operational	operational	operational
calibration	operational	operational	calibration	operational
diagnostic	diagnostic	diagnostic	diagnostic	diagnostic

Table 3.13 - Correspondence between Data Handling Modes and Units Modes (for ON Units)

3.7.4.2. Functions executed w.r.t. data handling modes

See also the SPIASW User's Manual in SPI UM Volume 3 Annex 6.

⇒ The functions are scheduled according to the data handling current mode, as specified in the following table:

Mode	Cyclic functions	Asynchronous functions
init		initialisation DPE configuration CSSW configuration
standby (1)	TC management TM management Modes management Units analogue monitoring mission monitoring Data handling monitoring On-board time management LSL management mRTU management	units autotest verification in automatic operational status other functions on TC request
standby (2)	TC management TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management On-board time distribution	functions on TC request
configuration	TC management TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management On-board time distribution	units configuration and units maintenance management in automatic operational status other functions on TC request
photon/photon	TC management (if status is not imminent off) TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management Scientific monitoring Photon/Photon data complete management	functions on TC request

Mode	Cyclic functions	Asynchronous functions
	Spectra data management PSD calibration data management Scientific data datation On-board time distribution	
emergency_TM	TC management TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management Scientific monitoring Photon/Photon data reduced management Spectra data management PSD calibration data management Scientific data datation On-board time distribution	functions on TC request
PSD_calibration	TC management TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management Scientific monitoring PSD calibration data management Scientific data datation On-board time distribution	functions on TC request
Diagnostic	TC management TM management Modes management Units analogue monitoring Units digital technological monitoring Mission monitoring Data handling monitoring On-board time management LSL management mRTU management Scientific monitoring Photon/Photon data reduced management Spectra data management PSD calibration data management Scientific data datation On-board time distribution	functions on TC request

⇒ When entering a new mode the cyclic functions associated to this new mode are started if not previously started.

⇒ When entering a new mode the cyclic functions associated to the previous mode are stopped if they are not associated with the new mode.

3.7.4.3. Triggering events definition

See also the SPIASW User's Manual in SPI UM Volume 3 Annex 6.

3.7.4.3.1. Ground generated events

⇒ The following telecommands are used for transition triggering purposes:

- conf_ON_OFF_TC
- conf_TC
- start_TC
- start_task_s/w_maintenance
- stop_task_s/w_maintenance
- emcy_TC
- diag_TC
- cal_TC
- standby_TC
- eclipse exit_TC

3.7.4.3.2. On-board generated events

⇒ The following on-board generated events are used for transition triggering purposes:

- flare_begin_e
- flare_end_e
- ESAM_begin_e
- ESAM_end_e
- Eclipse_begin_e
- Eclipse_end_e
- exp_off_e (imminent switch-off)

⇒ The following priorities are taken into account among the on-board generated triggering events:

(from the highest priority to the lowest)

- exp_off_e (imminent switch-off) (events coming next are ignored)
- eclipse_begin_e
- flare_begin_e
- ESAM_begin_e
- flare_end_e, eclipse_end_e and ESAM_end_e

3.7.4.4. Triggering events and other TC acceptance

See also the SPIASW User's Manual in SPI UM Volume 3 Annex 6.

⇒ The triggering events and other TC are accepted or rejected with respect to the current operational status according to the following table:

TC or event	Operational status	init	commanded	automatic	protected	imminent off
conf_on_off_TC	E0500	N.A.	E	R	R	N.A.
record_conf_TC	E0001-E0004 E0101-E0103 E0201-E0224 E0300-E0316 E0566-E0567 E0581-E0586	N.A.	E	R	R	N.A.
record_patch_TC	E0507-E0512	N.A.	E	R	R	N.A.
standby_TC	E0501-E0506	N.A.	E	E	R	N.A.
conf_TC		N.A.	E	R	R	N.A.
start_TC		N.A.	E	R	R	N.A.
diag_TC		N.A.	E	R	R	N.A.
emcy_TC		N.A.	E	R	R	N.A.
cal_TC		N.A.	E	R	R	N.A.
dump_TC	E0513-E0515	N.A.	E	R	R	N.A.
reset_patch_TC	E0516	N.A.	E	R	R	N.A.
load_param_TC	E0518-E0519	N.A.	E	R	E	N.A.
report_param_TC IASW and S/A	E0011-E0031 E0111-E0113 E0251-E0273 E0280-E0290 E0320-E0329 E0342-E0343 E0523-E0525 E0591-E0596	N.A.	E	R	E	N.A.
test_TC	E0517	N.A.	E	E	E	N.A.
Eclipse_exit_TC	E0555	N.A.	R	R	E	N.A.
Send_all_conf	E0556	N.A.	E	R	R	N.A.
Send_all_patches	E0557	N.A.	E	R	R	N.A.
Start_task_sw_ maintenance	E0563-E0565	N.A.	E	R	R	N.A.
Stop_task_sw_ maintenance	E0573-E0575	N.A.	E	R	R	N.A.
flare_begin_e	BCP	N.A.	E	E	E	N.A.
flare_end_e		N.A.	R	R	E	N.A.
ESAM_begin_e		N.A.	E	E	E	N.A.
ESAM_end_e		N.A.	R	R	E	N.A.
Eclipse_begin_e		N.A.	E	E	E	N.A.
Eclipse_end_e		N.A.	R	R	E	N.A.
expected_off_e		N.A.	E	E	E	N.A.

N.A. stands for Not Applicable: the TC are not read in the ICB
E stands for Executed by the SPIASW (but the resulting commands may however be rejected by the units)
R stands for Rejected by the SPIASW

The following table shows the telecommands that should not be sent in operational commanded status with respect to the current data handling mode. When the spectrometer will fly, the corresponding verification will be made by the ground segment. During test phases, the execution of some of those telecommands will fail, because the units will not accept the induced commands.

MODE / TC	standby1	standby2	config.	photon/ photon	emergency _TM	PSD_ calibration	diagnostic
conf_ON_OFF_TC	Y	Y	N**	N	N	N	N
conf_TC	N*	Y	N*	Y	Y	Y	Y
start_TC	N *	N *	Y	N *	N *	N *	N *
emcy_TC	N *	N *	Y	N *	N *	N *	N *
cal_TC	N *	N *	Y	N *	N *	N *	N *
diag_TC	N *	N *	Y	N *	N *	N *	N *
standby_TC	N *	N *	Y	Y	Y	Y	Y
record_conf_TC	N *	N *	Y	N*	N*	N*	N*
load_param_TC	Y	Y	Y	Y	Y	Y	Y
report_param_TC	Y	Y	Y	Y	Y	Y	Y
load_patch_TC	N*	N*	Y	N*	N*	N*	N*
record_patch_TC	N*	N*	Y	N*	N*	N*	N*
dump_TC	N *	N *	Y	N *	N *	N *	Y
reset_patch_TC	Y	Y	Y	Y	Y	Y	Y
test_TC	Y	Y	Y	Y	Y	Y	Y

Y stands for YES: the TC may be sent
N stands for NO: the TC should not be sent
* means that the induced commands will be rejected by the units
** This TC gives only the s/a electrical status to the IASW, but it has to impact on the s/a electrical status. As the s/a electrical status can be changed only in stand-by mode (1 or 2) the conf_ON_OFF shall be sent only in these modes.

3.7.4.5. Modes transitions

See also SPIASW User's Manual in SPI UM Volume 3 Annex 6.

The operational status transition from the init operational status are performed automatically according to the initialisation parameters.

In the following table, the first raw gives the current operational satus at the occurence of the triggering event, the first column indicate the different triggering events and the intersection gives the target operational status after the occurence of the triggering events.

Status / Triggering event	Commanded	Automatic	Protected
conf_on_off_TC	commanded	-	-
conf_TC	commanded	-	-
start_TC	commanded	-	-
emcy_TC	commanded	-	-
cal_TC	commanded	-	-
diag_TC	commanded	-	-
standby_TC	commanded	commanded	-
eclipse_exit_TC	commanded	-	-

⇒ All the other operational stati transitions are always triggered by the occurrence of a triggering event. This is managed according to the following table:

Only the events taken into account by the SPIASW are considered in the following table.

Status / **triggering event**	**commanded**	**automatic**	**protected**
flare_begin_e	protected	protected	protected
flare_end_e	-	-	automatic if no ESAM and no eclipse protected if ESAM or eclipse
ESAM_begin_e	protected	protected	protected
ESAM_end_e	-	-	automatic if no flare and no ESAM protected if flare or ESAM
expected_off_e	imminent_off	imminent_off	imminent_off

Table 3.14 - Events Taken into Account by the SPIASW

The current mode transition occurs either when triggered by a triggering event or automatically (only in operational status automatic or at the end of the initialisation).

⇒ When accepted by the SPIASW and not rejected by the units the triggering events generate the following transitions in the SPIASW current mode and updates in the commanded mode.

TC or event	current mode	commanded mode
conf_on_off_TC	standby (2)	standby (2)
standby_TC	changed in standby (2) if standby(1) standby(2) in other cases	unchanged in standby (2) if standby(1) standby(2) in other cases
conf_TC	configuration	configuration
start_TC	photon/photon	photon/photon
diag_TC	diagnostic	diagnostic
emcy_TC	emergency_TM	emergency_TM
cal_TC	PSD_calibration	PSD_calibration
flare_begin_e	If radiation mode = standby: standby(1) if standby (1) standby(2) in other cases If radiation mode = conf: unchanged if standby or conf configuration in other cases	unchanged
flare_end_e	commanded mode if no eclipse and no flare unchanged if eclipse or ESAM	unchanged
ESAM_begin_e	unchanged if standby configuration in other cases	unchanged if standby configuration in other cases
ESAM_end_e	commanded mode if no eclipse and no flare unchanged if eclipse or flare	unchanged
eclipse_begin_e	standby (1)	unchanged
eclipse_end_e	commanded mode if no ESAM and no flare unchanged if flare or ESAM	unchanged
expected_off_e (switch_off)	standby (2)	standby (1)

⇒ The following automatic transitions are implemented in operational status automatic, if the current mode is different from the commanded mode:

- standby1 ⇒ standby2 (end of autotest acquisition function)
- standby2 ⇒ configuration (no other specific condition) when Conf ON/OFF
- configuration ⇒ photon/photon (end of units configuration and patches loading and commanded mode = photon/photon)
- configuration ⇒ emergency_TM (end of units configuration and patches loading and commanded mode = emergency_TM)
- configuration ⇒ PSD_calibration (end of units configuration and patches loading and commanded mode = PSD_calibration)
- configuration ⇒ diagnostic (end of units configuration and patches loading and commanded mode = diagnostic)

3.7.4.6. Actions associated with triggering events and other telecommands

See also SPIASW User's Manual in SPI UM Volume 3 Annex 6.

The rejected telecommands and events are not considered in the following table.

The actions related to the starting and the determination of the cyclic functions are not described here. See § 3.7.4.2.

TC	Type	Sub-type	MF n°	Actions
CONF_ON_OFF_TC	5	3	E0500	• Updates the conf_ON_OFF status. • Triggers the start of the autotest acquisition function. • Updates the current mode and the command mode.
RECORD_CONF_TC	5	3	E0001-E0004 E0101-E0103 E0201-E02022 E0224 E0300-E0309	• Triggers the sending of the corresponding configuration block to the specified unit. • Updates and validates the corresponding configuration block in the SPIASW memory. • Updates the current mode and command mode.
SEND_ALL_CONF_ TC	5	3	E0556	• Triggers the loading of all the S/A will configuration already stored in IASW memory. • Updates the current mode and commanded mode.
ECLIPSE_EXIT_TC	5	3	E0555	• Triggers the transition from eclipse mode tow and operational (or actives modes). • Updates the current mode and commanded mode.
START_ MAINTENANCE_TC	5	1	E0563 E0564 E0565	• Allows to start the patels or dump memory S/A. • Stops the cyclical HK acquisitions for the concerned S/A.
START_ CALIBRATION_TC	5	1	E0566	• Allows to start ALS calibration process.
STOP_ MAINTENANCE_TC	5	2	E0573 E0574 E0575	• Stops to allow the patch of dump memory process.
RECORD_PATCH_TC	6	1	E0507 E0509 E0511	• Triggers the sending of the corresponding patch block to the unit. • Records the corresponding patch block in the SPIASW memory. • Updates the current mode and the commanded mode.
LOAD_PATCH_TC	6	1	E0508 E0510 E0512	• Triggers the sending of the corresponding patch block to the specified unit. • Updates the current mode and the commanded mode.
SEND_ALL_ PATCH_TC	6	1	E0557	• Triggers the loading of all the S/A patches already stored in IASW memory. • Updates the current mode and commanded mode.
START_TC	5	5	E0501	• Triggers the sending of the Start command to the ON units if all of them are configured. • Updates the current mode and the commanded mode.
EMCY_TC	5	5	E0506	• Triggers the sending of the Emergency_TC command to the ON units if all of them are configured. • Updates the current mode and the commanded mode.
CAL_TC	5	5	E0503	• Triggers the sending of the CAL command to the PSD if all of them are configured. • Updates the current mode and the commanded mode.

TC	Type	Sub-type	MF n°	Actions
DIAG_TC	5	5	E0504	• Triggers the sending of the Start command to the ON units if all of them are configured. • Updates the current mode and the commanded mode.
STANDBY_TC	5	5	E0505	• Triggers the sending of the Stand-by command to the ON units if all of them are configured. • Updates the current mode and the commanded mode. • Updates the operational status.
CONF_TC	5	5	E0502	• Triggers the sending of a conf command to all ON units. • Updates the current mode and the commanded mode.
LOAD_PARAM_TC	5	3	E0518 E0519	• Updates a set of SPIASW configuration parameters.
REPORT_PARAM_TC	5	4	E0011-E0014 E0020-E0031 E0111-E0113 E0251-E0273 E0280-E0290 E0320-E0329 E0342-E0343 E0523-E0525 E0567	• Triggers the Housekeeping command towards the specific unit, if any or read the value of the corresponding parameters in the SPIASW memory if the concerned sub-assembly is the SPIASW. • Triggers the preparation of an on-request HK packet with the required parameters.
DUMP_TC	6	2	E0513 E0514 E0515	• Triggers the dump command to the specified unit. • Triggers the preparation of an on-request HK packet with the dumped memory.
RESET_PATCH_TC	6	1	E0516	• Resets the patch area in the SPIASW memory.
TEST_TC	13	1	E0517	• The test_TC has no other effect than the telecommand verification activation.

Events	Actions
Flare_Begin_E	• Triggers the sending of a standby command to all ON units if the radiation mode parameter is standby. • Triggers the sending of a conf command to all units and a configuration command (HV OFF) to the ACS (if ON) if the radiation mode parameter is configuration and if the current mode is not standby. • Updates the current mode. • Updates the operational status.
Flare_End_E	• Triggers all the actions necessary to put the instrument back in the commanded mode, if there is currently no eclipse and no Esam : trigger the autotest acquisition function (if the end of flares occurs after an eclipse) send the configuration to the units , send the patches to the units, send the start/diag/cal command if necessary (when the commanded mode is the configuration mode or one of the active modes, the units configurations and patches are automatically loaded back to the units after a flare. • Updates the current mode. • Updates the operational status.
ESAM_Begin_E	• Triggers the sending of a stop command to all ON units if the current mode is not standby. • Updates the current mode and the commanded mode. • Updates the operational status.
ESAM_End_E	• Triggers all the actions necessary to put the instrument back in the commanded mode i there is currently no flare and no eclipse : trigger the start of the autotest acquisitio function (if the end of ESAM occurs after a flare or an eclipse). • Updates the current mode . • Updates the operational status.
Exp_OFF_E	• Triggers the sending of a standby command to all ON units. • Updates the current mode.
Broadcast Packet	• Updates the mission status. • Signals the corresponding on-board events. • Adapt the TM flow in accordance with TM_SHARE • Triggers the induced current mode, commanded mode and operational status changes.
Eclipse_Begin_E	• Triggers the sending of a standby command to all ON units. • Updates the current mode . • Updates the operational status.
Eclipse_End_E	• Triggers all the actions necessary to put the instrument back in the commanded more if there is currently no flare and no ESAM : trigger the autotest acquisition function, send type configuration to the units, send the patches to the units, send the start/diag/cal command if necessary (when the commanded mode is the configuration mode or one of the active modes, the units configuration and patches are automatically loaded back to the units after an eclipse) • Updates the current mode . • Updates the operational status.

3.7.4.7. Actions associated with automatic transition

See SPIASW User's Manual in SPI UM Volume 3 Annex 6.

Automatic Transitions	Actions
INIT => STANDBY1	• Triggers a standby command to all units (whether ON or OFF).
STANDBY1 => STANDBY2	• No specific action.
STANDBY2 => CONFIGURATION	• Triggers the sending of all the initialised configuration blocks and all the recorded patches to the units.
CONFIGURATION => PHOTON/PHOTON	• Triggers the sending of the report parameter command to all ON units to verify on-board their configuration status. • Triggers the sending of the start command to the ON units if all of them are configured.
CONFIGURATION => TM EMERGENCY	• Triggers the sending of the report parameter command to all ON units to verify on-board their configuration status. • Triggers the sending of the start command to the ON units if all of them are configured.
CONFIGURATION => CALIBRATION	• Triggers the sending of the report parameter command to all ON units to verify on-board configuration status. • Triggers the sending of the start command to the ON units if all of them are configured.
CONFIGURATION => DIAGNOSTIC	• Triggers the sending of the report parameter command to all ON units to verify on-board configuration status. • Triggers the sending of the start command to the ON units if all of them are configured

3.7.4.8. Operational constraints

See SPIASW User's Manual in SPI UM Volume 3 Annex 6.

3.7.4.8.1. DPE wait mode

The SPIASW will offer no specific operating mode where the DPE can be put in wait mode.

The wait mode is used in order to dump and load the DPE memory by DMA from the spacecraft.

After a wait mode the warm reset will be commanded.

3.7.4.8.2. Functions scheduling

For the cyclic functions, a 125 ms minor cycle is implemented.

For the cyclic functions, the scheduling strategy implements two priority levels.

During one minor cycle, the SPIASW executes high level priority functions included in the current mode.

During one minor cycle, the SPIASW executes low priority functions included in the current mode in proportion to the CPU time left by the high priority functions.

For the cyclic low priority functions, the SPIASW is able to take into account new data at the beginning of each minor cycle.

In photon/photon mode all but DFEE/PSD data correlation and spectra information processing functions are high level priority functions.

In emergency TM mode all but multiple events data processing functions are high level priority functions (TBC).

In all but photon/photon and emergency TM modes, all functions are high level priority functions.

3.7.4.8.3. On-board mechanisms

The following on-board mechanisms are implemented to answer to asynchronous events:

- flare detection (high background count and radiation belts crossing)
- imminent eclipse detection
- imminent switch off detection
- ESAM detection
- AFEE low voltage temperatures monitoring
- spacecraft pointing/depointing detection

It is possible to inhibit separately each on-board mechanism.

3.7.4.9. LSL error processing

3.7.4.9.1. Error kind

There are three kinds of LSL errors:

- LSL Time-Out,
- CS (Check-Sum) error (SA to DPE),
- NACK received (CS from DPE to SA, Command not allowed and First command after reset).

All these errors are processed in the same way.

3.7.4.9.2. Error processing

- **Change mode TC in commanded status**

When a LSL error occurs on a change mode command sent to one of the four SA (Sub-Assembly), the command on trouble is repeated. If this second command is in trouble too, a Stand-by command is sent to all the SA, and the IASW is set to Stand-by 2 mode. Then the modes are:

Mode change	Mode of 3 SA	Probable mode of the SA in trouble	IASW Mode
SBY → CONF	SBY	SBY	SBY
CONF → SBY	SBY	CONF	SBY
CONF → OPER	SBY	CONF	SBY
OPER → CONF	SBY	OPER	SBY
OPER → SBY	SBY	OPER	SBY

The only exception to this rule is the stand-by command sent to the SA during IASW initialisation: if there is an error on one or several of the stand-by commands sent to the four SA, the only error processing done is repeating the command.

- **Other TC in commanded status**

TC: On-Request, Dump, RecordConf, Load, StartCalACS, StartMaintenance, StopMaintenance, SendAllConf, SenAllPatch: in case of LSL error, the command is repeated.

It is to be noted that:

- StartMaintenance: cyclic commands to the SA are stopped.
- StopMaintenance: cyclic commands to the SA are started again.
- SendAllConf and SenAllPatch: all the commands are sent.

- **AFEE low voltage switch off** (temp.monitoring) (∀ the status)

In case of LSL error, the command is repeated. If the second command is in trouble too, a change mode to stand-by 2 is performed and the automatic configuration is inhibited. In this case, a dedicated contingency procedure shall be executed.

- **Cyclic commands** (∀ the status)

- SetTimeACS: in case of LSL error, the command is repeated.
- Other cyclic commands (scientific HK, technological HK, diagnostic HK): in case of LSL error, the command is NOT repeated.

In all cases, after N successive errors on cycle commands concerning the same SA, all the cycle commands of this SA are stopped. A ConfOnOff TC is needed to start again the cyclic commands of this SA. N is an IASW configuration parameter. Its default value is 3. Its number is E8971 and it is the byte 78 of theTC E518. The associated parameter is downloaded in On-Request and Cyclic TM (see attach pages).

All the asynchronous commands (On-board or on TC) concerning the SA in trouble are still possible.

A change mode to stand-by 2 is then performed and the automatic configuration is inhibited.

- **ConfOnOff TC**

On reception of the ConfOnOff TC, the IASW performs the acquisition of the autotest status of each SA.

If a LSL error occurs, the command is repeated.

If the result of the autotest is "failed" or if there are two consecutive LSL errors on the acquisition of the autotest status:

- The cyclic commands to the SA not is trouble are started.
- The cyclic commands to the SA in trouble are stopeed.
- All the asynchronous commands (On-board or on TC) concerning the SA in trouble are still possible.
- IASW is set to Stand-by 2.

- **Beginning of on-board event**

- If the LSL error occurs on a change mode command, it is processed as in Commanded Status.
- If the LSL error occurs during an ACS high voltage switch off command or during a StopMaintenance command, a change mode to Stand-by 2 is processed (Stand-by 1 in case of eclipse) (in case of the StopMaintenance command, the cyclic commands are started again).

In all the cases, the automatic configuration is inhibited, and the status is set to Protected.

- **End of on-board event**

- If a LSL error occurs during the check of the bit "All Commands Initiated", the command is repeated. If the value of the bit is 1 or if there are two consecutive LSL errors on the acquisition of the bit, the mode remains Configuration mode.
- Mode change, Autotest acquisition, Maintenance, Configuration: the error is processed as in Commanded Status.

In all the cases, the automatic configuration is stopped (if the error concerns a configuration command, all the configuration commands are sent before stopping the configuration; if the error concerns a maintenance command, all the maintenance commands are before stopping the configuration).

The status is set to Commanded, excepted when at the end of an eclipse, the status must remain Protected because of an other on-board event (for instance flare...): in this case, the automatic configuration is inhibited.

3.7.4.9.3. Other

- **TM filling**

Concerning Cyclic or On-Request acquisitions, available data are transmitted in TM packets (Case of the CS error received by the DPE). If there is not any data available (case of the LS Time-Out), the TM packets are filled with zeros).

- **On event messages**

The On-Event messages associated to the LSL error processing are shown in Volume 2.

3.7.5. AFEE software

3.7.5.1. General description of AFEE TM/TC box

The AFEE TM / TC box is a part of sub-assembly AFEE-1 of SPI instrument and this for the INTEGRAL project. This electronic box has for function to manage the interface between the DPE and the AFEE sub-assembly for commands and technological parameters.

The connection between the DPE and the AFEE TM / TC box is a RS422 serial connection of synchronous type. A specific circuit USART MA28151 manages the communication.

The AFEE TM / TC passes on the commands and acquires the technological servitude for 19 chains of spectrometry. For every chain, we have:

- 3 bits in exit ON/OFF HVPS, ON LVPS and OFF LVPS to put ON or OFF the LVPS-DET and HVPS.
- A reference analog exit for the HT, which allows programming the value of the command for the High tension of the detector of the chain.
- A reference analog exit for the THRESHOLD to program the low threshold of the analysis range.
- An exit port of logical levels CONFIG which allows to configure the considered chain (Selection HK to be coded, Validation Nominal and/or redundant exit coupler, Analysis range, High-Energy Clamping).
- A differential analog entry, which allows acquiring the technological parameters which one, wants to digitise.
- To be able to choose the temperature of regeneration of detectors, the AFEE TM / TC possesses two exit ports T_REF_ANNEALING to fix the orders of both heating systems.

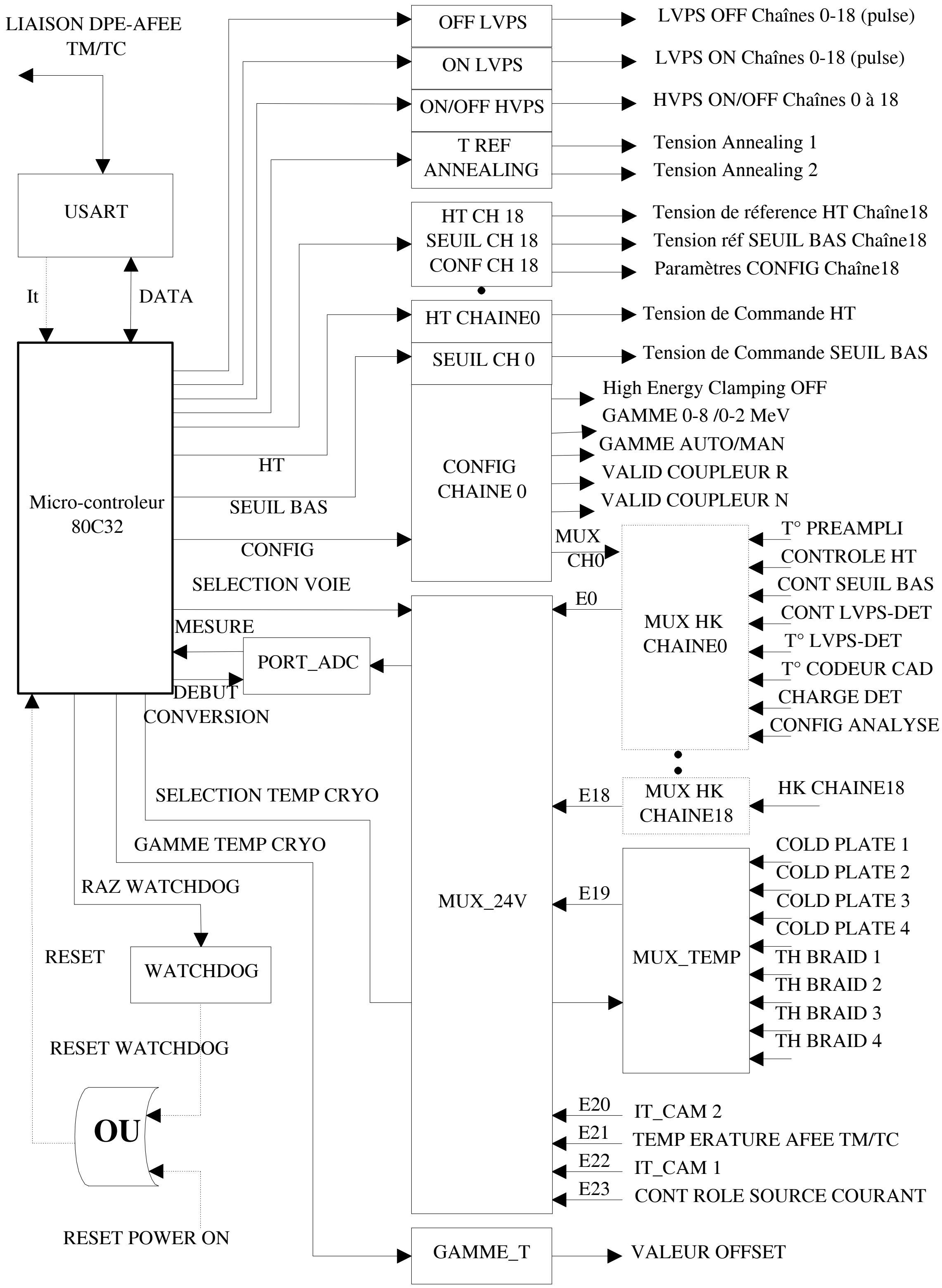
Besides acquiring the 19 chains servitude, the AFEE TM / TC should read 8 cryogenic temperatures and 4 general servitude. For the 8 cryogenic temperatures, to obtain a large range of temperature, one chooses by means of the exit port GAMME_T, the range of temperature (2 possible ranges) which one wants to cover. These 8 temperatures are selected by means of a 8 differential entries multiplexer MUX_TEMP.

The Analog/numeric coding is realised by means of a 12 bits converter PORT_ADC_MSB to acquire the 8 bits of strong weight and PORT_ADC_LSB for the 4 bits of weak weight. The entry of this converter is connected to the exit of a 24 entries multiplexer MUX_24V. By means of this multiplexer we choose to code either a parameter of a chain, or a cryogenic temperature or a parameter of the AFEE TM / TC.

A surveillance mechanism WATCHDOG allows to generate a signal RESET (period of 2 s) if that this is not periodically deactivated.

During the flight, the on board program lies in PROM (8 Kbytes) memory and complies from this one.

Synoptic presented on the following page shows the simplified architecture of the AFEE TM / TC.



SYNOPTIQUE DU BOITIER AFEE TM/TC

3.7.5.2. Definition of microprocessor memory space

The microprocessor used is an 80C32 of MHS. It possesses internal architecture on 8 bits and a addressable space on 16 bits (64 Kbytes). As it generates two signals separated from reading, it thus has 2 separated memory spaces:

- a memory space for the stocking of the program (READ ONLY and notPSEN signal).
- a memory space to store the data and reach the Entries/exit peripherals (READ / WRITE and notRD, notWR signals).

The figure 1 presented on the following page shows the use of these 2 memory spaces.

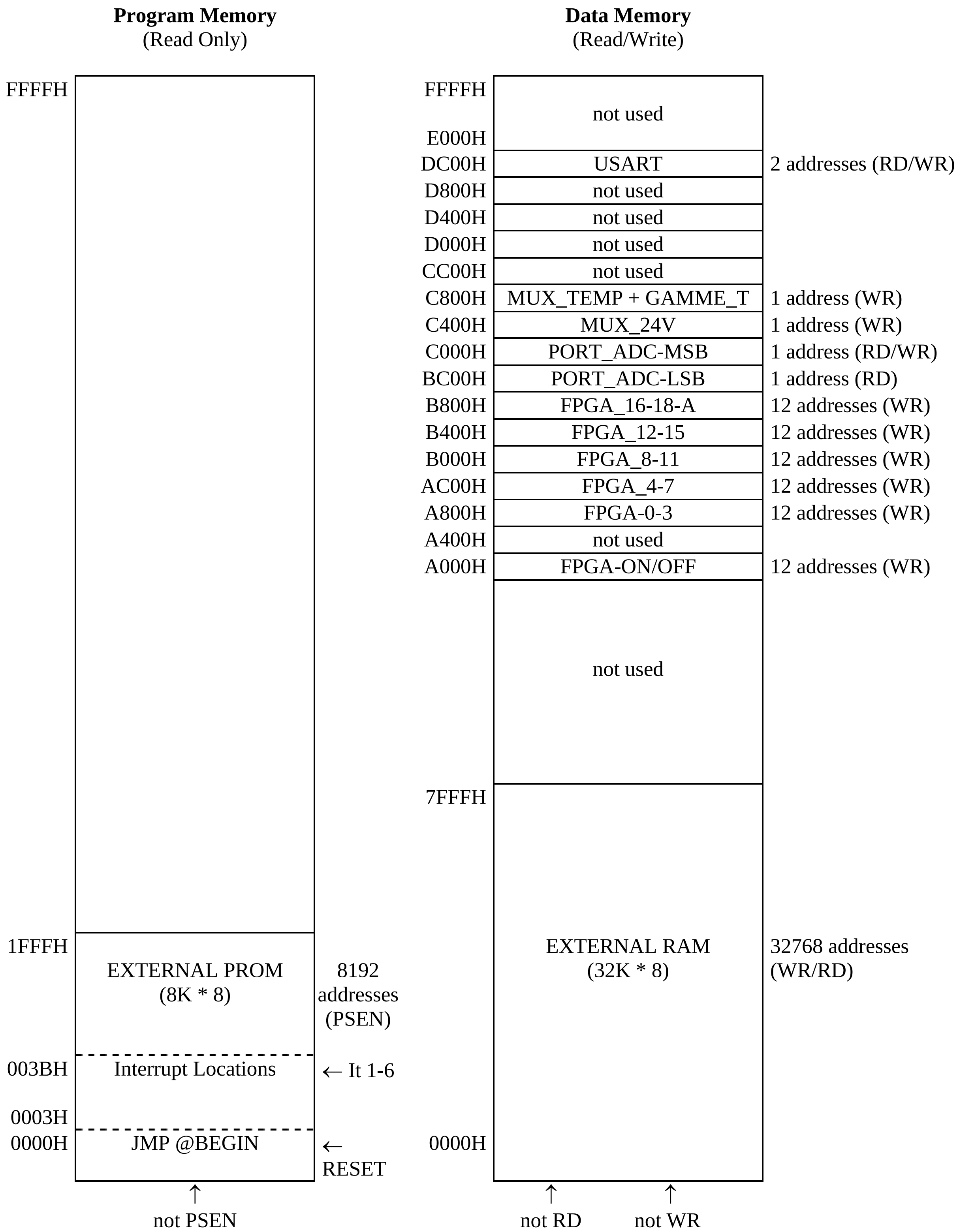
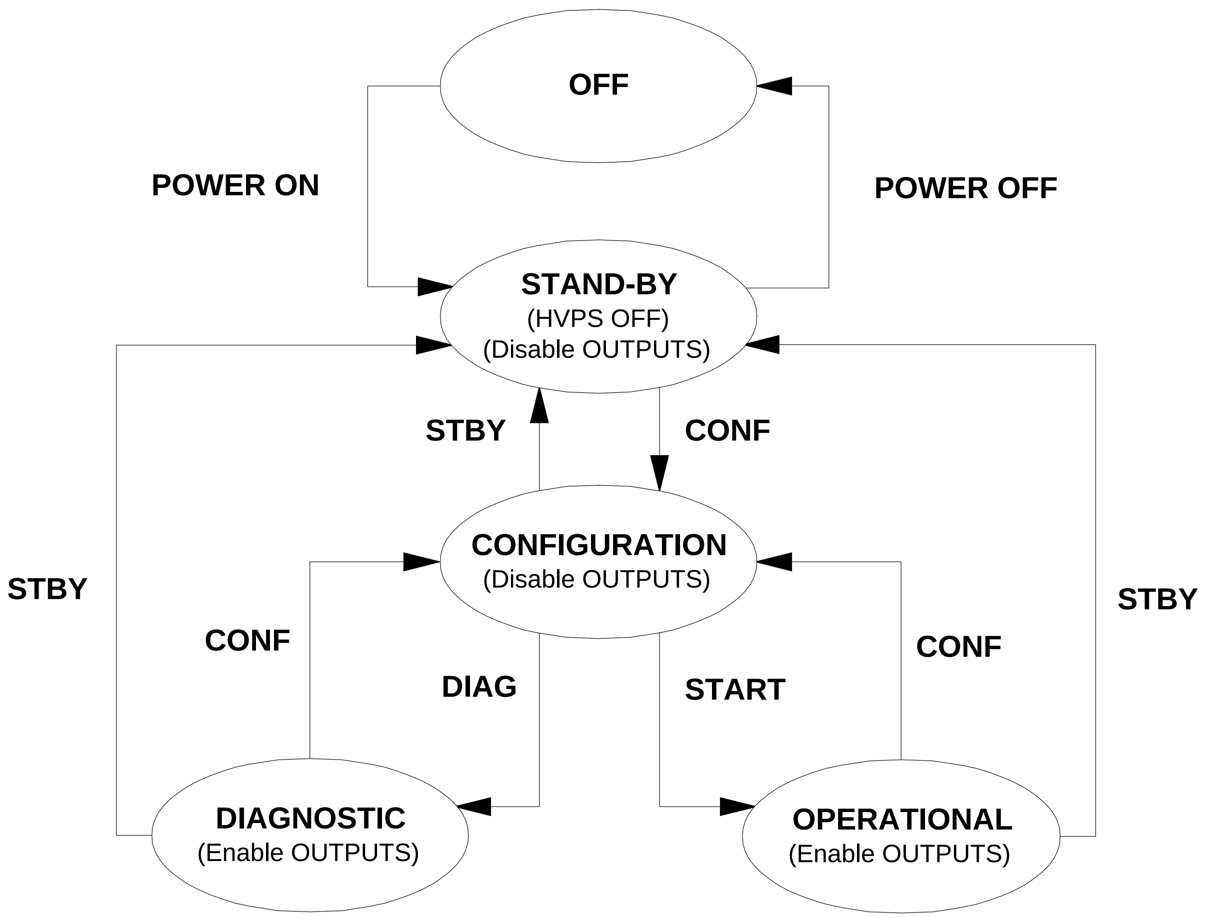


Figure 1 : MEMORY STRUCTURE OF AFEE TM/TC ELECTRONIC BOX

3.7.5.3. AFEE TM/TC mode treatment



3.7.5.4. FM SW version

The FM AFEE TM/TC software version is 2.02.

3.7.6. DFEE software

See Volume 3 Annex 7 DFEE User Manual.

3.7.6.1. Architecture

The core of the DFEE system is an ASIC which is composed of several machines working in parallel on the different tasks. An external clock gives the rythm to the system at 32 MHz.

- **Front function** is the first processing stage which consists to synchronize the inputs signals with the ASIC clock, to filter these signals and to apply to each one a predefine delay so that to align in time the 19 GE detectors signals. Each signal from the shield is extended in time with an adjustable value so that to garanty a events throwing out during all the period where the detectors can be blinded.
- **Association function** analyse the 19 detectors activity at each ASIC clock step. As soon as a detector (channel) indicates an activity, an association temporal window (adjustable up to 1 µs) is open, so that to gather in a same multidetector event all the activities of the others channels if any during this temporal window. For each active gathered channel, the association window is re-activated, so that to avoid an arbitrary multidetector event cutting. So the largest possible multidetector event is made up the 19 channels all active, since one channel which has been active will remaind in deadtime for 27 µs. If not any channel is active, the association machine classifies the event as simple (SE). If the only PSD channel has been active, the association machine classifies the event as PSD event (PE). If one of channel activity deals with an vetoed signal, the event is tagged as vetoed.

  The relative time between active dtectors inside an ME is measured by association function in ASIC clock units (30 ns), whereas the absolute time of an event SE, ME or PE is given in 100 µs units.
- **Primary object** is an ASIC FIFO internal memory which receives the events made by the association machine. It can contains up to 64 simple events (SE) and is used to wait for the sending of energies encoded by AFEE which takes place just after anolog/digital conversion, typically 27 µs after the detector signal activity sending.
- **Serial reception function,** while the transit time in the FIFO memory, the Serial reception machine decodes and records the tramsmitted values by th AFEE.
- **Acquisition function** extracts each Primary Object from internal FIFO, in order to assess if the energy values are already available, if so it transfert the event completed by its energy towards the external FIFO tables, where they are recordedaccording to their type SE, ME, PE. The vetoed tagged events are not recorded. The external FIFO's can contain 125 ms activity history.
- **Dialog function** read the external FIFO's and transmit the data towards DPE through HSL .
- **Control-command status and test function** manages on the LSL a communication with the DFEE Microcontroller. They exchange configuration commands, statii, counting number and deadtime processing from ASIC each second.

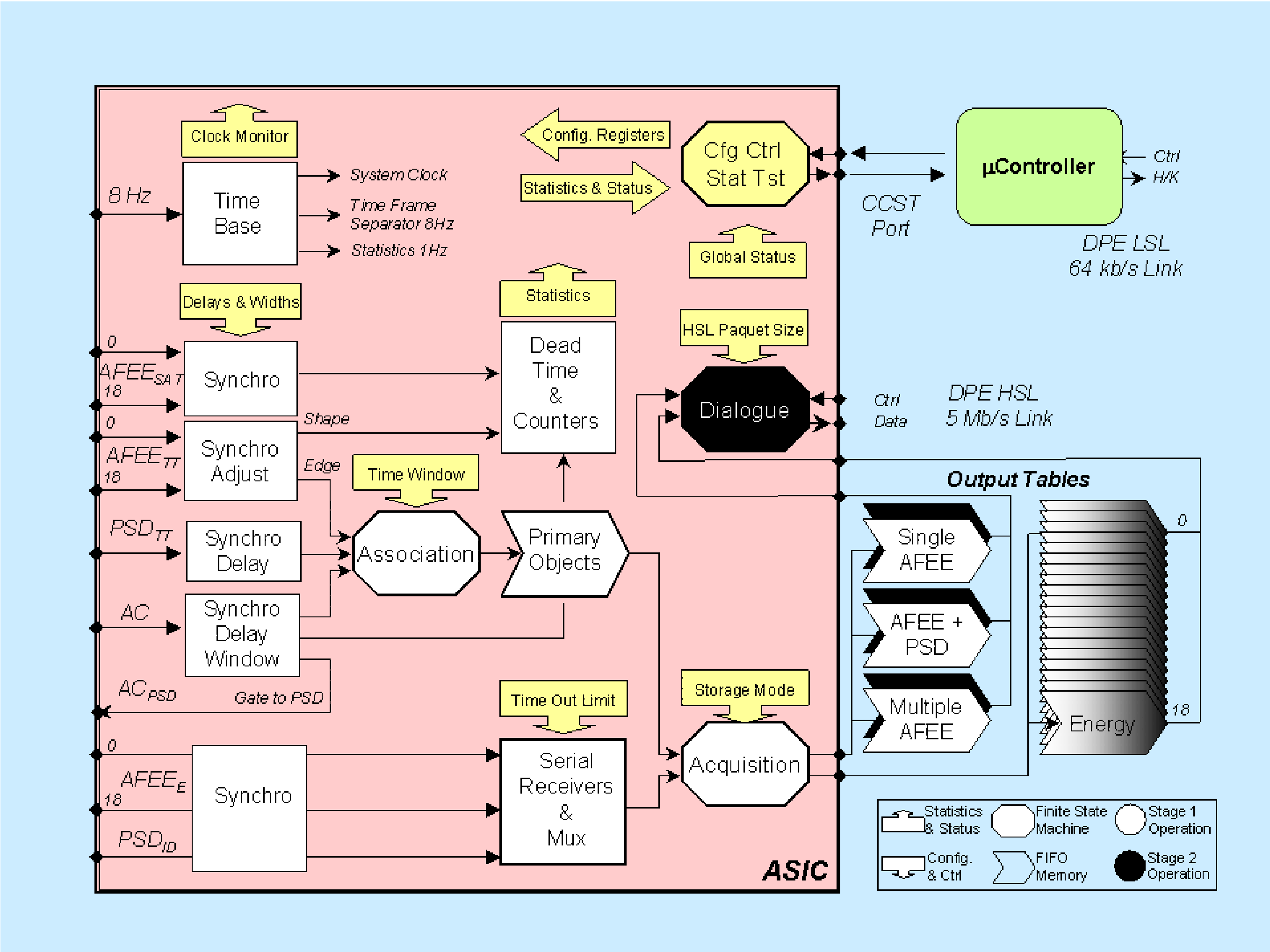


Figure 3.24 - DFEE Architecture

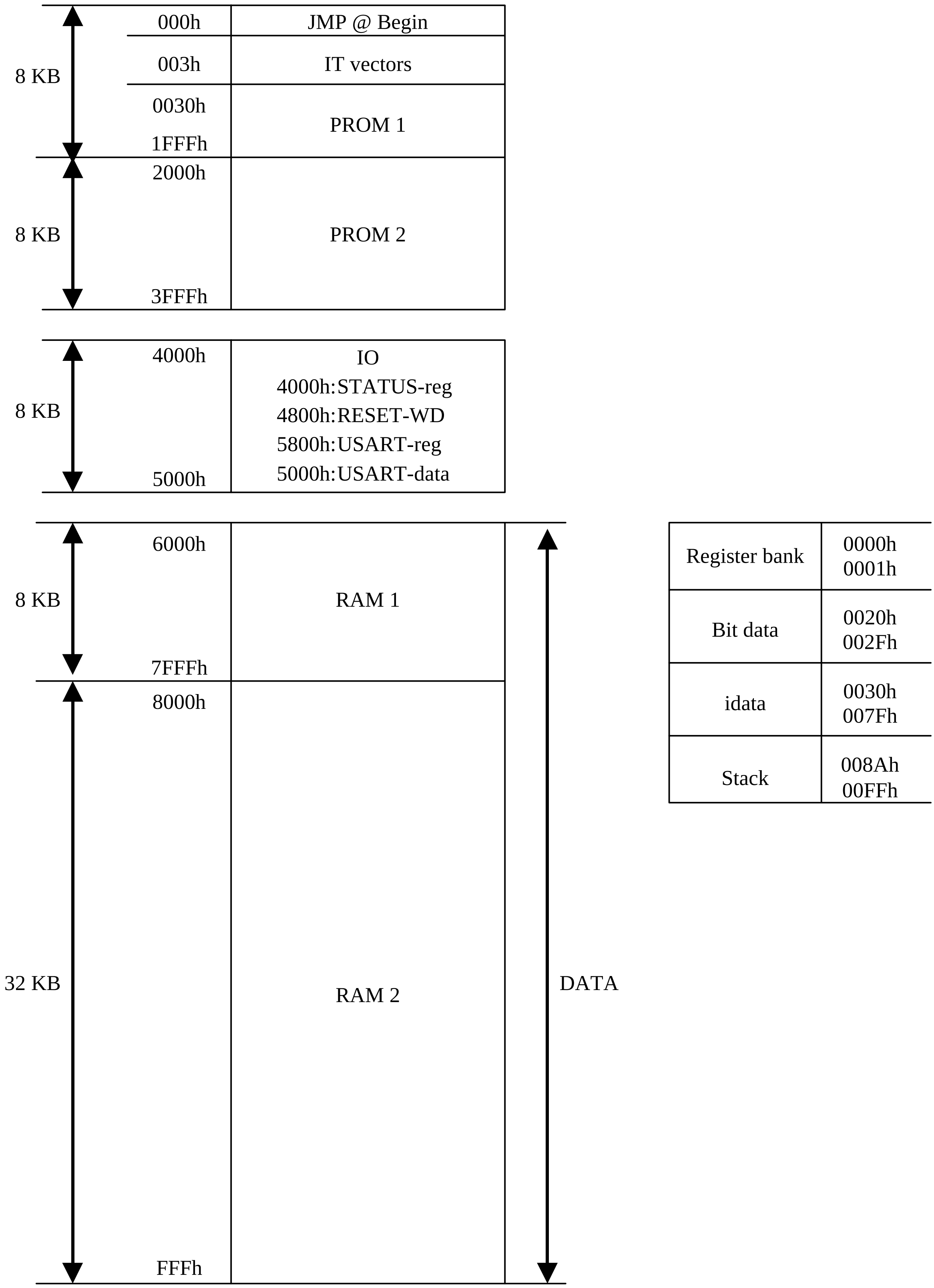


Figure 3.25 - DFEE Supervisor Memory Mapping

3.7.7. ACS software

3.7.7.1. Architecture

3.7.7.1.1. System environment

The VCU software shall run on an embedded microcontroller of type 80C32 clocked with 12 MHz. This microcontroller is a ROM less 8 Bit device with:

- 256 byte internal RAM
- 3 * 16 Bit timer/counter externally clocked with 4 kHz
- 16 kByte external PROM (EEPROM)
- 32 kByte external RAM

For the interface to the DPE a USART of type MA8251 will be used.
For data acquisition a 12 Bit ADC of type AD574 is provided.

The VCU software shall be developed in a high level language like C.

Figure 3.26 shows the VCU Hardware Architecture.

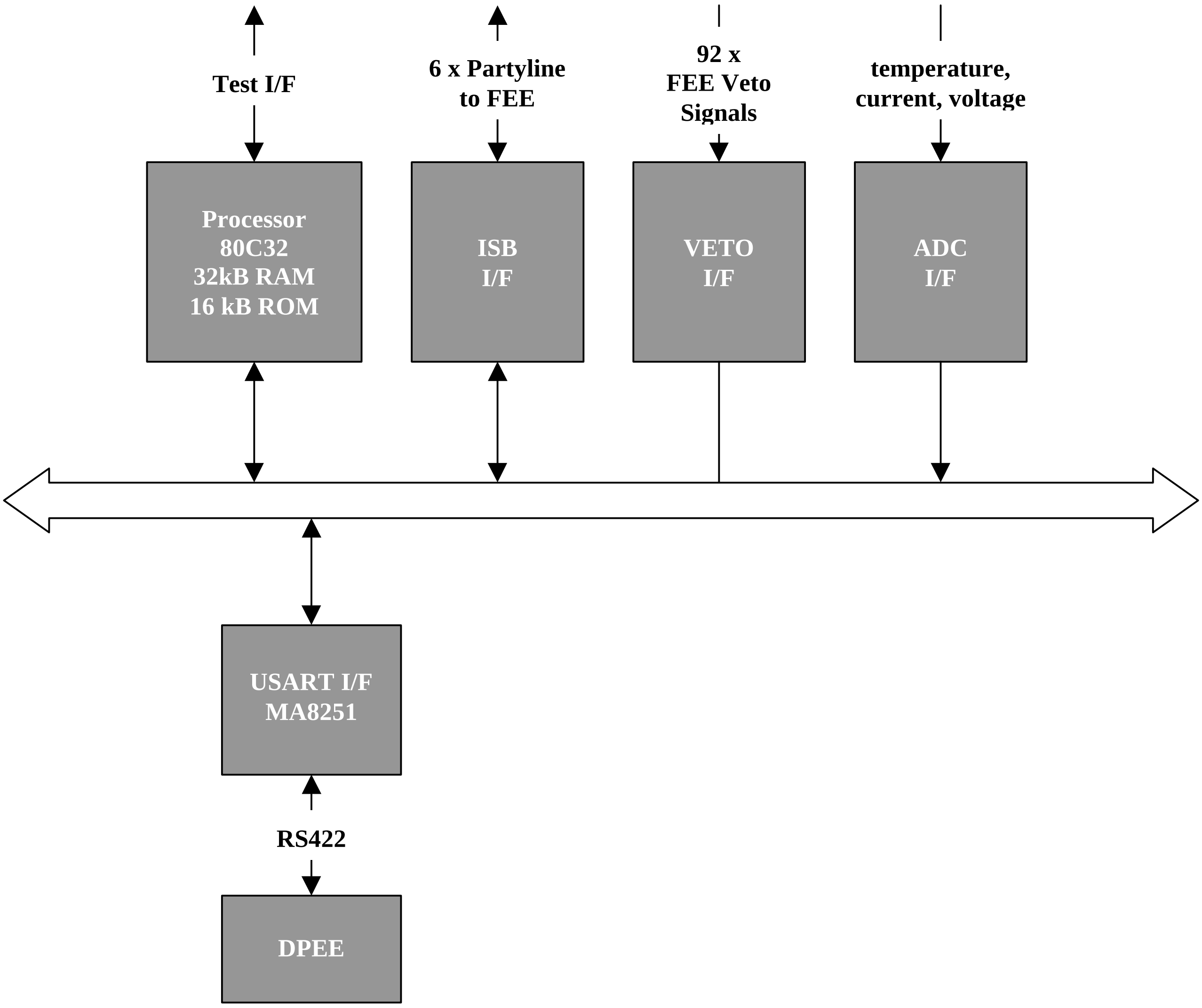


Figure 3.26 - VCU Hardware Architecture

3.7.7.1.2. VCU software

The figure below shows the hierarchy diagram of the VCU software. It is controlled from main which calls setupACS for initialization. Then it reaches and endless loop which calls the state machine functions. They use a set of functions for the specified activities. The marked grey routines shown handle interrupt service which are activated asynchronously.

After power on or watchdog reset startup is called which performs a jump to the main function.

Startup and copy ToRspBuf components are implemented in the assembler language, all other are in C.

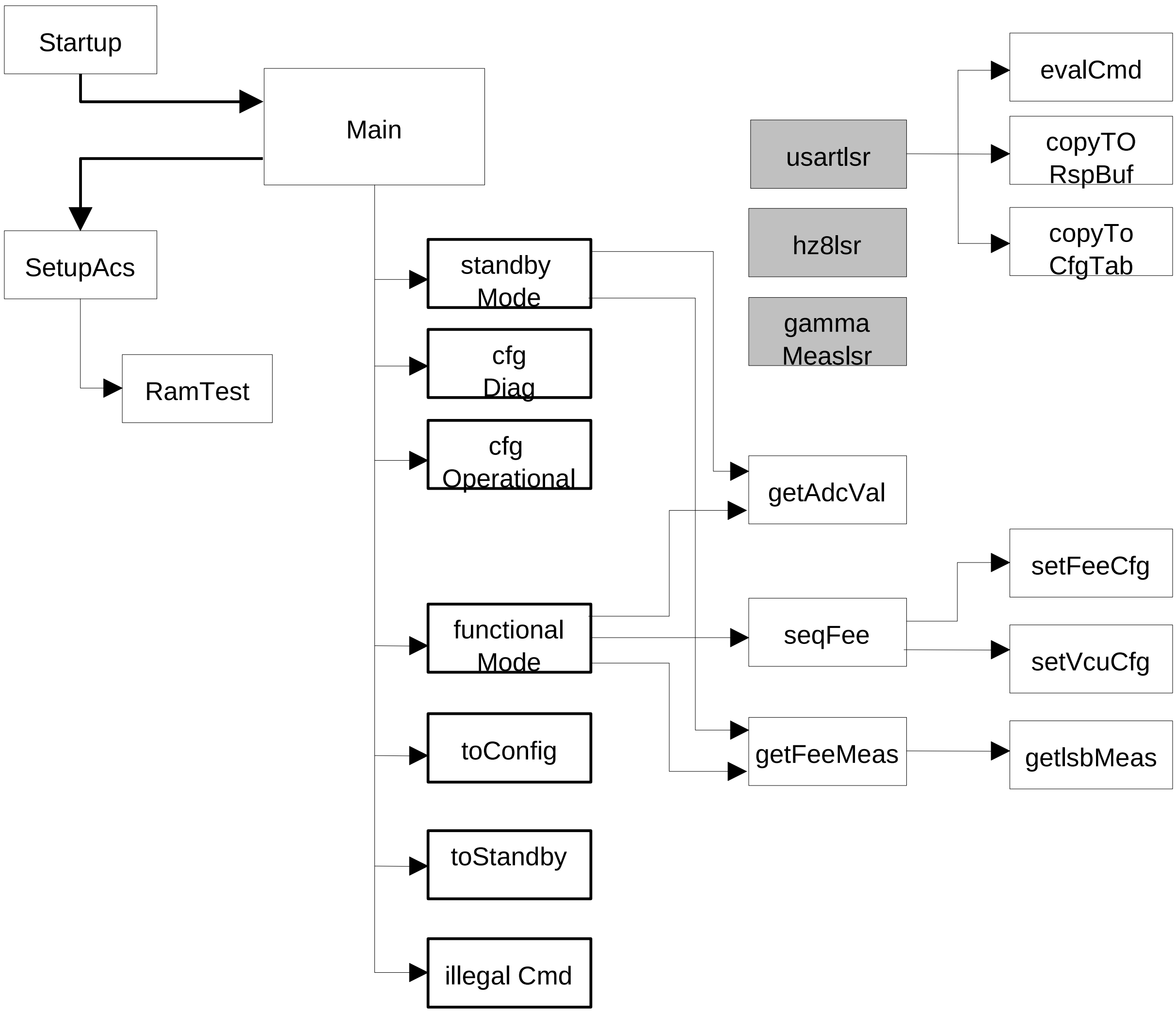


Figure 3.27 - VCU Software Hierarchy Diagram

3.7.7.2. Functions description

Name	Startup
Type	Runs after power on of the 80C32 and performs the jump to the main function.
Function	After power on data and program address space are swapped, i.e the code area start at 0 hex where the microprocessor stats fetching code. The startup software will copy the code area into the data space (that is now starting at 8000 hex). Then it clears the swap bit in ht Actel to get the original address arrangement back. From this point the program runs as an PRM copy within the data area. Program uploading and patching is now possible. It initializes the VCU software system in terms of internal setup, internal and external RAM initialization, setting the stack pointer and performing a jump to the main function. It will be called in case of power or after watchdog reset.
Interfaces	None
Dependencies	The execution of this function is necessary before invoking the remaining VCU software.
Data	None
Resources	None

Name	Main
Type	Main function of VCU software.
Function	It initiates the VCU SW via calling the function **setupAcs.** Then the main function controls the coordination of SW components via calling the state machine and perform resetting of the watchdog cyclically. The state machine is an array with pointers to functions. The array parameter 1 is the actual mode, array parameter 2 is the new commanded mode (if any). The return value is the mode which is set from the state machine functions.
Interfaces	None
Dependencies	The procedure main is invoked from the startup code. After executing the setup of the SW system the system is coordinated in relationship to the commanded VCU mode.
Data	None
Resources	none

Name	SetupAcs
Type	Procedure.
Function	Initializes the VCU system in terms of initialization of the related external interfaces.
Interfaces	None
Dependencies	Its execution is mandatory before invoking the remaining VCU SW
Data	None
Resources	All available external interfaces.

Name	InitCfgTab
Type	Procedure.
Function	Set the the configuration table to the default state. This will be done after power on and during the transition from any mode to Standby mode.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	dataRamTest
Type	Procedure.
Function	Checks the external Data RAM. In case of an error , an error will be set in theACS status.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	StandbyMode
Type	Function : part of the statemachine.
Function	Performs software activities in standby mode.
Interfaces	Return unsigned char actMode.
Dependencies	None
Data	None
Resources	None

Name	Functional mode
Type	Function : part of the statemachine.
Function	Performs software activities in all functional modes (Configuration, Diagnostic and Operational)
Interfaces	Return unsigned char actMode
Dependencies	None
Data	None
Resources	None

Name	cfgOperational
Type	Function : part of the statemachine.
Function	Performs software activities during mode transition from configuration to operational mode.
Interfaces	Return unsigned char actMode
Dependencies	None
Data	None
Resources	None

Name	CfgDiag
Type	Function : part of the statemachine.
Function	Performs software activities during mode transition from configuration to diagnostic mode.
Interfaces	Return unsigned char actMode
Dependencies	None
Data	None
Resources	None

Name	toConfig
Type	Function : part of the statemachine.
Function	Performs software activities from any mode to configuration mode.
Interfaces	Return unsigned char actMode
Dependencies	None
Data	None
Resources	None

Name	toStandby
Type	Function : part of the statemachine.
Function	Performs software activities from any mode to standby mode.
Interfaces	Return unsigned char actMode.
Dependencies	None
Data	None
Resources	None

Name	illegalCmd
Type	Function : part of the statemachine.
Function	Performs software activities if an invalid mode transition is commanded.
Interfaces	Return unsigned char actMode.
Dependencies	None
Data	None
Resources	None

Name	CyclicAutotest
Type	Procedure.
Function	Performs the cyclic autotest in Standby mode.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	energyCalibration
Type	Procedure.
Function	Performs the acquisition of the ACS calibartion data.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	getAdcVal
Type	Procedure.
Function	Performs the acquisition of the analogue measurements and the storage in the HK buffer. All 65 ms an analogue measurement is performed. For all 23 ADC measurements a time of 1.5 seconds is used.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	seqFEE
Type	Procedure.
Function	Set/read the FEE configuration in a cyclic manner
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	setFeeCfg
Type	Procedure.
Function	Calls from seqFee and start the requested service for the FEE.
Interfaces	Input unsigned char feeCmdType
Dependencies	None
Data	None
Resources	None

Name	setVcuCfg
Type	Procedure.
Function	Writes the pulse width and the 92 overall masks to the VCU registers.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	getFee Meas
Type	Procedure.
Function	Acquires the requested HK data from the FEE's.
Interfaces	Input unsigned char feeMeasType
Dependencies	None
Data	None
Resources	None

Name	getParity
Type	Procedure.
Function	Returns the parity bit of a 16-bit word.
Interfaces	Input unsigned short value return bit.
Dependencies	None
Data	None
Resources	None

Name	getlsbMeas
Type	Function.
Function	It is the hardware driver for the ISB bus. It is called from setFeeCfg and getFeeMeas.
Interfaces	Input unsigned short ISB address, return unsigned char.
Dependencies	None
Data	None
Resources	None

Name	hz8lsr
Type	Interrupt service routine.
Function	It is called after the falling edge of the 8 Hz signal. It writes the watchdog pattern cyclically to the hardware. For the gamma ray measurement the switching of the toggle buffer is managed in this function.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	gammaMeaslsr
Type	Interrupt service routine.
Function	Timer 1 acts as 8-bit reload timer and generates a software interrupt all 50 ms. This component acquires the 32-bit overall-counter from VETO I/F. The 32-bit integer value is converted to a 16-bit float value and stored in the overall-counter history buffer.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	usartlsr
Type	Interrupt service routine.
Function	Called if a new character is received from the USART or if a character is transmitted from the USART. In case of an received interrupt, the incoming character is evaluated and stored in the command buffer. In case of a transmission interrupt the response buffer is checked for more charcters to transmit.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	evalCmd
Type	Procedure.
Function	Called from usartlsr and evaluates the incoming comand.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	wait100µs
Type	Procedure.
Function	Wait for the requested time in microseconds
Interfaces	Input Uchar len
Dependencies	None
Data	None
Resources	None

Name	copyToRspBuf
Type	Assembler routine.
Function	Called from usartlsr and transfers n bytes from external memory (HK buffer) into internal memory (response buffer)
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	copyToCfgTab
Type	Assembler routine.
Function	Copy n bytes from internal memory (command buffer) into external memory (configuration table).
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	copyToXram
Type	Assembler routine.
Function	Copy n bytes from intenal memory to external memory.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	clearXram
Type	Assembler routine
Function	Clears (set to 0) n bytes in external memory.
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	maintenanceSw
Type	Main module.
Function	For SW maintenance it initializes the VCU SW for a maintenance session (e.g. disables all interrupts, uses only polling mechanism, etc)
Interfaces	None
Dependencies	None
Data	None
Resources	None

Name	sendSyncRsp
Type	Function.
Function	Sends the response to the DPE via the USART I/F, using polling method.
Interfaces	None
Dependencies	None
Data	None
Resources	None

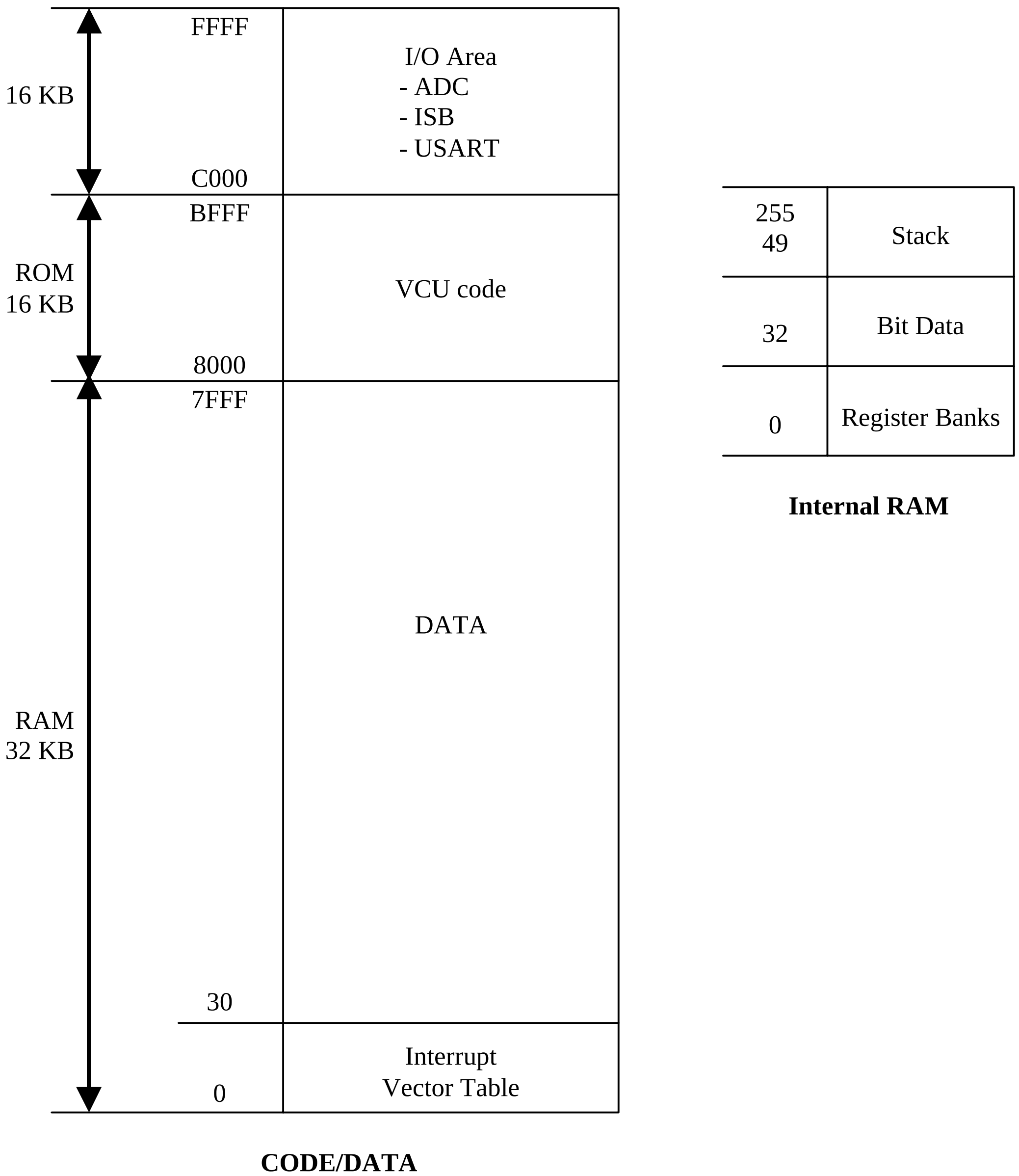


Figure 3.28 - VCU Memory Mapping

3.7.7.3. VCU I/O mapping

Table 3.15 shows the I/O mapping.

	Address	Read/ Write	Data Bus	Description	
Veto I/O Mapping	C000	r	D7-D0	reads C7-C0 of the overall-counter	
	C001	r	D7-D0	reads C15-C8 of the overall-counter	
	C002	r	D7-D0	reads C23-C16 of the overall-counter	
	C003	r	D7-D0	reads C31-C24 of the overall-counter	
	C004	r	-	clears and swaps the alternate counter	
	C005	r	D7-D0	reads the "FF-Mode-10" Error counter. (This counter should read zero unless SEU's cause errors within the veto delay logic).	
	C000	w	D7-D0	writes the veto mask bits V7-V0	0=enable, 1=disable
	C001	w	D7-D0	writes the veto mask bits V15-V8	
	C002	w	D7-D0	writes the veto mask bits V23-V16	
	C003	w	D7-D0	writes the veto mask bits V31-V24	
	C004	w	D7-D0	writes the veto mask bits V39-V32	
	C005	w	D7-D0	writes the veto mask bits V47-V40	
	C006	w	D7-D0	writes the veto mask bits V55-V48	
	C007	w	D7-D0	writes the veto mask bits V63-V56	
	C008	w	D7-D0	writes the veto mask bits V71-V64	
	C009	w	D7-D0	writes the veto mask bits V79-V72	
	C00A	w	D7-D0	writes the veto mask bits V87-V80	
	C00B	w	D3-D0	writes the veto mask bits V91-V88	
	C00C	w	-	resets the delay circuit	
	C00D	w	D5-D0	writes the veto rise time (D2-D0) and fall time (D5-D3) registers default after power on is 0	r/f=00 hex 150 ns r/f=01 hex 165 ns r/f=02 hex 180 ns r/f=03 hex 195 ns r/f=04 hex 210 ns r/f=05 hex 240 ns r/f=06 hex 270 ns r/f=07 hex 300 ns
	C00E	w	-	resets mask and delay time registrers	
	C00F	w	D0	writes the overall veto mask	M=0 Veto enabled M=1 Veto disabled
ADC I/O Mapping	C040	w	-	starts A/D conversion	
	C041	w	D5-D0	writes the MUX address M5-M0	M=00: Thermistor 0 M=01: Thermistor 1 M=02: Thermistor 2 M=03: Thermistor 3 M=04: Thermistor 4 M=05: Thermistor 5 M=06: Thermistor 6 M=07: Thermistor 7 M=08: Thermistor 8 M=09: Thermistor 9 M=0a: Thermistor 10 M=0b: Thermistor 11 M=0c: Thermistor 12 (VCU) M=0d: Thermistor 13 M=0e: Thermistor 14 M=0f: Thermistor 15

	Address	Read/ Write	Data Bus	Description	
ADC I/O Mapping (cont'd)					M=10: AC voltage M=20: AC current M=30: 2.5 V Reference M=40: +15V Supply M=50: -15V Supply M=60: +5V Supply M=70: Ground Reference
	C040	r	D7-D0	reads ADC data bits R11-R4	
	C041	r	D3-D0	reads ADC data bits R3-R0	
	C042	r	D0	reads the converter busy status	0=Ready, 1=Busy
DPE I/O Mapping	C080	w	D7-D0	writes the USART data port	
	C081	w	D7-D0	writes the USART control port	
	C080	r	D7-D0	writes the USART data port	
	C081	r	D7-D0	reads the USART status port	
VCU I/O Mapping	C0C0	w	D0	controls the VCU address mapping default after power on is 0	0=Swapping Off 1=Swapping On
	C0C1	w	D1-D0	writes the test bit output and the i/o control	D0: I/O Control 0=Inout, 1=Output D1: Test bit output data
	C0C2	w	D1-D0	sets the clock divider	0: 12 MHz (default) 1 : 6 MHz 2 : 3 MHz 3: 0 MHz (sleep mode)
	C0C3	w	D7-D0	writes the watchdog pattern (0xeb)	watchdog pattern is $ed
	C0C4	w	D7-D0	sets the 4 kHz clock divider	$f_{4k}=f_{bus}/(DIV+1)$ f_{bus}=1 MHz e.g. 1 MHz /(249+1)=4000
	C0C0	r	D7-D0	reads the status bits	D0: reset source (0=Power On, 1=Watchdog) D1: Test bit input D2: 8 Hz signal D3: USART Rx Ready D4: USART Tx Ready D5-D6: Clock Divider D7: Swap Status (0=Normal, 1=Swapped)
ISB I/O Mapping	C020	r	D7-D0	reads receiver 0 bits R7-R0	
	C021	r	D7-D0	reads receiver 0 bits R15-R8	
	C022	r	D7-D0	reads receiver 1 bits R7-R0	
	C023	r	D7-D0	reads receiver 1 bits R15-R8	
	C024	r	D7-D0	reads receiver 2 bits R7-R0	
	C025	r	D7-D0	reads receiver 2 bits R15-R8	
	C026	r	D7-D0	reads receiver 3 bits R7-R0	
	C027	r	D7-D0	reads receiver 3 bits R15-R8	
	C028	r	D7-D0	reads receiver 4 bits R7-R0	
	C029	r	D7-D0	reads receiver 4 bits R15-R8	
	C02A	r	D7-D0	reads receiver 5 bits R7-R0	
	C02B	r	D7-D0	reads receiver 5 bits R15-R8	
	C02C	r	D5-D0	reads busy status Bit B5-B0	
	C02E	r	D0	reads output enable status bit E0	

	Address	Read/ Write	Data Bus	Description	
ISB I/O Mapping (cont'd)	C020	w	D7-D0	writes command0 bits T7-T0	
	C021	w	D7-D0	writes command0 bits T15-T8 and starts transmission	
	C022	w	D7-D0	writes command1 bits T7-T0	
	C023	w	D7-D0	writes command1 bits T15-T8 and starts transmission	
	C024	w	D7-D0	writes command2 bits T7-T0	
	C025	w	D7-D0	writes command2 bits T15-T8 and starts transmission	
	C026	w	D7-D0	writes command3 bits T7-T0	
	C027	w	D7-D0	writes command3 bits T15-T8 and starts transmission	
	C028	w	D7-D0	writes command4 bits T7-T0	
	C029	w	D7-D0	writes command4 bits T15-T8 and starts transmission	
	C02A	w	D7-D0	writes command5 bits T7-T0	
	C02B	w	D7-D0	writes command5 bits T15-T8 and starts transmission	
	C02C	w	D0	writes I/F 0-5 output enable (1=enable)	
	C02E	w	D7-D0	resets all I/F 0-5 logic and programs the ISB clock divider	

Table 3.15 - VCU I/O Mapping

3.7.7.4. Sizing considerations

RAM and ROM estimates

- ROM available: 16 k Byte
- ROM used for VCU code: 12 k Byte
- ROM spare: 4 k Byte
- RAM available: 32 k Byte
- RAM used for data: 4 k Byte

The complete RAM (32 k Byte) can be reloaded from Ground inclusive the interrupt vectors.

3.7.7.5. Stack analysis

The following table shows the memory model of the 80C32 internal memory (256 bytes).

Four register banks uses 32 bytes of RAM starting at RAM address 0.

The next upper 16 bytes are used for bit data.

For the stack area, 64 bytes will be reserved (grey area).

The initial value of the stack pointer (set in startup component) will not excedd the value BF hex.

FF C0	Stack Area	64
BF 80	Internal Data (IDATA)	64
7F 30	Internal Data (DATA)	80
2f 20	Bit Data (BDATA)	16
1f.. 18	Register Bank 3 used for tbd	8
17.. 10	Register Bank 2 used for tbd	8
0f.. 08	Register Bank 1 used for tbd	8
07.. 00	Register Bank 0 main	8

Table 3.16 - VCU Software Stack Analysis

The following table shows typical stack operations and the number of bytes which are pushed on the stack:

N°	Stack operations	Stack usage (bytes) tbc
1.	function call	2
2.	interrupt service routine	5

The worst case scenario will be shown in the following table.

Level	Stack activity	Stack usage (bytes)
1.	main function calls subfunction	2
2.	subfunction calls subfunction	2
3.	subfunction calls subfunction	2
4.	subfunction calls library function	14
5.	low level interrupt occurs	5
6.	high level interrupt occurs	4

<u>Summary</u>:
29 bytes will be used from the 64 byte stack area
The stack area usage for the worst case is <u>below 46%.</u>

3.7.8. PSD software

3.7.8.1. PSD functionality

The PSD subassembly of the SPI telescope aboard the INTEGRAL spacecraft consists of an onboard characterisation of detector current pulses aiming in the reduction of instrumental background. The characterisation is done by a comparison of a measured pulse shape with a library of reference pulse shapes that have been determined during a calibration phase (either ground or in flight calibration).

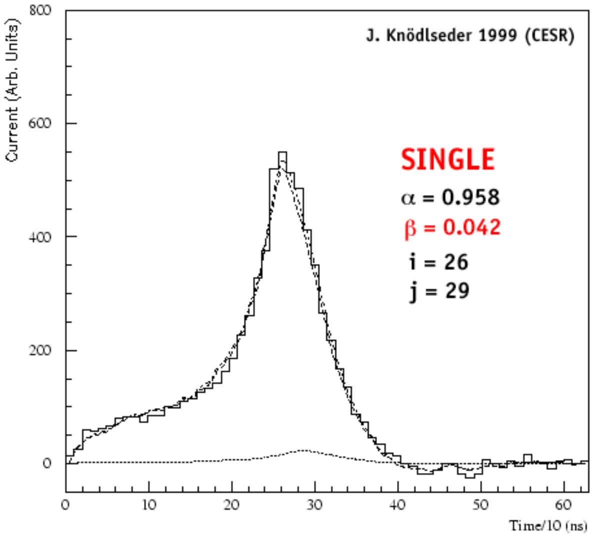
Recognition of a single-site event:

Either

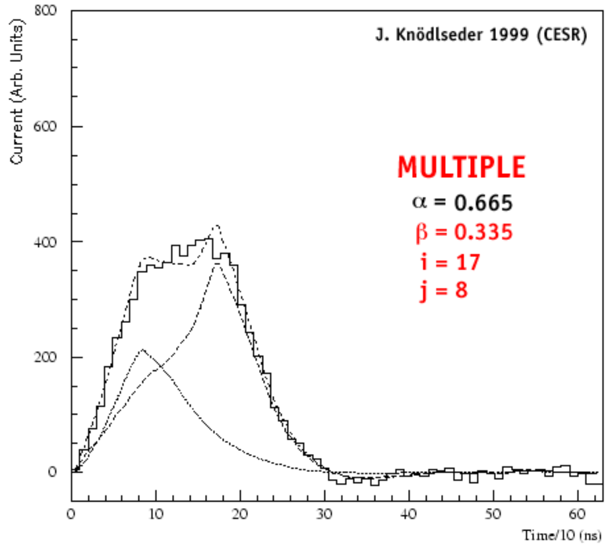
Time-to-peak spacing |i-j| ≤ SPC

Or

Smaller peak amplitude β ≤ TRS



Recognition of a multiple-site event:
Both
Time-to-peak spacing |i-j| > SPC
And
Smaller peak amplitude β > TRS



3.7.8.2. DSP32 software architecture

The PSD subassembly houses a DSP32C digital signal processor. This processor handles all communications with the environment (LSL, HSL, DFEE) and performs the scientific analysis of the digitised pulses shapes. The software in the PSD is composed of two parts:

1. The functional software (`eng.s`) that handles all interfaces and the data accumulation and preparation:

   - ✓ detector signals,
   - ✓ telecommands and house-keeping via LSL,
   - ✓ analysis telemetry via HSL,
   - ✓ DFEE identifier and time-tag

It provides the main loop of the PSD subassembly, allows for the configurational control of the system, identifies the detector signals to be analysed, accumulates detector pulse shapes and schedules them for scientific analysis, gathers scientific analysis results, puts them into the telemetry and collects statistics on the PSD performance.

2. The scientific software (`science.s`) that analyses the pulse shapes and handles the library management:

   - ✓ analyses a measured pulse shape in order to discriminate single-site interactions from multiple-site events
   - ✓ Handles the uploadable library templates and the writing of the EEPROMs.

The interface between eng and science is done via four subroutine calls:

- ✓ analinit : initialises the scientific analysis package
- ✓ anal : scientific analysis routine called for each event
- ✓ addlibrary : adds a library template to EEPROM
- ✓ correlate : pre-calculates library dependent constants

In the FM, the functional software has version number 230 and the scientific software has version number V1.08. For more detailed description of PSD Software please refer to PSD Software Description (in SPI User Manual Volume 3, Annex 8a).

3.7.8.3. PSD Memory Management

After start-up, the PSD program code that resides in PROM is copied into RAM and code execution will then be passed to RAM. The only exception is the software maintenance mode for which code execution takes place in PROM (hence the entire RAM area is patchable). For more information about the memory management, please refer to section 6 of PSD User Manual (in SPI User Manual Volume 3, Annex 8).

memory	start	end	size	package	speed	content
ROM	0X000000	0X007FFF	32k	both	slowest	copy of program code
EEPROM A	0X080000	0X0FFFFF	512k	science	slowest	library templates
ext. RAM	0X980000	0X987FFF	32k	both	fast	active copy of program code
ext. RAM	0X988000	0X988FFF	4k	eng	fast	event and curve buffer for HSL
ext. RAM	0X989000	0X9EFDFF	411,5k	science	fast	pre-calculated arrays
ext. RAM	0X9EFE00	0X9EFFFF	512	eng	fast	program stack
ext. RAM	0X9F0000	0X9FFFFF	64k	eng	fast	FIFO buffer for pulses
int. RAM 2	0XFFE000	0XFFE3FF	1k	eng	fast	program variables
int. RAM 2	0XFFE400	0XFFE7FF	1k	science	fast	program variables
int. RAM 0	0XFFF000	0XFFF2FF	768	eng	fast	program variables
int. RAM 0	0XFFF300	0XFFF7FF	1280	science	fast	program variables
int. RAM 1	0XFFF800	0XFFFFFF	2k	eng	fast	program variables

3.7.9. Interfaces characteristics between IASW and S/A

3.7.9.1. General characteristics

All command types reception must be treated by S/A SW as high priority requests to be treated in real time (command execution can be delayed)

- After POWER ON, the S/A SW runs an autotest of the S/A the result of which can be read later by IASW.
- Except during initialisation mode, the S/A SW is able to accept and execute any incoming command from IASW at any time (except during HK emission on LSL).
- In **STDBY** mode, the S/A SW runs cyclically (every 10 Minutes TBC) the autotest of the S/A and updates the autotest result, for an eventual read from IASW. The cyclic autotest is never result in the loss of incoming commands, and is aborted prior to enter configuration mode.
- When a S/A SW receives a mode, configuration, load/dump init command which is not allowed in its current mode (i.e. which does not belong to the S/A mode transition diagram) it ignores it, remains in current mode and sets the bit of the corresponding user's acknowledgement (bit N°-6 refer to following pages). Then it resets this bit for next user's acknowledgement.
- The S/A SW sets the status autotest bit according to the integrity of its RAM ROM and µprocessor; this bit is set to NOK if the S/A autotest result tells that the S/A is no longer capable to carry out properly LSL exchanges. The other results of autotest is reported using other available bits.
- At initialisation and after reception of init command the S/A SW configures the S/A in a default predefined state.
- The S/A SW does not change the mode or the configuration in an automatic way; changes are only allowed according to IASW commands.
- The S/A SW runs in RAM.
- The entire S/A SW is patchable but AFEE. When entering the S/A SW maintenance sub-mode, the S/A SWs jumps to the execution of a dedicated LOADER routine in PROM. This Loader complies to the command acceptance matrix below. When exiting the S/A SW maintenance sub-mode, the S/A SWs branchs back to the RAM software (e.g.: running a "warm" reset of the SW without copying PROM to RAM) and switch to CONFIGURATION mode. The bit N°0 of ACK/NACK (1st command after reset) is not affected by the <SW RESTART> command nor by the init command. When entering or exiting SW maintenance sub-mode, the S/A SWs are allowed to modify their current configuration.

3.7.9.1.1. S/A SW command processing

- The **STDBY** commands must be accepted and executed whatever the mode of the S/A is (except in Standby mode).
- The S/A SW has a buffer for incoming commands; the S/A SW sets to "0" the bit N°7 of status most significant byte when its command buffer is empty; that means that all commands have been initiated. In other cases this bit must be set to "1".
- S/A SW will remain in its current state (mode, configuration, processings, …) after reception of any command resulting in a checksum error status or in a “not allowed command” status.
- S/A SW complies with the following matrix of command acceptance versus current mode.

Current Mode / **Incoming command**	**STANDBY**	**CONFIGURATION**		**OPERATION**	**DIAG.**	**CAL.**
		CONF	**SW Maintenance**			
Mode command <START>	Not allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed
Mode command <CONF>	Allowed	Not allowed	Not allowed	Allowed	Allowed	Allowed
Mode command <DIAG>	Not allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed
Mode command <CAL> *	Not allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed
Mode command <STBY>	Not allowed	Allowed	Not allowed	Allowed	Allowed	Allowed
HK acquisition commands	Allowed	Allowed	Not allowed	Allowed	Allowed	Allowed
Configuration commands	Not allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed
Load commands	Not allowed	Not allowed	Allowed	Not allowed	Not allowed	Not allowed
Dump commands	Not allowed	Allowed	Allowed	Not allowed**	Allowed	Not allowed
Init commands	Not allowed	Not allowed	Allowed	Not allowed	Not allowed	Not allowed
SW restart / command	Not allowed	Not allowed	Allowed	Not allowed	Not allowed	Not allowed
SW maintenance command	Not allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed

* Only for PSD

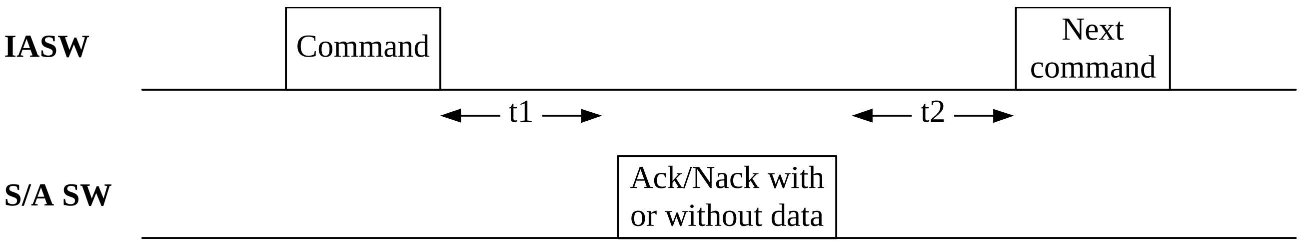
** Except for DFEE

3.7.9.1.2. S/A SW HSL and LSL management

- The S/A SW manages the USART to ensure that, in emission, it does not insert any synchronisation character in the message it sends.

- The S/A SW design ensures that during a reception of a LSL message, no incoming character is lost.

- A LSL exchange sequence follows the hereunder chronogram:



10 µsec < t1 < 500µsec
60 µsec < t2

No command is sent to S/A SW before the previous command user's acknowledge (and data when required) have been received by IASW or IASW time-out has occurred.

In order to deal with this timing it is advised that the S/A SW be always ready for commands reception and that it has a cyclic updating of its HK data buffers.

- In case of unrecognised command, the supposed length of the command is 4 bytes. So the S/A SW replies the ACK/NACK according to the timings (in previous bullet) in the case of a 4 byte-long command. When receiving an unrecognised command, S/A software asserts bit N° 7 (CS) of user’s acknowledgement to "0" and bit N° 6 to "1".

In case of a mode command requesting a forbidden mode transition (e.g. transition from STBY mode to OPER mode), S/A SW will set bit N° 6 of user’s acknowledgement to "1" and assert bit N° 7 according to the result of the CS test.

To sum up, bit N°6 is set to "1" on any of the following events:

- invalid code command (unrecognised command)

- invalid identifier in the command

- invalid mode transition

- This IASW will read first the HSL from DFEE then from PSD. This order is prefered because the DFEE AS/L is faster than the PSD SW which needs more time to process the last events arrived just before the following edge of 8 Hz.

3.7.9.1.3. DFEE / PSD sequencing and synchronisation

The IASW will guarantee that all mode change commands will be sent to S/As at the latest, 80 mSec after the beginning of the 8 Hz cycle, accordingly the S/As shall switch effectively to the new mode at the beginning of the next 8 Hz cycle.

The synchronization to enter and exit scientific modes is shown below. Mode indicated here is the mode at the beginning of 8 Hz cycle. The acquisition of technological HK is voluntarily not mentioned here.

SWITCH FROM CONF TO OPER/CAL SEQUENCE FOR PSD AND DFEE

8 Hz cycle number	n-4	n-3	n-2	n-1	n	n+1 (*)		n+17
IASW action	Sends START to AFEE	Sends START to ACS	Sends START/CAL to PSD	Sends START to DFEE		Starts scientific data acquisition from DFEE and PSD HSL		Starts scientific HK acquisition sequence from DFEE
PSD mode	CONF	CONF	CONF	OPER/CAL	OPER/CAL	OPER/CAL		OPER/CAL
DFEE mode	CONF	CONF	CONF	CONF	OPER	OPER		OPER
IASW mode	CONF	CONF	CONF	CONF	OPER/CAL	OPER/CAL		OPER/CAL

(*) It is the cycle of the beginning of DFEE and PSD enable.

The HSL data related to events occurred during the 8 Hz cycle k shall be sent to DPE HSL during the 8 Hz cycle k+1.

SWITCH FROM OPER/CAL TO CONF SEQUENCE FOR PSD AND DFEE

8 Hz cycle number	m-2	m-1	m	m+1	m+2	m+3 (*)
IASW action	Acquires scientific data from HSLs, scientific HK from DFEE LSL	Sends CONF to DFEE	Sends CONF to PSD	Sends CONF to ACS	Sends CONF to AFEE	Stops all HSL acquisition and scientific HK from DFEE
PSD mode	OPER/CAL	OPER/CAL	OPER/CAL	CONF	CONF	CONF
DFEE mode	OPER	OPER	CONF	CONF	CONF	CONF
IASW mode	OPER/CAL	OPER/CAL	OPER/CAL	OPER	OPER	CONF

(*) Depending on ACS HV switch-off, must be at cycle m+4.

For CONF to DIAG sequence, these two diagrams apply (replace OPER by DIAG mode), except that additional HK acquisitions (technological HK or specific DIAG HK) may be done starting in the 250 ms following cycle n+9 at a frequency defined by ground.

3.7.9.2. IASW sub-assemblies communication principle

There are two nominal and two redundant digital high speed links (up to 5 MHz) used for scientific and calibration data transmission from PSD and DFEE to DPE.

There are four nominal and four redundant multiplexed digital low speed links (up to 64 kHz) used for housekeeping data acquisition and commands transmission, from to the four sub-assemblies: ACS, AFEE, DFEE and PSD.

3.7.9.2.1. High speed link

This link shall be used for scientific data blocks transmission from PSD and DFEE to DPE in all scientific modes (CAL, DIAG and OPER modes).

Data are transmitted every 125 ms in synchronism with an enable signal driven by DPE.

Transmission duration inside a 125 ms period is continuous and remains identical during operational session. This duration value is transmitted by IASW with configuration commands.

Data are transmitted by the mean of one or several data blocks.

The data block starts with 3 identical 16 bits words (SOP) which include the type of transmitted data.

The data blocks stops with 3 identical 16 bits words (EOP) which include the number of 16 bit words of scientific data in the block.

Transmission stops synchronously with the enable signal, with 3 identical 16 bit words (EOT). Each of them contains the number of 16 bit words in the block, including the last EOP.

The words between the last EOP and the first EOT are the last Word Count for DFEE and are 00 for PSD.

Data are transmitted Msbyte and Msbit first.

3.7.9.2.2. Low speed link

- The IASW is always master of the start of an exchange.

- For each IASW command a related response will be provided by the sub-assembly. This response is called user's acknowledgement.

- HK data are transmitted to the DPE upon IASW request. They are transmitted in each mode by blocks of parameters with a fixed format and in a cyclic sequence; other formats and another cyclic sequence can be defined for diagnostic mode.

- The formats of generic commands such as mode commands are described in this paragraph, the others depending on S/A needs are described in the packet telecommand description paragraphs (Volume 4) which are a part of application data (from byte n° 5 to the end).

- As well specific HK block formats are described for each S/A in Volume 4.

The protocol is a double sync protocol, character oriented, 8 bits characters. No parity. Using USART28151 from GEC Plessey or MA8251.

USART shall be programmed for SYNC1/SYNC2 characters insertion when the transmitter buffer is empty. When there is no transmission, the output data drivers are at logical level "1".

3.7.9.2.3. Basic frame structure

All the messages or commands will be encapsulated for serial transmission as defined below:

SYNC1	**SYNC2**	MESSAGE	**CS**

Synchronisation characters Checksum

- SYNC characters:

  The synchronisation characters are placed in the serial data by the CPU and removed by the receiver USART; SYNC1 = 0A Hex SYNC2 = 05 Hex.

  For HK transmission from sub-assemblies, the number of bytes is fixed (about 32 bytes) for each HK block.

  The number of bytes in the message shall be an odd number.

- Transmission order:

  Transmission is performed LSB first (LSB is bit 7).

  In case of more than one byte parameter, the most significant byte of the word is transmitted first.

- Checksum:

  The checksum is performed by exclusive ORing of each 8 bits words (all bytes excluding leading SYNC characters) with the previous XORing result.

Configuration command message:

Code Cmd.Conf = "**C**"	ID Conf.	Data

Code Cmd configuration: 1 byte defined as "C" in ASCII or 43Hex pointing out that the following data are adjustable parameters which define the new configuration for the following operating sequence.

ID configuration: 1 byte pointing out the type or the configuration format which follows (refer to RD 21)

Data: Contains the values of the adjustable parameters (refer to RD 21)

For example: see only surrounded part

APID	Type	Sub-type	MF n°	Name	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	LS Bit n° 7
1025	5	3	E0003	tc-c_af_ch-par	Chain parameter setting	1	2 (TID)							
						2	3 (FID)							
						3	TC ID = 1							
						4	2 (AFEE)							
						5	"C"							
						6	03 Hex							
						7	E5050	E5070	E5090	E5130	E5150	0	0	0
						25	E5068	E5088	E5108	E5148	E5168	0	0	0
						26	Checksum							

Acquisition command message of HK data or of status:

Code Cmd.= "**K**"	ID	00

Code Cmd: 1 byte defined as "**K**" in ASCII or 4B Hex pointing out that this is an HK acquisition request or a status request.

ID: - for a **get status** ID is on 1 byte, **ID = 00Hex**.

For example: see only surrounded part

APID	Type	Sub-type	MF n°	Name	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	LS Bit n° 7
1025	5	4	E0031	tc-r_af_cryo	Request Cryogenic Temperatures	1	2 (TID)							
						2	33 (FID)							
						3	TC ID = 8							
						4	2 (AFEE)							
						5	"K"							
						6	21 Hex							
						7	00 Hex							
						8	CS							

This command packet has a fixed length of 4 bytes CheckSum included.

Loading command message:

Code Cmd.memory load = "**L**"	Most significant byte of Start address	Mid significant byte of Start address	Least significant byte of Start address	Number of bytes to load	Data

Code Cmd. memory load: 1 byte defined as "**L**" in ASCII or 4C Hex pointing out that the following is memory load data.

Start address: 3 bytes for the starting address of the memory to load.

Number of bytes to load: 1 byte to define the number of bytes to be loaded in S/A memory.

Data: 24 bytes of data to be loaded in memory. If less than 24 bytes are to be loaded, extra bytes beyond the **number of bytes to load** are filled with dummy bytes (00 Hex) to obtain a 24-byte data field.

This command packet has a fixed length of 30 bytes CheckSum included.

For example: see only surrounded part

APID	Type	Sub-type	MF n°	Name	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	LS Bit n° 7
1025	6	1	E0512	tc_load_pch-pd	Sending loading TC toward PSD	1 2	4 (16 bits encoded) (MID)							
						3	TC ID = 4							
						4	4 (PSD)							
						5	"L"							
						6	E8904							
						7	E8904							
						8	E8904							
						9	E8907							
						10	E8908							
						33	E8931							
						34	CS							

Memory dump command message:

Code Cmd.memory dump= "**D**"	Most significant byte of Start address	Mid significant byte of Start address	Least significant byte of Start address	Number of bytes to dump

Code Cmd. memory dump: 1 byte defined as "**D**" in ASCII or 44 Hex requesting for a memory dump.

Start address: Address of the beginning area to dump on 3 bytes

Number of bytes to dump: Number of bytes to dump on 1 byte

This command packet has a fixed length of 6 bytes, CheckSum included.

For example: see only surrounded part

APID	Type	Sub-type	MF n°	Name	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	LS Bit n° 7
1025	6	2	E0515	tc_dump_pd	Sending dump TC and related acquisition for PSD	1 2	4 (16 bits encoded) (MID)							
						3	TC ID = 6							
						4	4 (PSD)							
						5	"D"							
						6	E8932							
						7	E8932							
						8	E8932							
						9	E8935							
						10	CS							

Software command message:

Code software command ="**R**"	Software command ID	"00" Hex

Code software command: 1 byte defines as “R” in ASCII or 52 Hex.

Software command ID: see following table for definition.

Command	**Software command ID in ASCII**	**Software command ID in Hex value**
SW maintenance	M	4D
SW init	I	49
SW restart	R	52

These command packets have a fixed length of 4 bytes, checksum included.

- SW Maintenance command

Code command parameter ="**R**"	“M”	"00" Hex

This command packet has a fixed size of 4 bytes. The effect of this command is to make S/A SW enter Maintenance sub-mode.

- SW Restart command

Code command parameter ="**R**"	"R"	"00" Hex

This command packet has a fixed size of 4 bytes. The effect of this command is to make S/A SW exit Maintenance sub-mode.

- SW Init command

Code command parameter ="**R**"	"I"	"00" Hex

This command packet has fixed size of 4 bytes. The effect of this command is to make S/A SW init while in SW Maintenance sub-mode. The S/A copies the ROM into RAM and initializes all part of memory as for the first initialization.

Mode command message:

Code Mode command ="**M**"	Mode command ID	"00" Hex

Code Mode command: 1 byte defined as "**M**" in ASCII or 4D Hex.

Mode command ID: See following table for definition

Command	Mode command ID in ASCII	Mode command ID in Hex value
START	S	53
CONF	X	58
CAL	C	43
STBY	Y	59
DIAG	D	44

This command packet has a fixed length of 4 bytes

For example: see only surrounded part

APID	Type	Sub-type	MF n°	Name	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	LS Bit n° 7
1025	5	5	E0502	tc_mode_chg_x	Mode change STANDBY to CONFIGURATION or Back to CONF from OPE, CAL, DIAG modes	1	X							
						2	00 Hex							
						3	TC ID = 3							
						4	1 (IASW)							
						5	"M"							
						6	X							
						7	00 Hex							
					"CONF"	8	CS							

S/A SW response message:

- For all commands, except HK acquisition commands and dump command, the S/A SW will reply by an acknowledge after CS verification and check of command validity; this user's acknowledge response is on one byte and has the following format:

ACK/NACK	CS

The ACK/NACK byte is defined according to the table below:

Type or error	MS bit N°0	Bit N°1	Bit N°2	Bit N°3	Bit N°4	Bit N°5	Bit N°6	LS Bit N°7
CS error	Not(Bit N°7 OR Bit N°6 OR Bit N°1)		Reserved	Don't care	Don't care			0: no error 1: error
Not allowed command	Not(Bit N°7 OR Bit N°6 OR Bit N°1)		Reserved	Don't care	Don't care		0: no error 1: error	
Status autotest	Not(Bit N°7 OR Bit N°6 OR Bit N°1)		Reserved	Don't care	Don't care	0: OK 1: NOK		
1st command after reset	Not(Bit N°7 OR Bit N°6 OR Bit N°1)	0: not 1st command 1: 1st command	Reserved					

"Don't care" means that this bit is not checked by IASW but directly downloaded.

"Reserved" are set to "0" by the sub-assembly.

Bit N°0 =1 when no error occurred (i.e. no checksum error nor non-allowed command and not 1st command). It equals 0 in the other cases. The status of autotest has no effect on Bit N° 0. As an example the value of ACK/NACK byte is or more than or equal to 80 Hex for a correct transmission, and less than 80 Hex in other cases.

The Status Autotest bit N°5 is a copy of the equivalent bit of Status Byte defined below.

In the case of a negative acknowledge (NACK bit N°0 = 0) the S/A SW will always respond with this 2 bytes format.

Bit N°1 = 1 means that the command related to this ACK is the first one received by S/A since the last reset of S/A, otherwise this bit is set to "0" (used for detection of hazardous reset of S/A). An INIT command received by the S/A is not considered as a reset of S/A and doesn't set this bit.

Bit N°6 = 1 means that the command related to this ACK is not accepted by S/A with regard to its current mode (see matrix § 3.7.9.1.1).
For ACS S/A, this bit is linked with bit N°3 (Don't care bit) which means "Invalid Command Identifier".

- In the case of a HK acquisition response, the S/A SW will send back a response with the following format:

ACK/NACK	Data		Data	CS

The detailed formats for data are defined in the Volume 4. The number of bytes in a response must be even (ACK/NACK, Data, CS included). Each response has a fixed predefined number of bytes. ACK/NACK byte is defined here above.

- In case of a status acquisition, the response will have the following format:

ACK/NACK	00 Hex	Most significant byte of status	Medium significant byte of status	Least significant byte of status	CS

The response has a fixed length of 6 bytes (Checksum included)

The medium and least significant byte are specific to each S/A and are defined in Volume 4.

The most significant byte has the following definition

State or Event	MS bit N°0	Bit N°1	Bit N°2	Bit N°3	Bit N°4	Bit N°5	Bit N°6	LS Bit N°7
All commands initiated				Reserved	Reserved		Don't care	0: initiated 1: not initiated
Status autotest				Reserved	Reserved	0: OK 1: NOK	Don't care	
Current mode				Reserved	Reserved		Don't care	
STBY	0	0	0					
CONF	0	0	1					
OPER	0	1	0					
DIAG	0	1	1					
CAL	1	0	0					

"Don't can" means that this bit is not checked by IASW but directly dowloaded.

"Reserved" are set to "0" by the sub-assembly.

	17	34	E0369 Sequence count of gound TC with failure							
	18	35	E0495	E0496	0	0	0	E0497	E0498	E0499
HK acquisition response	18	36	00 Hex							
	19	37	E3881			0	0	E3882	0	E3883
Status acquisition response	19	38	0	0	0	0	E0896	0	E0898	E0899
	20	39	E0992				E0993			
	20	40	Checksum (Comment: on 5 bytes AFEE status)							
	21	41	E0695	E0696	0	E0693	E0694	E0697	E0698	E0699
	21	42	00 Hex							

- In case of a Memory Dump command, the response will have the following format:

ACK/NACK	Code Cmd .memory dump= "**D**"	Most significant byte of Start address	Mid significant byte of Start address	Least significant byte of Start address	Number of bytes to dump	Data	00 Hex	CS

Code Cmd. memory dump: 1 byte defined as "**D**" in ASCII or 44 Hex pointing out that the following is memory dumped data.

Start address: 3 bytes for the starting address of the dumped memory .

Number of dumped bytes: 1 byte to define the number of bytes dumped from S/A memory.

Data: 24 bytes of data dumped from memory. If less than 24 bytes are to be dumped, extra bytes beyond the **number of bytes to dump** are filled with dummy bytes (00 Hex) to obtain a 24-byte data field.

This response packet has a fixed length of 32 bytes, checksum included.

N° Block	Description	N° Byte	MS Bit n° 0	Bit n° 1	Bit n° 2	Bit n° 3	Bit n° 4	Bit n° 5	Bit n° 6	Bit n° 7
1	On-request dump DFEE	1 2	5 (16 bits encoded) (MID)							
		3	TC ID = 6							
		4	5 (DFEE)							
		5	User's acknowledgement							
		6	"D"							
		7	E3932							
		8	E3932							
		9	E3932							
		10	E3935							
		11	E3908							
		12	E3909							
		34	E3931							
		35	00 Hex							
		36	CS							

3.7.9.2.4. DFEE/ACS software

This § is TBW.

3.7.9.2.5. DPE/DFEE software handshake

The IASW starts the DFEE digital HK acquisitions after a delay > 1.5 ms from TF1 of the second 3.

3.7.10. TC packet structure definition and content

Nominal		Redundant		Type	S/type	Definition
DB Ref	APID	DB Ref	APID			
E0001	1025	F0001	1153	5	3	AFEE High Voltage setting:
E0002	1025	F0002	1153	5	3	AFEE low threshold setting:
E0003	1025	F0003	1153	5	3	AFEE Chain parameters setting:
E0004	1025	F0004	1153	5	3	AFEE Chains On/Off configuration and regeneration setting:
E0011	1025	F0011	1153	5	4	AFEE High Voltage configuration request:
E0012	1025	F0012	1153	5	4	AFEE low threshold configuration request:
E0013	1025	F0013	1153	5	4	AFEE Chain parameters configuration request:
E0014	1025	F0014	1153	5	4	AFEE Chains On/Off configuration and regeneration configuration request:
E0020 E0028	1025	F0020 F0028	1153	5	4	AFEE Preampli temperature request:
E0021	1025	F0021	1153	5	4	AFEE High Voltage request:
E0022	1025	F0022	1153	5	4	AFEE Low Threshold request:
E0023	1025	F0023	1153	5	4	AFEE LVPS voltage request:
E0024	1025	F0024	1153	5	4	AFEE DC-DC Converter temperature:
E0025 E0029	1025	F0025 F0029	1153	5	4	AFEE ADC temperature request:
E0026	1025	F0026	1153	5	4	AFEE Direct Current Output Voltage request:
E0027	1025	F0027	1153	5	4	AFEE Working range configuration request:
E0030	1025	F0030	1153	5	4	AFEE general parameters request:
E0031	1025	F0031	1153	5	4	AFEE Cryogenic Temperatures request:
E0101	1025	F0101	1153	5	3	DFEE Software parameters setting:
E0102	1025	F0102	1153	5	3	DFEE Front End lines reset and parameters setting:
E0103	1025	F0103	1153	5	3	DFEE Front end and sate machine definition:
E0111	1025	F0111	1153	5	4	DFEE Software parameters configuration request:
E0112	1025	F0112	1153	5	4	DFEE Front End lines reset and parameters configuration request:
E0113	1025	F0113	1153	5	4	DFEE Front end and state machine configuration request:
E0201-E0203	1025	F0201-F0203	1153	5	3	ACS System service:
E0204-E0206	1025	F0204-F0206	1153	5	3	ACS Veto signal configuration:
E0207-E0209	1025	F0207-F0209	1153	5	3	ACS Rate meter setting:
E0210-E0212	1025	F0210-F0212	1153	5	3	ACS Veto Signal Delay setting:

Nominal		Redundant		Type	S/type	Definition
DB Ref	APID	DB Ref	APID			
E0213-E0215	1025	F0213-F0215	1153	5	3	ACS Event trigger threshold definition:
E0216-E0218	1025	F0216-F0218	1153	5	3	ACS Event Discriminator definition:
E0219-E0221	1025	F0219-F0221	1153	5	3	ACS High Voltage setting:
E0222	1025	F0222	1153	5	3	ACS Others Veto parameters definition:
E0223		F0223				Deleted
E0224	1025	F0224	1153	5	3	ACS ISB communication ON/OFF: High voltage enabled/disabled each FEE individually
E0251-E0253	1025	F0251-F0253	1153	5	4	ACS System service configuration request:
E0254-E0256	1025	F0254-F0256	1153	5	4	ACS Veto signal configuration request:
E0257-E0259	1025	F0257-F0259	1153	5	4	ACS Rate meter configuration request:
E0260-E0262	1025	F0260-F0262	1153	5	4	ACS Veto Signal Delay configuration request:
E0263-E0265	1025	F0263-F0265	1153	5	4	ACS Event trigger threshold configuration request:
E0266-E0268	1025	F0266-F0268	1153	5	4	ACS Event Discriminator configuration request:
E0269-E0271	1025	F0269-F0271	1153	5	4	ACS High Voltage configuration request:
E0272	1025	F0272	1153	5	4	ACS Other Veto parameters configuration request:
E0273	1025	F0273	1153	5	4	ACS ISB communication ON/OFF request:
E0280	1025	F0280	1153	5	4	ACS Voltage and Current value request:
E0281	1025	F0281	1153	5	4	ACS Veto Shield temperatures request:
E0282-E0287	1025	F0282-F0287	1153	5	4	ACS Analogue Status request:
E0288-E0290	1025	F0288-F0290	1153	5	4	ACS Alert Status request:
E0300	1025	F0300	1153	5	3	PSD Detector enable setting:
E0301-E0302	1025	F0301-F0302	1153	5	3	PSD Low Threshold for energy setting:
E0303-E0304	1025	F0303-F0304	1153	5	3	PSD High Threshold for energy setting:
E0305	1025	F0305	1153	5	3	PSD A/D offsets setting:
E0306-E0308	1025	F0306-F0308	1153	5	3	PSD Definition of library selection and control setting:
E0309	1025	F0309	1153	5	3	PSD Definition of curves transmission rate:
E0310-E0316	1025	F0310-F0316	1153	5	3	PSD Definition of library description and control:
E0320	1025	F0320	1153	5	4	PSD detector enable setting request
E0321-E0322	1025	F0321-F0322	1153	5	4	PSD Low Threshold for energy configuration request:

Nominal		Redundant		Type	S/type	Definition
DB Ref	APID	DB Ref	APID			
E0323-E0324	1025	F0323-F0324	1153	5	4	PSD High Threshold for energy configuration request:
E0325	1025	F0325	1153	5	4	PSD A/D offsets configuration request:
E0326-E0328	1025	F0326-F0328	1153	5	4	PSD Library selection and control configuration request:
E0329	1025	F0329	1153	5	4	PSD Curves transmission rate configuration request:
E0342-E0343	1025	F0342-F0343	1153	5	4	PSD Library Channel Status, soft and analogue control:
E0500	1025	F0500	1153	5	3	IASW On-Off configuration update:
E0501	1025	F0501	1153	5	5	Mode Change: “Start” from Configuration to Operational mode
E0502	1025	F0502	1153	5	5	Mode Change: “Conf” from Stand-by to Configuration or back to Configuration from Operational, Calibration or Diagnostic modes
E0503	1025	F0503	1153	5	5	Mode Change: “Cal” from Configuration to PSD Calibration mode
E0504	0125	F0504	1153	5	5	Mode Change: “Diag” from Configuration to Diagnostic mode
E0505	1025	F0505	1153	5	5	Mode Change: “STBY” back to Stand-by from Configuration, Operational, Calibration and Diagnostic modes
E0506	1025	F0506	1153	5	5	Mode Change: “Emergency” from Configuration to TM Emergency mode
E0507	1025	F0507	1153	6	1	Record Patch table update for DFEE:
E0508	1025	F0508	1153	6	1	Load Patch table update for DFEE:
E0509	1025	F0509	1153	6	1	Record Patch table update for ACS:
E0510	1025	F0510	1153	6	1	Load Patch table update for ACS:
E0511	1025	F0511	1153	6	1	Record Patch table update for PSD:
E0512	1025	F0512	1153	6	1	Load Patch table update for PSD:
E0513	1025	F0513	1153	6	2	DFEE dump memory request:
E0514	1025	F0514	1153	6	2	ACS dump memory request:
E0515	1025	F0515	1153	6	2	PSD dump memory request:
E0516	1025	F0516	1153	6	1	Patch table reset:
E0517	1025	F0517	1153	13	1	Right TC acceptation:
E0518	1025	F0518	1153	5	3	Non exposure parameters for IASW setting:

Nominal		Redundant		Type	S/type	Definition
DB Ref	APID	DB Ref	APID			
E0519	1025	F0519	1153	5	3	Exposure parameters for IASW setting:
E0523	1025	F0523	1153	5	4	Non exposure parameters for IASW configuration request:
E0524	1025	F0524	1153	5	4	Exposure parameters for IASW configuration request:
E0525	1025	F0525	1153	5	4	IASW ON-OFF configuration Request:
E9023	1024	F9023	1152	5	5	SPI DPE 1 mode transition to initial: TBC
E9024	1024	F9024	1152	5	5	SPI DPE 1 mode transition to nominal: IASW Start
E0555	1025	F0555	1153	5	3	Eclipse exit ground TC:
E0556	1025	F0556	1153	5	3	All configuration commands already loaded sending:
E0557	1025	F0557	1153	6	1	All patches already loaded sending:
E0563	1025	F0563	1153	5	1	ACS start task S/W maintenance:
E0564	1025	F0564	1153	5	1	PSD start task S/W maintenance: After sending this TC, PSD reply NACK, thePSD status mode = 0, because IASW doesn't acquire the HK and the TM data is set to 0.
E0565	1025	F0565	1153	5	1	DFEE start task S/W maintenance: After sending this TC, DFEE reply NACK, the DFEE status mode = 0, because IASW doesn't acquire the HK and the TM data is set to 0.
E0566	1025	F0566	1153	5	1	ACS start calibration process:
E0567	1025	F0567	1153	5	4	ACS calibration data request:
E0573	1025	F0573	1153	5	2	ACS stop task S/W maintenance:
E0574	1025	F0574	1153	5	2	PSD stop task S/W maintenance:
E0575	1025	F0575	1153	5	2	DFEE stop task S/W maintenance: After sending this TC, DFEE is able to accept the following TC only 1.5 sec after
E0581-E0586	1025	F0581-F0586	1153	5	3	Diagnostic parameters setting
E0591-E0596	1025	F0591-F0596	1153	5	4	Diagnostic configuration request

Nominal		Redundant		Type	S/type	Definition
DB Ref	APID	DB Ref	APID			
E9800-E9801	129			2	2	DPE 1 relay 0 OFF/ON
E9802-E9803	129			2	2	DPE 1 relay 1 OFF/ON
E9960	129			2	2	Set CDE 1 Master in LLM
E9961	129			2	2	Set CDE 1 Slave in LLM
E9962	129			2	2	Set CDE 1 Master in Standby
E9963	129			2	2	Set CDE 1 Slave in Standby
E9966	129			2	2	CDE 1 Master In Standby: Change Compressor Amplitude
E9967	129			2	2	CDE 1 Slave in Standby: Change Compressor Amplitude
E9968	129			2	2	Set CDE 1 relay in configuration LCL1+2:
E9969	129			2	2	Set CDE 1 relay in configuration LCL1 only:
		E9980	129	2	2	Set CDE 2 Master in LLM
		E9981	129	2	2	Set CDE 2 Slave in LLM
		E9982	129	2	2	Set CDE 2 Master in Standby
		E9983	129	2	2	Set CDE 2 Slave in Standby
		E9986	129	2	2	CDE2 Master In Standby: Change Compressor Amplitude
		E9987	129	2	2	CDE 2 Slave in Standby: Change Compressor Amplitude
		E9988	129	2	2	Set CDE 2 relay in configuration LCL1+2:
		E9989	129	2	2	Set CDE 2 relay in configuration LCL1 only:
P3030-P3031						CDE 1 LCL1 power OFF/ON
P3060-P3061						CDE 1 LCL2 power OFF/ON
		P3270-P3271				CDE 2 LCL1 power OFF/ON
		P3300-P3301				CDE 2 LCL2 power OFF/ON
P4040-P4041						AFEE 2 IF TM/TC Main OFF/ON
P4044-P4045						DPE Main OFF/ON
P4048-P4049						ACS Main OFF/ON
P4052-P4053						DFEE Main OFF/ON

DB Ref	APID	DB Ref	APID	Type	S/type	Definition
P4056-P4057						PSD Main OFF/ON
P4060-P4061						AFEE Detector Main power supply OFF/ON
P4088-P4089						Cryostat Thermal Control Main OFF/ON
P4120-P4121						Cryocooler Compensation heaters Main OFF/ON
		P4338-P4339				Cryostat Thermal Control Redundant OFF/ON
		P4370-P4371				Cryocooler Compensation heaters Redundant OFF/ON
T5000-T5001						CDE 1 Compressor heater power supply OFF/ON
T5005-T5006						Camera unit's Main heaters OFF/ON
T5010-T5011						Heat pipe thaw Main heater OFF/ON
T5015-T5016						Annealing Main heaters OFF/ON
T5020-T5021						Antifreeze 1 Main heater OFF/ON
T5025-T5026						Antifreeze 2 Main heater OFF/ON
T5035-T5036						Mask + ACS Main heaters OFF/ON
		P4290-P4291				AFEE 2 IF TM/TC Redundant OFF/ON
		P4294-P4295				DPE 2 OFF/ON
		P4298-P4299				ACS Redundant OFF/ON
		P4302-P4303				DFEE Redundant OFF/ON
		P4306-P4307				PSD Redundant OFF/ON
		P4310-P4311				AFEE Detector Redundant power supply OFF/ON
		T5105-T5106				Camera unit's Redundant heaters OFF/ON
		T5100-T5101				CDE 2 Compressor heater power supply OFF/ON
		T5110-T5111				Heat pipe Thaw heater Redundant OFF/ON
		T5115-T5116				Annealing heater Redundant OFF/ON
		T5120-T5121				Antifreeze heater 1 redundant OFF/ON
		T5125-T5126				Antifreeze heater 2 redundant OFF/ON
		T5135-T5136				Mask + ACS Redundant heaters OFF/ON
T5575-T5576						CDE Heater A power supply OFF/ON
		T5675-T5676				CDE Heater B power supply OFF/ON

3.7.11. TM packet structure and content definition

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
240108	1024	69602	1152	1	8	vc0	CSSW Housekeeping parameters:
60000	1120	65000	1248	2	0	vc1	Science Housekeeping 1: DFEE counters 1st and 2nd seconds
60001	1121	65001	1249	2	1	vc1	Science Housekeeping 2: DFEE counters 3rd and 4th seconds
60002	1122	65002	1250	2	2	vc1	Science Housekeeping 3: DFEE counters 5th and 6th seconds
60003	1123	65003	1251	2	3	vc1	Science Housekeeping 4: DFEE counters 7th and 8th seconds
60004	1124	65004	1252	2	4	vc1	Science Housekeeping 5: DFEE counters 1st to 8th seconds
60011	1025	65011	1153	1	5	vc0	Cyclical housekeeping parameters acquisition - One cycle = 8 s: ACS counters HK technological parameters
60060	1025	65060	1153	1	6	vc0	Cyclical housekeeping parameters acquisition - 8 cycles = 64 s: PSD parameters
60601	1025	65601	1153	1	7	vc0	Cyclical housekeeping parameters acquisition - 80 cycles = 640 s 1st pkt: AFEE and ACS parameters
60602	1025	65602	1153	1	8	vc0	Cyclical housekeeping parameters acquisition - 80 cycles = 640 s 2nd pkt: ACS parameters, PSD library status and HK technological parameters
61000	1088	66000	1216	0	0	vc1	Photon/Photon acquisition in nominal mode:
61001	1089	66001	1217	0	1	vc1	Photon/Photon acquisition in Emergency TM mode:
61002	1090	66002	1218	0	2	vc1	Photon/Photon acquisition in Calibration mode:
61003	1091	66003	1219	0	3	vc1	Photon/Photon acquisition in Diagnostic mode:
61100	1104	66100	1232	1	0	vc1	Spectra acquisition in Photon/Photon mode: Anticoincidence OFF
61101	1105	66101	1233	1	1	vc1	Spectra acquisition in TM Emergency mode: Anticoincidence ON
61136-61147	1136-1147	66264-66275	1264-1275	3	0-11	vc1	Diagnostic telemetry

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
63841	1025	68841	1153	1	9	vc0	Cyclical housekeeping parameters acquisition - 480 cycles = 3840 s 1st pkt: AFEE, DFEE, ACS configuration parameters
63842	1025	68842	1153	1	10	vc0	Cyclical housekeeping parameters acquisition - 480 cycles = 3840 s 2nd pkt: ACS configuration parameters
63843	1025	68843	1153	1	11	vc0	Cyclical housekeeping parameters acquisition - 480 cycles = 3840 s 3rd pkt: PSD and IASW configuration parameters
63844	1025	68844	1153	1	12	vc0	Cyclical diagnostic parameters configuration acquisition - 480 cycles = 3840 s 4th pkt
64000/64000	1029	69000/69000	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 1: AFEE High voltage configuration
64000/64001	1029	69000/69001	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 2: AFEE low threshold configuration
64000/64002	1029	69000/69002	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 3: Detectors chains parameters configuration
64000/64003	1029	69000/69003	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 4: Detectors chains ON/OFF configuration
64000/64004	1029	69000/69004	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 5: Front end lines reset and parameters setting for: dead time calculation, association algorithm, HSL configuration
64000/64005	1029	69000/69005	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 6: AFEE Front End and state machine definition
64000/64006	1029	69000/69006	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 7: DFEE software parameters
64000/64007	1029	69000/69007	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 8: ACS System Service 1: watchdog, test config response, HV conf
64000/64008	1029	69000/69008	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 9: ACS System Service 2: watchdog, test config response, HV conf
64000/64009	1029	69000/69009	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 10: ACS System Service 3: watchdog, test config response, HV conf

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
64000/64010	1029	69000/69010	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 11: Veto generation condition 1
64000/64011	1029	69000/69011	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 12: Veto generation condition 2
64000/64012	1029	69000/69012	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 13: Veto generation condition 3
64000/64013	1029	69000/69013	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 14: Rate meter configuration 1
64000/64014	1029	69000/69014	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 15: Rate meter configuration 2
64000/64015	1029	69000/69015	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 16: Rate meter configuration 3
64000/64016	1029	69000/69016	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 17: Veto delay configuration 1
64000/64017	1029	69000/69017	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 18: Veto delay configuration 2
64000/64018	1029	69000/69018	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 19: Veto delay configuration 3
64000/64019	1029	69000/69019	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 20: Event trigger threshold configuration 1
64000/64020	1029	69000/69020	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 21: Event trigger threshold configuration 2
64000/64021	1029	69000/69021	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 22: Event trigger threshold configuration 3
64000/64022	1029	69000/69022	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 23: Energy discriminator configuration 1
64000/64023	1029	69000/69023	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 24: Energy discriminator configuration 2

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
64000/64024	1029	69000/69024	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 25: Energy discriminator configuration 3
64000/64025	1029	69000/69025	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 26: High Voltage PMT configuration 1
64000/64026	1029	69000/69026	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 27: High Voltage PMT configuration 2
64000/64027	1029	69000/69027	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 28: High Voltage PMT configuration 3
64000/64028	1029	69000/69028	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 29: Veto pulse width and veto mask configuration for all FEE. Overall veto masked configuration.
64000/64029	1029	69000/69029	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 30: PSD: Detectors enables
64000/64030	1029	69000/69030	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 31: PSD: Low threshold for energy channel n° 0 to n° 8
64000/64031	1029	69000/69031	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 32: PSD: Low threshold for energy channel n° 9 to n° 18
64000/64032	1029	69000/69032	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 33: PSD: High threshold for energy channel n° 0 to n° 8
64000/64033	1029	69000/69033	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 34: PSD: High threshold for energy channel n° 9 to n° 18
64000/64034	1029	69000/69034	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 35: A/D offsets
64000/64035	1029	69000/69035	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 36: Library selection and control n° 1 Detector n° 0 to 6
64000/64036	1029	69000/69036	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 37: Library selection and control n° 2 Detector n° 6 to 12
64000/64037	1029	69000/69037	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 38: Library selection and control n° 3 Detector n° 13 to 18

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
64000/64038	1029	69000/69038	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 39: Curves transmission rates
64000/64039	1029	69000/69039	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 40: Non exposure parameters configuration for IASW
64000/64040	1029	69000/69040	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 41: Exposure parameters configuration for IASW
64000/64041	1029	69000/69041	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 42: S/A ON/OFF configuration
64042/64042	1030	69042/69042	1158	6	2	vc0	On-Request housekeeping parameters acquisition n° 43: Dump DFEE memory
64042/64043	1030	69042/69043	1158	6	2	vc0	On-Request housekeeping parameters acquisition n° 44: Dump VCU memory
64042/64044	1030	69042/69044	1158	6	2	vc0	On-Request housekeeping parameters acquisition n° 45: Dump PSD memor
64000/64046	1029	69000/69046	1157	5	4	vc0	On-Request housekeeping parameters acquisition n° 47: ISB communication ON/OFF for each FEE
64000/64640	1029	69000/69640	1157	5	4	vc0	On-Request AFEE Preampli temperature (detectors 0-8) acquisition:
64000/64641	1029	69000/69641	1157	5	4	vc0	On-Request AFEE High Voltage acquisition:
64000/64642	1029	69000/69642	1157	5	4	vc0	On-Request AFEE Low Threshold acquisition:
64000/64643	1029	69000/69643	1157	5	4	vc0	On-Request AFEE LVPS voltage acquisition:
64000/64644	1029	69000/69644	1157	5	4	vc0	On-Request AFEE DC-DC Converter temperature:
64000/64645	1029	69000/69645	1157	5	4	vc0	On-Request AFEE Analogue Digital Converter temperature (detectors 0-8) acquisition:
64000/64646	1029	69000/69646	1157	5	4	vc0	On-Request AFEE Digital Converter output voltage acquisition:
64000/64647	1029	69000/69647	1157	5	4	vc0	On-Request AFEE Working range configuration acquisition:
64000/64648	1029	69000/69648	1157	5	4	vc0	On-Request AFEE Preampli temperature (detector 9-18) acquisition:
64000/64649	1029	69000/69649	1157	5	4	vc0	On-Request AFEE Analogue Digital Converter temperature (detectors 9-18) acquisition:

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
64000/64650	1029	69000/69650	1157	5	4	vc0	On-Request AFEE general parameters acquisition:
64000/64651	1029	69000/69651	1157	5	4	vc0	On-Request AFEE cryogenic temperatures acquisition:
64000/64652	1029	69000/69652	1157	5	4	vc0	On-Request ACS Power supply and current value acquisition:
64000/64653	1029	69000/69653	1157	5	4	vc0	On-Request ACS Veto Shield temperatures acquisition:
64000/64654	1029	69000/69654	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 0-14) acquisition:
64000/64655	1029	69000/69655	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 15-29) acquisition:
64000/64656	1029	69000/69656	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 30-44) acquisition:
64000/64657	1029	69000/69657	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 45-59) acquisition:
64000/64658	1029	69000/69658	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 60-75) acquisition:
64000/64659	1029	69000/69659	1157	5	4	vc0	On-Request ACS FEE Analogue Status (FEE 76-91) acquisition:
64000/64660	1029	69000/69660	1157	5	4	vc0	On-Request ACS FEE Alert Status (FEE 0-30) acquisition:
64000/64661	1029	69000/69661	1157	5	4	vc0	On-Request ACS FEE Alert Status (FEE 31-61) acquisition:
64000/64662	1029	69000/69662	1157	5	4	vc0	On-Request ACS FEE Alert Status (FEE 62-91) acquisition:
64000/64663	1029	69000/69663	1157	5	4	vc0	On-Request PSD Library Status Channel (n° 0 to 11) acquisition:
64000/64664	1029	69000/69664	1157	5	4	vc0 vc0	On-Request PSD Library Status Channel (n° 12 to 18) soft and analogue control acquisition:
64000/64700	1029	69000/69700	1157	5	4		ACS calibration data
64000/64901 to 64000/64906	1029	69000/69901 to 69000/69906	1157	5	4	vc0	On-request diagnostic parameters configuration acquisition
61136	1136	66264	1264	3	0	vc7	Diagnostic data blocks 1 to 8
61137	1137	66265	1265	3	1	vc7	Diagnostic data blocks 9 to 16
61138	1138	66266	1266	3	2	vc7	Diagnostic data blocks 17 to 24
61139	1139	66267	1267	3	3	vc7	Diagnostic data blocks 25 to 32
61140	1140	66268	1268	3	4	vc7	Diagnostic data blocks 33 to 40
61141	1141	66269	1269	3	5	vc7	Diagnostic data blocks 41 to 48
61142	1142	66270	1270	3	6	vc7	Diagnostic data blocks 49 to 56

Nominal		Redundant		Type	S/type	Ch	Definition
DB Ref	APID	DB Ref	APID				
61143	1143	66271	1271	3	7	vc7	Diagnostic data blocks 57 to 64
61144	1144	66272	1272	3	8	vc7	Diagnostic data blocks 65 to 72
61145	1145	66273	1273	3	9	vc7	Diagnostic data blocks 73 to 80
61146	1146	66274	1274	3	10	vc7	Diagnostic data blocks 81 to 88
61147	1147	66275	1275	3	11	vc7	Diagnostic data blocks 89 to 96

3.7.12. TM and TC parameters description

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F0001	60601/9 65601/9	64650 69650	AFEE	E/F0030			Cc 6327	Cc 6700	AFEE I/F TM/TC source current 1ma acquisition: Current source 1mA acquisition over 12 bits Units: mA
E/F0002	60601/9 65601/9	64650 69650	AFEE	E/F0030			Cc 6328	Cc 6701	AFEE I/F TM/TC temp acquisition (electronic board): AFEE TM/TC electronic board temperature over 12 bits Units: degC
E0003	63841/4 68841/4	64003 69003	AFEE	E/F0014	E/F0004	E5003	A 6361	A 6361	Outgassing/Annealing regulation system 1 control: Detector regeneration temperature threshold n° 1: 0 ⇒ Annealing 255 ⇒ Outgassing Units: n/a
E0004	63841/4 68841/4	64003 69003	AFEE	E/F0014	E/F0004	E5004	A 6361	A 6361	Outgassing/Annealing regulation system 2 control: Detector regeneration temperature threshold n° 2: 0 ⇒ Annealing 255 ⇒ Outgassing Units: n/a
E0005									Deleted
E0006									Deleted
E0007-E0009									Spares
E/F0010-E/F0028	63841/1 68841/1	64000 69000	AFEE	E/F0011	E/F0001	E/F5010-E/F5028	Cc 6500 To 6518	Cc 6500 To 6518	AFEE High Voltage setting: High voltage level setting for each detector in the range 0-5.0 kV 0 ⇒ 0 V (after power on) Units: kV
E/F0029	240108		IASW						IASW SW version number: – Units: n/a – Gives the IASW version number in hexadecimal display
E/F0030-E/F0048	63841/2 68841/2	64001 69001	AFEE	E/F0012	E/F0002	E/F5030-E/F5048	Cc 6600 To 6618	Cc 6600 To 6618	AFEE Low threshold setting: Low detection threshold for each detector in the range 0-300 keV 0 ⇒ 0 keV (after power on: 128 keV) Units: keV
E/F0049	240108		IASW				A 6320	A 6320	Mode: IASW current mode: INIT/STAND-BY1/STAND-BY2/CONF/PHOTON/CAL/EMCY/DIAG Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E0050-E0068	63841/3 68841/3	64002 69002	AFEE	E/F0013	E/F0003	E5050-E5068	A 6329		High energy clamping: High energy clamping (desaturating impulse) for detector. 0 ⇒ ON (enable) 1 ⇒ OFF (disable) Units: n/a
E/F0069	240108		IASW				A 6321	A 6321	Operational Status: IASW current status: COMMAND/AUTO/PROTEGE/IMMINENT-OFF Units: n/a
E0070-E0088	63841/3 68841/3	64002 69002	AFEE	E/F0013	E/F0003	E5070-E5088	A 6302		Working range: Selection of the detector energy working range: 0 – 2 MeV or 0 – 8 MeV 0 ⇒ 0 – * 2 MeV range selected (after power on) 1 ⇒ 0 – * 8 MeV range selected Units: n/a The energy bit range is set to 1 for photon energy in the range 0 – 8 MeV and set to 0 for photon energy in the range 0 – 2 MeV, whatever the mode (auto or manual). In manual mode the bit range is ignored by the IASW and all the photons are taken into account in the low energy spectrum. The low energy limit is defined by the low threshold detection parameter. The choice of automatic or manual range AFEE parameter setting shall be the same for all the AFEE chains (0 to 18) * Depend upon the low threshold detection setting (param. E5030 to E5048)
E/F0089	240108		IASW				A 6304	A 6304	Eclipse: Units: n/a
E0090-E0108	63841/3 68841/3	64002 69002	AFEE	E/F0013	E/F0003	E5090-E5108	A 6303		Manual/Automatic selection: Manual or automatic selection of the detector working range setting. Shall be the same for all detectors. 0 ⇒ Automatic (after power on) 1 ⇒ Manual Two ranges available. Allows choosing the range 0 – * 2 MeV and 2 MeV – 8 MeV Units: n/a * Depend upon the low threshold detection setting (param. E5030 to E5048)
E/F0109	240108		IASW				A 6304	A 6304	Imminent switch off: Units: n/a
E/F0110	240108		IASW						PH-PH buffer overflow: nb of overflows of the PH-PH buffer within one 8 s (not synchronised with TM cycle)
E/F0111	240108		IASW						S/A patch table occupation: nb of patches stored in IASW patch table
E/F0112	240108								ICB science sub-buffer counter: nb of packets not stored in the ICB science sub-buffer within one 8 s (not synchronized with TM cycle)
E0113-E0128									Spares
E/F0129	240108		IASW				A 6304	A 6304	Imminent radiation belts: Units: n/a
E0130-E0148	63841/3 68841/3	64002 69002	AFEE	E/F0013	E/F0003	E5130-E5148	A 6308		Redundant coupler validation: Redundant AFEE output selection towards the DFEE for each chain. All enabled outputs shall be selected for normal or for redundant. 0 ⇒ non validated ⇒ Disable (after power on) 1 ⇒ validated ⇒ Enable Units: n/a
E/F0149	240108		IASW	E/F0013			A 6304	A 6304	High Background count: Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E0150-E0168	63841/3 68841/3	64002 69002	AFEE		E/F0003	E5150-E5168	A 6308		Main coupler validation: Main AFEE output selection towards the DFEE for each chain. All enabled outputs shall be selected for normal or for redundant. 0 ⇒ non validated ⇒ Disable (after power on) 1 ⇒ validated ⇒ Enable Units: n/a
E/F0169	240108		IASW				A 6304	A 6304	ESAM: Units: n/a
E0170-E0188	63841/4 68841/4	64003 69003	AFEE	E/F0014	E/F0004	E5170-E5188	A 6306		ON / OFF LVPS AFEE: AFEE Low Power supply On / Off command for each chain 0 ⇒ OFF (after power on) 1 ⇒ ON Units: n/a
E0189	240108		IASW						Spare
E0190-E0208	63841/4 68841/4	64003 69003	AFEE	E/F0014	E/F0004	E5190-E5208	A 6306		ON / OFF HVPS AFEE: AFEE High Power supply On / Off command for each chain 0 ⇒ OFF (after power on) 1 ⇒ ON Units: n/a
E0209	63841/4 68841/4	64003 69003	AFEE	E0014	E/F0004	E5209	A 6307		Temperature range selection for Cold Plate and Thermal braids: 0 ⇒ range 1: 62 K – 410 K (after power on) 1 ⇒ range 2: 62 K – 128 K Units: n/a
E/F0210-E/F0228	60601/1 60602/7 65601/1 65602/7	64640 64648 69640 69648	AFEE	E/F0020 E/F0028			Cc 6004	Cc 6702	PA 2 temperature acquisition: Preampli temperature for each detector independently over 12 bits (0 ⇐ TempPA ⇐ 511°K) Units: degK
E/F0229	240108		IASW						Photon/Photon occupation: – Units: n/a
E0230-E0248	60601/8	64647	AFEE	E0027			A 6302		Detector working range selection Acquisition: Selection of the detector energy working range: 0 keV – 2 MeV or 0 keV – 8 MeV 0 ⇒ 0 keV – 2 MeV range selected (after power on) 1 ⇒ 0 keV – 8 MeV range selected Units: n/a
E0249									Deleted: merged with E0229 (DM231)
E/F0250-E/F0268	60601/2 65601/2 240108	64641 69641	AFEE IASW	E/F0021			Cc 6400 Cc 6421 To Cc 6438	Cc 6707 to Cc 6725	AFEE High voltage acquisition: High voltage value for each detector independently over 8 bits (0 ⇐ HVPS ⇐ 5000 V) Units: kV
E/F0269	240108		IASW						Ground TC number read: Roll over counter (Min = 0; Max = 32767)
E/F0270-E/F0288	60601/3 65601/3	64642 69642	AFEE	E/F0022			Cc 6620 To Cc6638	Cc 6620 To Cc6638	AFEE low detection threshold acquisition: Low detection threshold value for each detector independently over 8 bits (0 ⇐ Low threshold ⇐ 255 keV) Units: keV

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F0289	240108		IASW						On-board TC number read: Roll over counter (Min = 0; Max = 32767)
E/F0290-E/F0308	60601/4 65601/4	64643 69643	AFEE	E/F0023			Cc 6378	Cc 6706	AFEE detector low voltage acquisition: Low voltage value for each detector independently over 8 bits (0 ⇐ LVPS ⇐ 10 V) Units: V Parameters always acquired even if LVPS are OFF. In this case, the parameters values are not significant.
E/F0309	240108		IASW						Sequence count of the last Ground TC read: – Units: n/a
E/F0310-E/F0328	60601/5 65601/5	64644 69644	AFEE	E/F0024			Cc 6326	Cc 6704	AFEE DC-DC converter temp. acquisition: LVPS temperature for each detector independently over 8 bits (0 ⇐ TempLVPS ⇐ 511°K) Units: degK
E/F0329	240108		IASW						Sequence count of the last On-board TC read: – Units: n/a
E/F0330-E/F0348	60601/6 60602/8 65601/6 65602/8	64645 64649 69645 69649	AFEE	E/F0025 E/F0029			Cc 6009	Cc 6703	AFEE ADC temperature acquisition: ADC temperature for each detector independently over 12 bits (0 ⇐ TempADC ⇐ 511°K) Units: degK
E/F0349	240108		IASW						Ground TC number read failure number: Roll over counter (Min = 0; Max = 32767)
E/F0350-E/F0368	60601/7 65601/7	64646 69646	AFEE	E/F0026			Cc 6406	Cc 6705	AFEE Direct Current output voltage: Direct current output voltage value for each detector independently over 8 bits (0 ⇐ DC_output ⇐ - 2,5 V)
	240108		IASW						Units: V
E/F0369	240108		IASW						Sequence count of Ground TC with failure: – Units: n/a
E0370-E0388	60601/8 65601/8	64647 69647	AFEE	E/F0027			A 6303		Manual or automatic working range selection acquisition: Manual or automatic selection of the detector working range setting 0 ⇒ Automatic (after power on) 1 ⇒ Manual. – Units: n/a
E0389-E0390									Spares
E/F0391-E/F0394	60602/9 65602/9	64651 69651	AFEE	E/F0031			Cc 6330 Cc 6331	Cc 6726 Cc 6727	Cold plate operating temp acquisition: Cryogenic temperature for Cold Plate N° 1 to 4 over 12 bits Range 1: (62°K ⇐ TempCRYO ⇐ 410°K) Cc are 6331 or 6727
	60011/14 65011/14		IASW						Range 2: (62°K ⇐ TempCRYO ⇐ 128°K) Cc are 6330 or 6726 – Units: K
E/F0395-E/F0398	60602/9 65602/9	64651 69651	AFEE	E/F0031			Cc 6330 Cc 6331	Cc 6726 Cc 6727	Thermal braids temp acquisition: Cryogenic temperature for Thermal Braid N° 1 to 4 over 12 bits Range 1: (62°K ⇐ TempCRYO ⇐ 410°K) Cc are 6331 or 6727
	60011/14 65011/14		IASW						Range 2: (62°K ⇐ TempCRYO ⇐ 128°K) Cc are 6330 or 6726 Units: K

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E0399	60602/9 65602/9 60011/14 65011/14	64651 69651	AFEE IASW	E/F0031			A 6307		Cryogenic Temperatures: Temperature range selection for temperature Telemetry (Cold Plate and Th. braids) over 1 bit 0 ⇒ range 1: 62K-410K (after power ON) 1 ⇒ range 2: 62K-128K Units: n/a
E0400-E0490	63841/11-13 68841/11-13	64010 64011 64012 69101 69011 69012	ACS	E/F0254 E/F0255 E/F0256	E/F0204 E/F0205 E/F0206	E5400-E5490	A 6309		ACS extended veto signal generation forced/standard: Control dependence on overrange trigger. If 0, an extended signal is generated when overrange trigger goes active during integration cycle. If 1, each veto signal is generated as extended veto signal. 0 ⇒ Standard 1 ⇒ Forced Units: n/a
E0491-E0494									Spares
E/F0495	240108		AFEE				A 6383	A 6383	Acknowledgement status: AFEE ack/nack check
E/F0496	240108		AFEE				A 6382	A 6382	Acknowledgement status: AFEE ack/nack 1st command after reset
E/F0497	240108		AFEE				A 6381	A 6381	Acknowledgement status: AFEE ack/nack auto-test status
E/F0498	240108		AFEE				A 6380	A 6380	Acknowledgement status: AFEE ack/nack Not allowed command
E/F0499	240108		AFEE				A 6384	A 6384	Acknowledgement status: AFEE ack/nack Checksum error
E0500-E0590	63841/8-10 68841/8-10	64007 64008 64009 69007 69008 69009	ACS	E/F0251 E/F0252 E/F0253	E/F0201 E/F0202 E/F0203	E5500-E5590	A 6306		FEE switch HV on/off: The command switches the FEE high voltages on/off. Power-on reset switches the high voltage off. For reliability reasons, the high voltages shall be switched off TBD msec before the FEE is powered down 0 ⇒ OFF (after power on) 1 ⇒ ON Units: n/a
E0591-E0592	63841/10 68841/10	64009 69009	ACS	E/F0253	E/F0203	E5591-E5592	A 6306		PSAC switch High Voltage On/Off: The command switches the PSAC high voltage 1 and 2 on/off 0 ⇒ OFF (after power on) 1 ⇒ ON Units: n/a
E0593-E0594									Spares
E/F0595	240108		DFEE				A 6383	A 6383	Acknowledgement status: DFEE ack/nack check – Units: n/a
E/F0596	240108		DFEE				A 6382	A 6382	Acknowledgement status: DFEE ack/nack 1st command after reset – Units: n/a
E/F0597	240108		DFEE				A 6381	A 6381	Acknowledgement status: DFEE ack/nack auto-test status – Units: n/a
E/F0598	240108		DFEE				A 6380	A 6380	Acknowledgement status: DFEE ack/nack Not allowed command – Units: n/a
E/F0599	240108		DFEE				A 6384	A 6384	Acknowledgement status: DFEE ack/nack Checksum error – Units: n/a
E0600-E0690	63841/8-10 68841/8-10	64007 64008 64009 69007 69008 69009	ACS	E/F0251 E/F0252 E/F0253	E/F0201 E/F0202 E/F0203	E5600-E5690	A 6308		FEE watchdog function enabled/disabled: Disabling the watchdog function resets the watchdog time gater counter. Thus the watchdog interval is always constant (about 32.7 ms). Power-on reset disables the watchdog function. Units: n/a
E0691-E0692									Spares
E/F0693	240108		ACS				A 6386	A 6386	ACS invalid command code:

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F0694	240108		ACS				A 6385	A 6385	ACS invalid command identifier:
E/F0695	240108		ACS				A 6383	A 6383	Acknowledgement status: ACS ack/nack check – Units: n/a
E/F0696	240108		ACS				A 6382	A 6382	Acknowledgement status: ACS ack/nack 1st command after reset – Units: n/a
E/F0697	240108		ACS				A 6381	A 6381	Acknowledgement status: ACS ack/nack auto-test status – Units: n/a
E/F0698	240108		ACS				A 6380	A 6380	Acknowledgement status: ACS ack/nack Not allowed command – Units: n/a
E/F0699	240108		ACS				A 6384	A 6384	Acknowledgement status: ACS ack/nack Checksum error – Units: n/a
E0700-E0790	63841/8-10 68841/8-10	64007 64008 64009 69007 69008 69009	ACS	E/F0251 E/F0252 E/F0253	E/F0201 E/F0202 E/F0203	E5700-E5790	A 6308		FEE response: The command enables/disables the FEE response on the ISB. Thus only HK are concerned, veto signal is OK. If it is disabled no response occurs. If response is enabled FEE transmits the appropriate response. Power-on reset disables the FEE response. Units: n/a
E0791	63841/10 68841/10	64009 69009	ACS	E/F0253	E/F0203	E5791	A 6308		PSAC PEB response: The command enables/disables the PSAC PEB response on the ISB. Thus only HK are concerned, veto signal is OK. If it is disabled no response occurs. If response is enabled PSAC transmits the appropriate response. Power-on reset disables the PSAC response. Units: n/a
E0792-E0794									Reserved for Alenia needs
E/F0795	240108		PSD				A 6383	A 6383	Acknowledgement status: PSD ack/nack check – Units: n/a
E/F0796	240108		PSD				A 6382	A 6382	Acknowledgement status: PSD ack/nack 1st command after reset – Units: n/a
E/F0797	240108		PSD				A 6381	A 6381	Acknowledgement status: PSD ack/nack auto-test status – Units: n/a
E/F0798	240108		PSD				A 6380	A 6380	Acknowledgement status: PSD ack/nack Not allowed command – Units: n/a
E/F0799	240108		PSD				A 6384	A 6384	Acknowledgement status: PSD ack/nack checksum error – Units: n/a
E0800-E0890	63841/11-13 68841/11-13	64010 64011 64012 69010 69011 69012	ACS	E/F0254 E/F0255 E/F0256	E/F0204 E/F0205 E/F0206	E5800-E5890	A 6308		FEE veto signal configuration: The command enables/disables CSA control and veto signal generation. If 0, no integration cycles and thereby either event latch and CSA reset signals or veto signals are generated. If 1, valid event triggers initiate integration cycles, event latch and CSA reset signals or veto signals are generated. Thus no more veto signals either counter incrementation. If 1, valid event triggers initiate integration cycles, event latch and CSA reset signals are generated. 0 ⇒ Disable (after power on) 1 ⇒ Enable Units: n/a
E0891	63841/13 68841/13	64012 69012	ACS	E/F0256	E/F0206	E5891	A 6308		PSAC PEB veto signal configuration: Idem as above for PSAC PEB. Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E0892-E0895									Spares
E/F0896	240108		AFEE				A 6308	A 6308	Status acquisition Medium SB: Output status from AFEE to DFEE: 0 = DISABLE; 1 = ENABLE Units: n/a
E0897									Spare
E/F0898	240108		AFEE				A 6001	A 6001	Status acquisition Medium SB: PROM_self-test status result: 0 = OK; 1 = NOK Units: n/a
E/F0899	240108		AFEE				A 6001	A 6001	Status acquisition Medium SB: RAM_self-test status result: 0 = OK; 1 = NOK Units: n/a
E0900-E0990	63841/11-13 68841/11-13	64010 64011 64012 69010 69011 69012	ACS	E/F0254 E/F0255 E/F0256	E/F0204 E/F0205 E/F0206	E5900-E5990	A 6322		FEE veto signal driver configuration report: Enables/disables the veto signal driver. The veto signal lines are set to high impedance when disabled. Thus veto signal is permanently 1. Nevertheless counters are OK. 0 ⇒ Enable 1 ⇒ Disable (after power on) Units: n/a
E0991	63841/13 68841/13	64012 69012	ACS	E/F0256	E/F0206	E5991	A 6322		PSAC PEB veto signal driver configuration report: Enables/disables the veto signal driver of the PSAC. The veto signal lines are set to high impedance when disabled. Units: n/a
E/F0992	240108		AFEE						Status acquisition LSB: (bits 3 to 0 with bit 0 Msb) On-board software version number – Units: n/a
E/F0993	240108		AFEE						Status acquisition LSB: (bits 7 to 4 with bit 7 Lsb) On-board software revision number – Units: n/a
E0994-E0999									Spares
E1000-E1090	63841/8-10 68841/8-10	64007 64008 64009 69007 69008 69009	ACS	E/F0251 E/F0252 E/F0253	E/F0201 E/F0202 E/F0203	E6000-E6090	A 6318		FEE veto test signal configuration report: This command configures the test pulse generator. power-on reset disables the test pulse generator. The test pulse generator can be continuous test pulses (3.9 kHz), burst of 2047 test pulses (3.9 kHz), continuous test pulses (62.5 kHz). Note: the burst mode must not be started earlier than 530 ms (2047/3.9 kHz) after reset otherwise 2048 test pulses instead of 2047 may be generated. Alias table n°6318 – Units: n/a
E1091	63841/10	64009	ACS	E0253	E0203	E6091	A 6323		Test pulses Burst: This command configures the test pulse generator. power-on reset disables the test pulse generator. The test pulse generator is a burst of 129 pulses (62.5 kHz). 0 ⇒ No test Pulses (after power on) 1 ⇒ Burst of 129 pulses Units: n/a
E1092-E1099									Spares have been reserved but not defined

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E1100-E1190	63841/11-13 68841/11-13	64010 64011 64012 69010 69011 69012	ACS	E/F0254 E/F0255 E/f0256	E/F0204 E/F0205 E/F0206	E6100-E6190	A 6309		FEE veto signal generation: Controls dependence on energy discriminator for the ACS FEE: if 0, veto signal is generated when energy discriminator goes active during integration cycle, if 1, each valid event trigger generates a veto signal. 0 ⇒ Standard (after power on) 1 ⇒ Forced Units: n/a
E1191	63841/13 68841/13	64012 69012	ACS	E/F0256	E/F0206	E6191	A 6309		FEE veto signal generation for PSAC: Idem as above
E1192-E1199									Spares have been reserved but not defined
E1200-E1290	63841/11-13 63841/11-13	64010 64011 64012 69010 69011 69012	ACS	E/F0254 E/F0255 E/F0256	E/F0204 E/F0205 E/F0206	E6200-E6290	A 6308		FEE extended veto signal generation: Enables/disables generation of extended veto signals indicating an overrange event. If 0, no extended signal are generated, if 1, veto signals are generated as extended veto signals when overrange conditions are met. 0 ⇒ Disable (after power on) 1 ⇒ Enable Units: n/a
E1291									Spare
E/F1292	240108		ACS				A 6325	A 6325	Status acquisition Medium SB bit n°0 MSB: Power On Status Normal hardware power on = 0; watchdog power on = 1 This bit will set/reset only once after power on Units: n/a
E/F1293	240108		ACS						Status acquisition Medium SB bit n°1 MSB: OBT Synchronisation missing This bit will be set to "1" after power on and indicates a missing OBT synchronisation. It will be reset to "0" after receiving the acsGetGammaStartTime HK command – Units: n/a
E1294									Spare
E/F1295	240108		ACS				A 6327	A 6327	Status acquisition Least SB bit n° 0: Start Address or Length error in Load/Dump command. 0 = no error; 1 = error In case of a Load command this flag indicates: - an invalid start address (valid range is from 0 – 07FFF hex) or - an invalid length (> 24 byte) In case of a Dump command this flag indictates: - an invalid length (> 24 byte) Units: n/a
E/F1296	240108		ACS				A 6327	A 6327	Status acquisition Medium SB bit n° 4: ISB response parity error or Address command code 0 = no error; 1 = error This flag will be set if the VCU receives one of the following response from the ISB bus: - Parity error - Address/Command code not ok In case of an FEE configuration error the corresponding FEE number will be set in diagnostic block 4. Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F1297	240108		ACS				A 6327	A 6327	Status acquisition Medium SB bit n° 5: FEE configuration error 0 = no error, 1 = error This flag will be set if the configuration of the FEE's fails: The 6 «data» bits in the command word are not equal to the 6 «parameter» bits in the response word for the following FEE configuration services: - set system service - set veto signal configuration - start rate meter - set veto propagation delay - set event threshold - set energy threshold - set high voltage In case of an FEE configuration error the corresponding FEE number will be set in diagnostic block 4. Units: n/a
E/F1298	240108		ACS				A 6326	A 6326	Status acquisition Medium SB bit n° 6: Gamma measurement 8 Hz Interrupt Counter Error no loss = 0; loss = 1 This flag will be set if the acquisition of the gamma measurement data will not be requested in the specified timing (all seconds = 64 * 125 ms cycles) Units: n/a
E/F1299	240108		ACS				A 6327	A 6327	Status acquisition Medium SB bit n° 7: Conf Command parameter error 0 = no error; 1 = error This flag will be set if a configuration command contains a parameter which exceeds the following limits: - the veto-signal propagation delay value for AFEE (not for the PSAC) is not in the range from 0 to 11 Units: n/a
E1300-E1391	63841/14-18 63842/1 68841/18-18 68842/1	64013 64014 64015 69013 69014 69015	ACS	E/F0257 E/F0258 E/F0259	E/F0207 E/F0208 E/F0209	E6300-E6391	Cc 6402		FEE veto rate meter measurement time: It starts immediately the rate meter. The measurement is performed for the commanded measurement time. Power-on reset resets the rate meter parameter, no measurement is performed. Units: sec
E1392-E1394									Spare
E/F1395	240108		ACS				Cc 6308	Cc 6308	VCU watchdog status: Reflects the setting of bit "VCU WD DIS/EN" of configuration command "C" 43 Hex and is not cleared after reading the ACS status.
E/F1396	240108		ACS				Cc 6342	Cc 6342	Status acquisition Least SB bit n° 4 : Calibration stopped: 0 => calibration nominal 1 => calibration aborted This bit will be set to «1», if an active ACS calibration will be aborted by one of the following events: - a mode transition will be commanded or - a Reset-HV will be commanded This bit will be set to «0» after the ACS status will be read from the DPE Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E1397-E1398									Spare
E/F1399	240108		ACS				A 6343	A 6343	Calibration status: 0 ⇒ Calibration not allowed 1 ⇒ Calibration measurement awaiting 2 ⇒ Calibration active 3 ⇒ Calibration ready for dump 4 ⇒ Calibration dump on progress 5 ⇒ Calibration dump completed Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E1400-E1490	63842/2-4 68842/2-4	64016 64017 64018 69016 69017 69018	ACS	E/F0260 E/F0261 E/F0262	E/F0210 E/F0211 E/F0212	E6400-E6490	Cc 6311		FEE veto delay: It adds an additional delay related to the shortest propagation delay for the veto signal (can be used to adjust the propagation delay of the full signal chain from the PMT anode to the DFEE input). Power-on reset sets the propagation delay parameter to 0, no additional delay is added. These parameters are connected to E1299. If the value is out of range: 0 to 11 (raw value) the E1299 parameter will be set to 1. In this case, the veto pulse is not generated by the concerned FEE. The ACS propagation delay parameters are different from the PSAC one. Units: nsec
E1491	63842/4 68842/4	64018 69018	ACS	E/F0262	E/F0212	E6491	A 6331		PSAC veto delay value report: Units: n/a
E1492	63842/4 68842/4	64018 69018	ACS	E/F0262	E/F0212	E6492	A 6332		PSAC veto delay additional parameter: Units: n/a
E1493 E/F1494	240108		PSD				A 6349	A 6349	Status acquisition Medium SB: Library control – Units: n/a Default value = 0. Set to 1 upon reception of first library upload command (I1B Hex) and until the 7 blocks (0B Hex to 11 Hex) have been received. The reception of the last command sets this bit to 0.
E/F1495	240108		PSD				A 6348	A 6348	Status acquisition Medium SB: Program error – Units: n/a Signals if a runtime error occurred during execution of the PSD on-board software. This Bit is reset to 0 as soon as the HK13 (hex) housekeeping block is read. This housekeeping block contains the error type (E3880) that identifies the type of the runtime error.
E1496-E1499									Spares
E1500-E1590	63842/5-7 68842/5-7	64019 64020 64021 69019 69020 69021	ACS	E/F0263 E/F0264 E/F0265	E/F0213 E/F0214 E/F0215	E6500-E6590	Cc 6319		FEE event trigger threshold: It controls the event trigger threshold by setting the duty cycle of the corresponding PWM signal. Power-on reset sets the event threshold parameter to 11111. The ACS event threshold parameter are different from the PSAC one. Units: mV
E1591	63842/7 68842/7	64021 69021	ACS	E/F0265	E/F0215	E6591	Cc 6324		FEE event trigger threshold PSAC: Units: mV
E1592-E1599	240108		PSD						Status acquisition LSB: – Units: n/a unused
E1600-E1690	63842/8-10 68842/8-10	64022 64023 64024 69022 69023 69024	ACS	E/F0266 E/F0267 E/F0268	E/F0216 E/F0217 E/F0218	E6600-E6690	Cc 6312		FEE energy discriminator: It controls the energy discriminator threshold by setting the duty cycle of the corresponding PWM signal. Power-on reset sets the energy threshold parameter to 111111. The ACS energy threshold parameters are different from the PSAC one. Units: mV
E1691	63842/10 68842/10	64024 69024	ACS	E/F0268	E/F0218	E6691	Cc 6321		FEE energy discriminator PSAC: It controls the energy discriminator threshold by setting the duty cycle of the corresponding PWM signal. Power-on reset sets the energy threshold parameter to 111111. Units: mV
E1700-E1790	63842/11-13 68842/11-13	64025 64026 64027 69025 69026 69027	ACS	E/F0269 E/F0270 E/F0271	E/F0219 E/F0220 E/F0221	E6700-E6790	Cc 6313		FEE High Voltage level: It controls the high voltage level by setting the duty cycle of the corresponding PWM signal. Power-on resets set the high voltage level parameter to 00000. (980 v) Units: V

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E1791-E1792	63842/13 68842/13	64027 69027	ACS	E/F0271	E/F0221	E6791-E6792	Cc 6322		PSAC High Voltage level: It controls the high voltage level by setting the duty cycle of the corresponding PWM signal. Power-on resets set the high voltage level parameter to 00000. (850 v) Units: V
E1800-E1890	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E6800-E6890	A 6314		FEE veto mask enable/disable: It enables/disables the veto signal 0 ⇒ Veto signal Disable 1 ⇒ Veto Signal Enable – Units: n/a
E1891	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E6891	A 6314		PEB veto mask enable/disable: It enables/disables the veto signal 0 ⇒ Veto signal Disable 1 ⇒ Veto Signal Enable – Units: n/a
E1892-E1897	E1997								Spares
E1898	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E6898	A 6328		Veto pulse width: It sets the veto pulse width in VCU – Units: nsec (min = 0 ; max = 29)
E1899 E1900									Deleted Spares
E1901-E1996	63844 68844	64901-64906 69901-69906	IASW	E/F0591-E/F0596	E/F0581-E/F0586	E6901-E6996	A 6402		S/A identifiers for diagnostic purposes Minimum value = 2 Maximum value = 5 Units: N/A
E1997-E1999									Spares
E2000	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E7000	A 6324		Configuration Data Switch VCU RAM/FEE commands echo: 0 ⇒ Configuration table selected in VCU RAM (default value after switch-on) 1 ⇒ FEE echo of commands sent to FEE Units: n/a
E2001	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E7001	A 6308		ACS overall veto mask: It enables/disables the overall veto signals. 0 ⇒ Disable 1 ⇒ Enable Units: n/a
E2002-E2024	60601/12-13 65601/12-13	64654 64655 69654 69655	ACS	E/F0282 E/F0283			A 6400		FEE HV status (a): Units: n/a
E2025	63842/14 68842/14	64028 69028	ACS	E/F0272	E/F0222	E7025	A 6308		VCU watchdog enable/disable This parameter is set to 0 (disable) after switch ON, but shall be enabled by configuration file loading for normal operation. After activation the WD could not be changed.
E2026-E2032									Spares
E2033		64700 69700	ACS	E/F0567					Calibration data packets counter:
E2034-E2049		64700 69700	ACS	E/F0567					Calibration data: sample n°0 to n°15 – Units: n/a
E2050-E2060									Spares
E2061-E2062	60011/2 65011/2		ACS						OBT: – Units: n/a (TBC)

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2063	60011/2 65011/2		ACS						8 Hz delay counter: The delay counter contains the number of 8 Hz interrupts after receiving the current OBT sync until switching the toggle buffers. Expected value = 64 – Units: n/a
E2064-E2100	60601/13-15 65601/13-15	64655 64656 64657 69655 69656 69657	ACS	E/F0283 E/F0284 E/F0285			A 6400		FEE HV status (b):
E/F2101	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	UCR0 temperature acquisition: – Units: degC

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F2102	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	UCR1 temperature acquisition: – Units: degC
E/F2103	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	UCR2 temperature acquisition: – Units: degC
E/F2104	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LCR0 temperature acquisition: – Units: degC
E/F2105	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LCR1 temperature acquisition: – Units: degC
E/F2106	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LCR2 temperature acquisition: – Units: degC
E/F2107	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	SSA0 temperature acquisition: – Units: degC
E/F2108	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	SSA1 temperature acquisition: – Units: degC
E/F2109	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	SSA2 temperature acquisition: – Units: degC
E/F2110	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LVS0 temperature acquisition: – Units: degC
E/F2111	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LVS1 temperature acquisition: – Units: degC
E/F2112	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	LVS2 temperature acquisition: – Units: degC
E/F2113	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	VCU temperature acquisition n°12: – Units: degC
E/F2114-E/F2116	60601/11 65601/11	64653 69653	ACS	E/F0281			Cc 6410	Cc 6410	Plastic scintillator temperatures acquisition: – Units: degC
E2117-E2120									Spares
E/F2121	60601/10 65601/10	64652 69652	ACS	E/F0280			Cc 6404	Cc 6404	VCU AC current voltage acquisition: – Units: A
E/F2122	60601/10 65601/10	64652 69652	ACS	E/F0280			Cc 6403	Cc 6403	VCU AC Voltage acquisition: – Units: V
E/F2123	60601/10 65601/10	64652 69652	ACS	E/F0280			Cc 6413	Cc 6413	VCU + 5V supply voltage: – Units: V
E2124-E2130									Spares
E/F2131	240108		ACS				A 6327	A 6327	Medium SB acquisition Fstatus bit n° 2: Cyclic self-test status: 0 no error 1 error Valid in Stand-by only This bit will be set to «1» if the cyclic auto-test function detects a ROM/RAM comparison failure. The memory address of the first occurrence will be entered in diagnostic block 4. It will be set to «0» after a mode transition to configuration – Units: n/a
E/F2132	240108		ACS				A 6327	A 6327	Medium SB acquisition status bit n° 3: Rate meter error: 0 no error: 1 error This flag will be set if the valid bit (D5) is set in the ISB response word of an readRateMeter command. In addition the corresponding FEE number will be set in diagnostic block 4. – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2133	60011/1 65011/1		ACS				A 6360		Rate meter group number acquisition: FEE group number (8 FEE/group). There are 92 rate-meters, 8 samples per group, 12 groups read each 8 s. – Units: n/a
E2134-E2141	60011/1 65011/1		ACS						Rate meter of 8 FEE groups (MSB + LSB): Count rate per FEE of all particles detected in the scintillator modules for a variable duration of 0.131 s to 1.9 s transmitted cyclically per packet of 8 every 8 s. – Units: n/a
E2142-E2149									Spares
E2150-E2240	60601/12-17 65601/12-17	64654- 64659 69654- 69659	ACS	E/F0282 E/F0283 E/F0284 E/F0285 E/F0286 E/F0287			A 6400		FEE digital status 5V: – Units: n/a
E2241	60601/17 65601/17	64659 69659	ACS				A 6400		FEE PSAC + 5V status: – Units: n/a
E2242-E2249									Spares
E2250-E2340	60601/12-17 65601/12-17	64654- 64659 69654- 69659	ACS	E/F0282 E/F0283 E/F0284 E/F0285 E/F0286 E/F0287			A 6400		FEE analogue status 5 V: – Units: n/a
E2341	60601/17 65601/17	64659 69659	ACS	E/F0287			A 6400		FEE PSAC +/- 9 V status: – Units: n/a
E2342-E2349									Spares
E2350-E2399	60601/12-17 65601/12-17	64654- 64659 69654-69659	ACS	E/F0282 E/F0283 E/F0284 E/F0285 E/F0286 E/F0287			A 6400		FEE analogue status - 5V: – Units: n/a
E2400-E2491	63843/14 68843/14	64046 69046	ACS	E/F0273	E/F0224	E7400-E7491	A 6308		FBI ISB communication: ISB communication ON/OFF for each FEE – Units: n/a
E2492-E2499									Spares
E2500-E2590	63841/14-15 63842/1 68841/14-15 68842/1	64013- 64015 69013- 69015	ACS	E/F0257 E/F0258 E/F0259	E/F0207 E/F0208 E/F0209	E7500-E7590	A 6316		FEE veto pulse integration cycles count: If 0, count veto pulses, if 1, count integration cycles – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F2591	240108		PSD						HK0 MSB: byte involving parameters E/F3890 E/F3899 E/F3892
E/F2592	240108		PSD						HK0 mSB: byte involving parameters E/F1494 E/F1495
E/F2593	240108		PSD						HK0 LSB: always equal 0
E/F2594	240108		AFEE						HK0 MSB: byte involving parameters E/F3881 E/F3882 E/F3883
E/F2595	240108		AFEE						HK0 mSB: byte involving parameters E/F0896 E/F0898 E/F0899
E/F2596	240108		AFEE						HK0 LSB: byte involving parameters E/F0992 E/F0993
E/F2597	240108		ACS						HK0 MSB: byte involving parameters E/F3887 E/F3888 E/F3889
E/F2598	240108		ACS						HK0 mSB: byte involving parameters E/F1292 E/F1293 E/F1296 E/F1297 E/F1298 E/F1299 E/F2131 E/F2132
E/F2599	240108		ACS						HK0 LSB: byte involving parameters E/F1295 E/F1395 E/F1396 E/F1399
E2600-E2690	60602/1-3 65602/1-3	64660-64662 69660-69662	ACS	E/F0288 E/F0289 E/F0290			A 6401		FEE alert status acquisition: – Units: n/a
E2691-E2694									Spares

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2695	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7695	A 6308		EnHslErrAct: Automatic ASIC reset on HSL error detection Mapping: (0 ⇒ disable: default value, 1 ⇒ enable) Applicable range (0, 1)
E2696	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7696			NHslErrAct Threshold: Filter for automatic ASIC reset if E2695 is enabled
E2697	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7697	A 6355		Inhibition auto-test CODE: Enable/Disable the Code area auto-test. The DFEE SW runs cyclically some autotests to check the integrity of the code in RAM (comparison to PROM) and the ASIC. These autotests can be inhibited or not individually for the following restart or watchdog operations. If 0 performs all autotests, 1 all autotests inhibited.
E2698	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7698	A 6355		Inhibition auto-test ASIC: Enable/Disable the ASIC auto-test. The DFEE SW runs cyclically some autotests to check the integrity of the code in RAM (comparison to PROM) and the ASIC. These autotests can be inhibited or not individually for the following restart or watchdog operations. If 0 performs all autotests, 1 all autotests inhibited
E2699	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7699	A 6355		Inhibition auto-test RAM: Enable/Disable the RAM area auto-test. The DFEE SW runs cyclically some autotests to check the integrity of the code in RAM (comparison to PROM) and the ASIC. These autotests can be inhibited or not individually for the following restart or watchdog operations. If 0 performs all autotests, 1 all autotests inhibited.
E2700	63841/7 68841/7	64006 69006	DFEE	E/F0111	E/F0101	E7700			HSL Error number Threshold: Define the HSL error number allowed before setting the Alert HSL error status within HK0 and HK4. (0; 15) def = 1. The HSL error alert bit is set when, in any particular second, the number of HSL packets in error is greater or equal to the applied threshold. If the threshold is set to 0, the alerts will be always set. Any number greater than 8 will disable the alert.
E2701	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7701	A 6333		Reset Front Tframe (RstFrontTFrame): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 ⇒ No Reset; 1 ⇒ Reset]. Function: When 0, The Front Tframe sub-unit of the DFEE ASIC, which controls the Run and Time Frame boundaries, is enabled for operation. When 1, the Front Tframe unit is kept into the Reset state and does not operate. The time frame sequencer is stopped (test purpose) Purpose: In conjunction with all other Reset* flags, this flag defines the set of DFEE ASIC sub-units that should be left in Reset by the micro-controller software when going to operational mode. In the nominal mode of operation, all sub-units should be activated (Reset* = False). One or more sub-units may be left inactive during test phases, or possibly during flight in degraded mode, if declared defective. – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2702	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7702	A 6333		Reset Front veto (RstFrontVeto): Idem, for the sub-unit in charge of the ACS signal processing. If = 1, the veto pulse input read is forced to 0 (no veto pulse read). Test purpose or in-flight degraded mode. – Units: n/a
E2703	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7703	A 6333		Reset Front PSD (RstFrontPSD): Idem, for the sub-unit in charge of the PSD signal processing. If = 1, the PSD TT input read is forced to 0 (no PSD TT read). Test purpose or in-flight degraded mode – Units: n/a
E2704-E2722	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7704-E7722	A 6333		Reset Front AFEE n° 0 to n° 18 (RstFrontAfeei) Idem, for the sub-units in charge of the AFEE signal processing. If = 1, the AFEEi TT input read is forced to 0 (no AFEEi TT read). – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2723	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7723	A 6333		Reset Count VPSD (RstCountVPsd): Idem, for the sub-unit in charge of the ACS veto gate and PSD signal activity and dead time counts. If = 1, veto PSD and veto dead time counts are forced to 0. Test purpose. – Units: n/a
E2724-E2742	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7724-E7742	A 6333		Reset Count AFEE n° 0 to n° 18 (RstCountAfeei): Idem, for the sub-units in charge of the AFEE signal activity and dead time counts. If = 1, AFEE i TT counts and AFEE dead time are forced to 0. Test purpose. – Units: n/a
E2743	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7743	A 6333		Reset ASSO SM (RstAssoSm): Idem, for the Finite State Machine sub-unit in charge of the association of time signals into Primary Objects. If = 1, there is no association into primary objects by the state machine. Test purpose. – Units: n/a
E2744	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7744	A 6333		Reset POBJ SM (RstPobjSm): Idem, for the Finite State Machine sub-unit in charge of the temporary storage of Primary Objects. If = 1, there is no Primary Objects temporary storage by the state machine. Test purpose. – Units: n/a
E2745	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7745	A 6333		Reset RCVE SM (RstRcveSm): Idem, for the Finite State Machine sub-unit in charge of the ordered production of Energy and Id values. If = 1, there is no ordered production by the state machine of Energy and identifier values. Test purpose. – Units: n/a
E2746	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7746	A 6333		Reset RCVE serial (RstRcveSerial): Idem, for the Finite State Machine sub-unit in charge of the reception of the 20 serial word streams corresponding to AFEE energy and PSD Id. If = 1, reception of Energy words and identifiers are performed by the state machine. Test purpose. – Units: n/a
E2747	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7747	A 6333		Reset ACQ SM (RstAcqSm): Idem, for the Finite State Machine sub-unit in charge of the construction and storage of the SE, ME and PE and SP output tables. If = 1, there is no construction and storage by the state machine, of the SE, ME, and PE in the output tables. Test purpose. – Units: n/a
E2748	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7748	A 6333		Reset Dial SM (RstDialSm): Idem, for the Finite State Machine sub-unit in charge of the construction and synchronisation of the HSL output bit stream. If = 1, there is no construction and synchronisation of the HSL output bit stream. Test purpose. – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2749	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7749	A 6308		Enable count Dead Time AFEE (EnCntDtAfee): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 ⇒ Disable; 1 ⇒ Enable]. Function: When disable, DFEE ignore the AFEE nominal time tag for dead time valuation. When enable, DFEE includes its contribution in the channel dead time measurement. Applies to all channels. Purpose: [disable: Test, integration, investigation on dead time contributions; enable: Nominal mode of operation]. – Units: n/a
E2750	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7750	A 6308		Enable count Dead Time AFEE sat. (EnCntDtAfeeSat) Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 ⇒ Disable; 1 ⇒ Enable]. Function: When disable, DFEE ignores the AFEE Saturating Time Tag for dead time valuation; When enable, DFEE includes its contribution in the channel dead time measurement. Applies to all channels. Purpose: [disable: Test, integration, investigation on dead time contributions; enable: Nominal mode of operation]. – Units: n/a
E2751	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7751	A 6308		Enable DEAD time Veto Gate (EnCntDtVetoGate): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 ⇒ Disable; 1 ⇒ Enable]. Function: When Disable, DFEE ignores the internal AFEE Veto Gate for dead time valuation; When Enable, DFEE includes its contribution in the channel dead time measurement. Applies to all channels. Purpose: [Disable: Test, integration, investigation on dead time contributions; Enable: Nominal mode of operation]. – Units: n/a
E2752									Deleted
E2753	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7753	A 6390		CFG ASSO Multi Window size (AssoMultWinSize): Type: 5-bit unsigned integer. Applicable range: [0..31]. Base unit: ASIC Clk period. Function: Defines the maximum time interval between two following members in a multiple object. Purpose: Used by the DFEE ASIC to aggregate events after front-end time alignment and to classify them into the 3 basic types: Single Events (SE), Psd Events (PE) and Multiple Events (ME). – Units: ns
E2754						E7745			Deleted
E2755						E7755			Deleted
E2756	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7756	A 6308		CFG ASSO Enable PSD (AssoEnablePsd): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => disable; 1 => enable]. Function:When disable, DFEE ignores PSD Time Tag while building objects. When enable, DFEE uses its internal aligned PSD Time Tag. Purpose: [disable: Test and/or integration, PSD still counted; enable: Nominal mode of operation]. – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2757-E2775	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7757-E7775	A 6308		<u>CFG ASSO Enable n° 0 - n° 18 (AssoEnableAfeei):</u> Type: Vector(i = 0 to 18) of 1-bit boolean elements. Applicable range of each element: [0, 1]. Mapping: [0 => disable; 1 => enable]. Function: When disable, DFEE ignores AFEE i internal Time Tag while building objects. When enable DFEE uses its internal aligned AFEE Time Tag for channel #i. Purpose: [Disable: Test and/or integration, AFEE#i still counted; enable: Nominal mode of operation]. – Units: n/a
E2776	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7776			<u>CFG RCVE Time Out Miss Energy (ToutValMissNrj):</u> Type: 5-bit unsigned integer. Applicable Range: [0..31]. Base unit: ASIC Clk period. Function: Defines the time interval after which the DFEE, once a Time Tag has been observed, ceases to wait for the corresponding Energy/Id serial transaction. If time out is declared, the missing Energy/Id value is replaced by special value $0000 (hexadecimal). Purpose: To guarantee non-blocking forward progress in the DFEE event processing, to secure the Time Frame to Time Frame flip-flop for HSL output tables, and to help identify faulty channels. Mapping: Linear scale. Defines the value Tmiss = (26 + 128 * (ToutValMissNrj +1)) ASIC Clk periods. A Energy/Id Timeout condition is declared if an isolated Time Tag is not followed by a complete serial Energy/Id transaction within Tmiss ASIC Clk periods. The actual waiting time is increased when Time Tag pile-up occurs. – Units: n/a
E2777	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7777	A 6304		<u>CFG ACQ Keep SE (EvtKeepSe):</u> Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, prevents the DFEE from writing SE objects into the HSL SE output table. Note that, if the companion flag EvtKeepPE is Yes, the SE table may still receive the AFEE portion of PE events which are lately reclassified due to the absence of the PSD "Processed" flag. When Yes, enables the DFEE to write SE objects into the HSL SE output table. Purpose: [No: Test and/or integration, high rate flight condition; Yes: Nominal mode of operation]. – Units: n/a
E2778	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7778	A 6304		<u>CFG ACQ Keep ME (EvtKeepMe):</u> Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, prevents the DFEE from writing ME objects into the HSL ME output table table. When Yes, enables the DFEE to write them into the HSL ME output table. Purpose: [No: Test and/or integration, high rate flight condition; Yes: Nominal mode of operation]. – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2779	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7779	A 6304		CFG ACQ Keep PE (EvtKeepPe): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, prevents the DFEE from writing PE objects into the HSL PE output table. When Yes, enables the DFEE to write them into the HSL PE output table. Purpose: [No: Test and/or integration, high rate flight condition; Yes: Nominal mode of operation]. – Units: n/a
E2780	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7780	A 6304		CFG ACQ Keep PP (EvtKeepPP): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, prevents the DFEE from writing PSD only (Pure Psd) objects into the HSL ME output table. When Yes, enables the DFEE to write PP objects into the HSL ME output table, whatever the value of the EvtKeepME companion flag. Purpose: [No: nominal mode of operation; Yes: Test and/or integration, PSD vs AFEE dead time investigation]. – Units: n/a
E2781	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7781	A 6304		CFG ACQ Event Force No vetoed (EvtForceNVeto): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, the DFEE writes objects into the SE, ME and PE output tables only if they are non-vetoed. When Yes, forces the DFEE to write the objects into the HSL SE, ME, and PE output tables with no consideration of their veto status. In either case, storage depends also on EvtKeepSE, EvtKeepME, EvtKeepPE and EvtKeepPP. Storage into Spectra is independantly controlled by SpeStorageMode, and may depend on the veto status even if EvtForceNVeto is set to Yes . Purpose: [No: nominal mode of operation; Yes: Test and/or integration]. – Units: n/a
E2782	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7782	A 6370		CFG ACQ Spectra Storage Mode (SpeStorageMode): Type: 2-bit enumerated field. Applicable range: [None, Vetoed Only, SE Non Vetoed Only, All]. Mapping: ["00" => None; "01" => Vetoed Only; "10" => SE Non Vetoed Only; "11" => All]. Function: Defines the constituents of the Spectra tables SP0 to SP18. If at least one AFEE Time Tag is vetoed in an object, the veto criterium is globally applied to all other energies included in this object. Purpose: Scientific decision; "SE Non Vetoed Only" mode is intended to address high rate situations where SE, ME and PE are disabled and only spectra are returned to earth. – Units: n/a
E2783	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7783			CFG DIAL HSL Transfert lenght bit (HslXferLength): Type: 16-bit unsigned integer. Applicable Range: [0, 24576]. Function: Defines HSL length transfer (number of 16 bits words). This number must be equal to the corresponding DPE parameter value. Purpose: To produce a correctly formatted HSL bit stream towards the DPE. This number must be pre-negotiated and applied to both DPE and DFEE. – Units: n/a

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E2784	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7784	A 6304		EvtSetTimeFmtPe: Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, the DFEE writes objects into the PE output table with the PSD Id unchanged. When Yes, the DFEE replace in the PSD Id. the address field, by the time duration between the AFEE TT and the corresponding PSD TT and the Processed flag by the Dt sign (0 if PSD TT occurs before the AFEE TT). Operational constraint: in this case, the IASW correlation parameter shall be disable. Purpose: [No: nominal mode of operation; Yes: Test and/or integration]. – Units: n/a
E2785	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7785	A 6304		EvtForceProcPe: Type: 1-bit boolean. Applicable range: [0, 1]. Mapping: [0 => No; 1 => Yes]. Function: When No, the PE candidate objects are written in the output PE table, only if the PSD id. process flag is set to 1 (PSD processed event). The others PE events are discarded and the corresponding AFEE data is routed to the SE table. Otherwise, all PE candidate objects are written in the output table. Purpose: [No: nominal mode of operation; Yes: Test and/or integration]. – Units: n/a
E2786	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7786			(ToutScaleDropNrj): Type: 4-bit unsigned integer. Applicable rang: [0..15]. Function: Defines the time interval after which a serial energy/Id is discarded if not assigned to a Time Tag.
E2787	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7787	A 6356		Mode resolution (LowResMode): Type: 1-bit boolean. Applicable range: [0, 1]. Mapping:[0 => Normal; 1 => Low]. Function: Define the internal clock resolution for events datation. Normal resolution is used for nominal operation with 20 MHz clock frequency (50 ns time resolution). Low resolution gives an half resolution.
E2788	63841/5 68841/5	64004 69004	DFEE	E/F0112	E/F0102	E7788	A 6371		Anti-coincidence Mode (AcMode): Type: 2-bit unsigned integer. Applicable range: [0, 3]. Mapping: [0 => AcOFF; 1 => AcOn; 2 => AcInverted; 3 => AcForced]. Function: Defines the usage of the Veto Pulse (AC signal): AC disabled (no event vetoed) AC enabled (events vetoed if VP active; nominal mode) AC inverted (events vetoed if VP inactive) AC forced (all events are vetoed independently of the VP state) – Units: n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2789									Spares
E/F2790	240108	DFEE							Acknowledgment status: byte involving parameters E0595-E0599
E/F2791	240108	DFEE							HK00 MSB byte E/F3884-E/F3886 E/F4001 alert management purpose
E/F2792	240108	DFEE							HK00 Medium byte E/F4002-E/F4009
E/F2793	240108	DFEE							HK00 LSB byte involving parameters E/F4010-E/F4017
E/F2794-E/F2795	240108	DFEE							Reserved for ECOE purpose
E/F2796	240108	PSD							Acknowledgment status: byte involving parameters E/F0795-E/F0799
E/F2797	240108	AFEE							Acknowledgment status: byte involving parameters E/F0495-E/F0499
E/F2798	240108	ACS							Acknowledgment status: byte involving parameters E/F0694-E/F0699
E2799									Spare

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E2800-E2818	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7800-E7818	Cc 6380		Adjust Delay for AFEE saturated TT DelayAfeeSat_i): Type: Vector(i = 0 to 18) of 4-bit unsigned integer elements. Applicable range of each element: [0.15]. Mapping: Linear scale. 0 to 750 ns Base unit: ASIC Clk period. Function: saturated AFEE i TT delay adjustment – Units: ns
E2819									Spare
E2820-E2838	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7820-E7838	Cc 6380		Adjust Delay for AFEE TT (DelayAfeeTT_i): Type: Vector(i = 0 to 18) of 4-bit unsigned integer elements. Applicable range of each element: [0..15]. Base unit: ASIC Clk period. Function: AFEE i TT delay adjustment Mapping:Linear scale. 0 to 750 ns – Units: ns
E2839									Spare
E2840	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7840	Cc 6380		Delay Veto First (DelayVetoFrst): Type: 4-bit unsigned integer. Applicable Range: [0..15]. Base unit: ASIC Clk period. Function: Defines the delay applied to the Veto Pulse before issuing the corresponding PSD Veto Gate. Mapping:Linear scale. 0 to 750 ns – Units: ns
E2841	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7841	Cc 6385		Delay Veto Second (DelayVetoScnd): Type: 6-bit unsigned integer. Applicable Range: [0..63]. Base unit: ASIC Clk period. Function: Defines the additional delay applied to the Veto Pulse before building the internal veto gate. Mapping:Linear scale. 0 to 3.15 µs – Units: ns
E2842	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7842	Cc 6381		Extended threshold (XtndThresh): Type: 8-bit unsigned integer. Applicable Range: [0..255]. Mapping: Linear scale. 0 = 0.1 µs 1 => 255; 0.2 µs to 12.89 µs Base unit: ASIC Clk period. Function: Defines the threshold used to discriminate nominal and saturated ACS Veto Pulse. If the ACS pulse width is smaller than XtndThresh-2, the ACS veto signal is declared as nominal; otherwise, it is declared as saturating. Depending on the classification, the applied veto gate is formed by extending the original pulse by a value which is function of either XtndGateBelow or XtndGateAbove. Purpose: To produce a larger, adjustable Veto Gate when the ACS encountered a saturating condition. – Units: ns

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E2843	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7843	Cc 6382		PSD TT delay (DlyPsd): Type: 5-bit unsigned integer. Applicable Range: [0..31]. Mapping: Linear scale. 0 to 1.55 µs Base unit: ASIC Clk period. Function: Defines the delay applied to the PSD Time Tag to obtain a uniformly aligned set of signals at the association point, where objects are built up. Purpose: To compensate for systematic differential delays, in order to reach the object association point with aligned Time Tags. – Units: ns
E2844	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7844	Cc 6383		Extended gate above threshold (XtndGateAbove): Type: 8-bit unsigned integer. Applicable Range: [0..255]. Mapping: Linear scale; -50 ns to 50.95 µs Base unit: ASIC Clk period. Function: Defines the extension applied to the Veto Pulse when it is declared as saturating (pulse width above or equal to threshold). Purpose: To produce a larger, adjustable Veto Gate when the ACS encountered a saturating condition – Units: ns
E2845	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7845	Cc 6384		Extended gate below threshold (XtndGateBelow): Type: 8-bit unsigned integer. Applicable Range: [0..255]. Mapping: Linear scale. –50 ns to 12.7 µs Base unit: ASIC Clk period. Function: Defines the extension applied to the Veto Pulse when it is declared as nominal (pulse width below threshold). Purpose: To produce an adjustable Veto Gate when the ACS is in nominal condition. – Units: ns
E2846 E2847									Deleted Deleted
E2848	63841/6 68841/6	64005 69005	DFEE	E/F0113	E/F0103	E7848	A 6359		Route Mode (RouteMode): Type: 2-bit unsigned integer. Applicable range: [0, 3]. Mapping: [0 => Normal; 1 => RouteSat; 2 => RouteACleft; 3 => RouteACboth]. Allows to internally route some input signals as an other input as following: Route Nothing (Nominal mode) Route AFEE sat TT as AFEE nom. TT Route AC gate left edge as PSD TT Route AC gate both edges as PSD TT
E2849-E2879 E2880-E2909 E2910-E2942			 DFEE			 E7880-E7909			Spares Deleted Reserved for diagnostic purposes

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E2943-E2950									Spare
E2951-E2960	60011/3-12 65011/3-12		ACS						Recorded counter acquisition: – Units: n/a
E2961-E3120	60011/3-12 65011/3-12		ACS						Overall counter n° 1 to 160 acquisition: Though these parameters are HK ones, they are decoded at ISDC. MOC don't care. – Units: n/a
E3121-E3161	60601/15-17 65601/15-17	64657-64659 69657-69659	ACS	E/F0285 E/F0286 E/F0287			A 6400		FEE analogue status - 5V (b): – Units: n/a
E3162	60601/17 65601/17	64659 69659	ACS	E/F0287			A 6400		FEE PSAC 28 V status: – Units: n/a
E3163									Spare
E3164-E3254	60601/16/17 65601/16/17	64654-64659 69654-69659	ACS	E/F0282 E/F0283 E/F0284 E/F0285 E/F0286 E/F0287			A 6400		FEE temperature status: – Units: n/a
E3255									Spare
E3256-E3286	60601/16/17 65601/16/17	64658 64659 69658-69659	ACS	E/F0286 E/F0287			A 6400		FEE HV status (c): – Units: n/a
E3287	60601/17 65601/17	64659 69659	ACS	E/F0287			A 6400		FEE PSAC HV PS1 status: – Units: n/a
E3288	60601/17 65601/17	64659 69659	ACS	E/F0287			A 6400		FFE PSAC HV PS2 status: – Units: n/a
E3289	60601/17 65601/17	64659 69659	ACS	E/F0287			A 6400		FEE Auxiliary Analogue Supply status: – Units: n/a
E3290			ACS						Deleted
E3290	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8290			Library selection for detector n° 7: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 7.
E3291	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8291			Event word decode K5 for detector n° 7: (0; 31) Not used
E3292	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8292			Number of time steps for detector n° 7: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 7.
E3293	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8293			Number of templates for detector n° 7: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 7. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 7.
E3294	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8294			Decode parameter K3 for detector n° 7: (0; 255) range (0; 100) Not used

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E3295	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8295			Library selection for detector n° 8: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 8.
E3296	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8296			Event word decode K5 for detector n° 8 : (0 ; 31) Not used
E3297	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8297			Number of time steps for detector n° 8 : (0 ; 255) range (6 ; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 8.
E3298	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8298			Number of templates for detector n° 8 : (0 ; 255) range (0 ; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 8. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 8.
E3299	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8299			Decode parameter K3 for detector n° 8 : (0 ; 255) range (0 ; 100) Not used
E3300									Spare
E3301	60000/1 60001/1 60002/1 60003/1 65000/1 65001/1 65002/1 65003/1		DFEE						Number of Second counter from START (odd sec): NsecFrontStart – Units: sec
E3302-E3306									Deleted
E3307	60000/1 60001/1 60002/1 60003/1 65000/1 65001/1 65002/1 65003/1		DFEE						Count Veto Gate (odd sec) ((CntVetoGate): Type: 24-bit unsigned integer. Applicable range: [0..16777215]. Function: Gives the number of distinct AC veto gates that were produced over the corresponding second. Purpose: To monitor the activity of the ACS, and allow for consistency checks with the SE, ME, PE and SP scientific data. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should never happen at the targeted ASIC frequency. Comment: The AC veto gate is a combination of the "below" and "above" veto gates. The value is not a measurement of the number of ACS Veto pulse signals that were actually received, since internal overlap between following pulses may occur in the DFEE when building the veto gate. It may be lower than the sum of CntVetoGateBelow and CntVetoGateAbove, since overlap may occur between them when doing the combination. – Units: n/a

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E3308	60000/1 60001/1 60002/1 60003/1 65000/1 65001/1 65002/1 65003/1		DFEE						Count Veto Gate Dead Time (odd sec) (CntVeto GateDTime): Type: 24-bit unsigned integer. Applicable range: [0..16777215]. Base Unit: ASIC Clk period*2. Function: Gives the actual dead time created by the combined AC veto gate in the DFEE, over the corresponding second. Purpose: To monitor the activity of the ACS, and check consistency with the other count values (the various counts produced for the ACS and the AFEE related counts). Boundary conditions: The value may not saturate over a second at the targeted ASIC operating frequency. Mapping: The value is an unnormalised measurement of dead time. A fractional dead time value may be obtained by multiplying it by2/sum(TimeClkMonTF_i), over the same time period – Units: n/a
E3309	60000/1 60001/1 60002/1 60003/1 65000/1 65001/1 65002/1 65003/1		DFEE						Count PSD Time Tag (odd sec) (CntPsdTT): Type: 16-bit unsigned integer. Applicable range: [0..65535]. Function: Gives the number of PSD TimeTags seen in the corresponding second. Purpose: To monitor the activity of the PSD, and allow for consistency checks with the SE, ME, PE and SP scientific data. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval – Units: n/a
E3310	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8310			Library selection for detector n° 9: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 9.
E3311	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8311			Event word decode K5 for detector n° 9: (0; 31) Not used
E3312	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8312			Number of time steps for detector n° 9: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 9.
E3313	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8313			Number of templates for detector n° 9: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 9. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 9.
E3314	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8314			Decode parameter K3 for detector n° 9: (0; 255) range (0; 100) Not used
E3315	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8315			Library selection for detector n° 10: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 10.
E3316	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8316			Event word decode K5 for detector n° 10: (0; 31) Not used

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E3317	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8317			Number of time steps for detector n° 10: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 10.
E3318	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8318			Number of templates for detector n° 10: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 10. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 10.
E3319	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8319			Decode parameter K3 for detector n° 10: (0; 255) range (0; 100) Not used
E3320-E3338	60000/1-7 60001/1-7 60002/1-7 60003/1-7 65000/1-7 65001/1-7 65002/1-7 65003/1-7		DFEE						CntAfeeTT (odd second) Type: Vector(i = 0 to 18) of 16-bit unsigned integer elements. Applicable range of each element: [0..65535]. Function: Gives the number of Time Tags seen on AFEE channel #i in the corresponding second. Purpose: To monitor the activity of the corresponding AFEE channel, and allow consistency checks with the SE, ME, PE and SP scientific data. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should not happen under normal circumstances, because the counter range exceeds the maximum rate of the AFEE Time Tag signal. – Units: n/a
E3339									Spare
E3340-E3358	60000/1-7 60001/1-7 60002/1-7 60003/1-7 65000/1-7 65001/1-7 65002/1-7 65003/1-7		DFEE						CntAfeeTTSat (odd second) Type: Vector(i = 0 to 18) of 16-bit unsigned integer elements. Applicable range of each element: [0..65535]. Function: Gives the number of Saturating Time Tags seen on AFEE channel #i in the corresponding second. Purpose: To monitor the activity of the corresponding AFEE channel. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should not happen under normal circumstances, because the counter range exceeds the maximum rate of the AFEE Saturating Time Tag signal. – Units: n/a
E3359									Spare
E3360-E3378	60000/1-7 60001/1-7 60002/1-7 60003/1-7 65000/1-7 65001/1-7 65002/1-7 65003/1-7		DFEE						CntAfeeNVeto (odd second) Type: Vector(i = 0 to 18) of 16-bit unsigned integer elements. Applicable range of each element: [0..65535]. Function: Gives the number of Non-Vetoed Time Tags seen on AFEE channel #i in the corresponding second. Purpose: To monitor the activity of the corresponding AFEE channel, and allow for consistency checks with the SE, ME, PE and SP scientific data. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should not happen under normal circumstances, because the counter range exceeds the maximum rate of the AFEE Time Tag signal – Units: n/a
E3379									Spare

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3380-E3398	60000/1-7 60001/1-7 60002/1-7 60003/1-7 65000/1-7 65001/1-7 65002/1-7 65003/1-7		DFEE						CntAfeeDtime (odd second) Type: Vector(i = 0 to 18) of 24-bit unsigned integer elements. Applicable range of each element: [0..16777215]. Base Unit: ASIC Clk period*2. Function: Gives the actual dead time observed on AFEE channel #i during the corresponding second. Purpose: To monitor the activity of the corresponding AFEE channel, and check consistency with the other count values (the various counts produced for this channel and the ACS related counts). Boundary conditions: The value may not saturate over a second at the targeted ASIC operating frequency. Mapping: The value is an unnormalised measurement of dead time. A fractional dead time value may be obtained by multiplying it by2/sum(TimeClkMonTF_i), over the same time period. – Units: n/a
E3399-E3400 E3497-E3499									Spares
E3401-E3496	63844 68844	64901-64906 69901-69906	IASW	E/F0591-E/F0596	E/F0581-E/F0586	E8401-E8496			Block acquisition identifier for diagnostic purposes Minimum value = 0 Maximum value = 255 This identifier points at the relevant diagnostic table – see V2 - § 1.1.10 Unit: N/A
E3500	60004/15 65004/15		DFEE						Count Veto Gate Below (sec 1) Type: 24-bit unsigned integer. Applicable range: [0..16777215]. Function: Gives the number of times when the original ACS veto pulse was declared as below threshold (AC non-saturating condition, counted over the corresponding second. Purpose: To monitor the activity of the ACS. The value is not a measurement of the actual number of ACS Veto signals below threshold that were received, since internal overlap may occur in the DFEE when building the "below" veto gate. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should never happen at the targeted ASIC frequency. – Units: n/a
E3501	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8501			Library selection for detector n° 11: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 11.
E3502	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8502			Event word decode K5 for detector n° 11: (0; 31) Not used
E3503	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8503			Number of time steps for detector n° 11: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 11.
E3504	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8504			Number of templates for detector n° 11: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 11. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 11.
E3505	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8505			Decode parameter K3 for detector n° 11: (0; 255) range (0; 100) Not used

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3506	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8506			Library selection for detector n° 12: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 12.
E3507	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8507			Event word decode K5 for detector n° 12: (0; 31) Not used
E3508	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8508			Number of time steps for detector n° 12: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 12.
E3509	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8509			Number of templates for detector n° 12: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 12. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 12.
E3510	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8510			Decode parameter K3 for detector n° 12: (0; 255) range (0; 100) Not used
E3511-E3518	60004/15 65004/15		DFEE						TimeClkTF_1 to TimeClkTF_8 (sec 1) Type: Vector(i = 1 to 8) of 24-bit unsigned integer elements. Applicable range of each element: [0..16777215]. Base Unit: ASIC Clk period. Function: Gives the number of ASIC Clk periods that were observed during Time Frame #i of the corresponding second (the Time Frame intervals are delimited by the following active edges of the Clk8Hz signal). Purpose: To monitor the differential drift between the Clk8Hz signal and the ASIC Clk oscillator. Boundary conditions: When adding the TimeClkMonTF_i values over a given period, the exact number of clocks produced over this period is obtained. Short-term and/or long-term drifts can thus be derived. – Units: n/a
E3519	60060/1 65060/1		PSD						Last HSL identifier sent to DFEE: label Mirrors the last DFEE identifier label that was sent from the PSD to the DFEE.
E3520	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8520			Library selection for detector n° 13: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 13.
E3521	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8521			Event word decode K5 for detector n° 13: (0; 31) Not used
E3522	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8522			Number of time steps for detector n° 13: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 13.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3523	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8523			Number of templates for detector n° 13: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 13. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 13.
E3524	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8524			Decode parameter K3 for detector n° 13: (0; 255) range (0; 100) Not used

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3525	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8525			Library selection for detector n° 14: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 14.
E3526	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8526			Event word decode K5 for detector n° 14: (0; 31) Not used
E3527	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8527			Number of time steps for detector n° 14: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 14.
E3528	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8528			Number of templates for detector n° 14: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 14. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 14.
E3529	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8529			Decode parameter K3 for detector n° 14: (0; 255) range (0; 100) Not used
E3530	60060/1 65060/1		PSD	E/F0328	E/F0308				Last HSL identifier sent to DFEE: flag Mirrors the last DFEE identifier processing flag that was sent from the PSD to the DFEE.
E3531-E3532	60000/1.8 65000/1.8		DFEE	E/F0328	E/F0308				CntPsdDropped sec 1 to sec 8) Type: 16-bit unsigned integer. Applicable range: [0..65535]. Function: Gives the number of PE events that were demoted to SE over the corresponding second, due to the presence of the "Non Processed" Flag in the PSD Identifier. Purpose: To monitor the activity of the PSD, and allow for consistency checks with the SE, ME, PE and SP scientific data. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval – Units: n/a
E3533	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8533			Library selection for detector n° 15: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 15.
E3534	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8534			Event word decode K5 for detector n° 15: (0; 31) Not used
E3535	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8535			Number of time steps for detector n° 15: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 15.
E3536	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8536			Number of templates for detector n° 15: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 15. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 15.
E3537	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8537			Decode parameter K3 for detector n° 15: (0; 255) range (0; 100) Not used

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3538	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8538			Library selection for detector n° 16: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 16.
E3539	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8539			Event word decode K5 for detector n° 16: (0; 31) Not used
E3540	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8540			Number of time steps for detector n° 16: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 16.
E3541	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8541			Number of templates for detector n° 16: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 16. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 16.
E3542	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8542			Decode parameter K3 for detector n° 16: (0; 255) range (0; 100) Not used
E3543									Spares
E3544-E3551	60004/15-22 65004/15-22		DFEE						Count Veto Gate Above (CntVetoAbove): Type: 24-bit unsigned integer. Applicable range: [0..16777215]. Function: Gives the number of times when the original ACS veto pulse was declared as below threshold (AC saturating condition, counted over the corresponding second. Purpose: To monitor the activity of the ACS. The value is not a measurement of the actual number of ACS Veto signals above threshold that were received, since internal overlap may occur in the DFEE when building the "above" veto gate. Boundary conditions: The upper bound value is returned if the counter goes into saturation during the counting interval. This should never happen at the targeted ASIC frequency. – Units: n/a
E3552	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8552			Library selection for detector n° 17: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 17.
E3553	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8553			Event word decode K5 for detector n° 17: (0; 31 Not used
E3554	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8554			Number of time steps for detector n° 17: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 17.
E3555	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8555			Number of templates for detector n° 17: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 17. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 17.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3556	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8556			Decode parameter K3 for detector n° 17: (0; 255) range (0; 100) Not used
E3557	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8557			Library selection for detector n° 18: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 18.
E3558	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8558			Event word decode K5 for detector n° 18: (0; 31) Not used
E3559	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8559			Number of time steps for detector n° 18: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 18.
E3560	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8560			Number of templates for detector n° 18: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 18. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 18.
E3561	63843/9 68843/9	64037 69037	PSD	E/F0328	E/F0308	E8561			Decode parameter K3 for detector n° 18: (0; 255) range (0; 100) Not used
E3562-E3569	60000/1.8 65000/1.8		DFEE						OBT: On-board Time – Units: cuc time
E3570-E3602									Spare
E3603	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8603	A 6347		Global Front End trigger for Operational, Calibration, Standby, and Configuration modes Defines the first of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set just above the noise level. The parameter is only affecting the PSD trigger characteristics if the PSD is either commanded into operational, calibration, standby, or configuration mode.
E3604	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8604	A 6346 A 6446		Low level discriminator for Operational, Calibration, Standby, and Configuration modes LSB: If E3605 = 0 use A 6346 if not use A 6446 Together with E3605, this parameter defines the second of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set above the global front-end trigger level. The parameter is only affecting the PSD trigger characteristics if the PSD is either commanded into operational, calibration, standby, or configuration mode.
E3605	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8605			Low level discriminator for Operational, Calibration, Standby, and Configuration modes MSB: Together with E3604, this parameter defines the second of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set above the global front-end trigger level. The parameter is only affecting the PSD trigger characteristics if the PSD is either commanded into operational, calibration, standby, or configuration mode.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3606	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8606	A 6345		Time window for Operational, Calibration, Standby, and Configuration modes : Defines the time window during which the detector pulse must raise above both the global front-end trigger level and the low-level discriminator level. This time window is applied globally to all 19 detection chains. The parameter is only affecting the PSD trigger characteristics if the PSD is either commanded into operational, calibration, standby, or configuration mode.
E3607	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8607	A 6344		Gain Control for Operational, Calibration, Standby, and Configuration modes : Defines the gain range for the detector pulses. This parameter does not affect the trigger characteristics. The parameter is only affecting the PSD if it is either commanded into operational, calibration, standby, or configuration mode.
E3608-E3609						E8608-E8609			Spares
E3610-E3628	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8610-E8628	A 6322		Disable/Enable for detector n°0 to n° 18 for Diagnostic mode : Enables or disables the 19 detection chains individually. Disabled detection chains do not lead to PSD event triggers, neither they are taken into account for multiple detector event suppression. The parameter is only affecting the PSD trigger characteristics if the PSD is commanded into diagnostic mode.
E3629	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8629	A 6347		Global Front End trigger for Diagnostic mode : Defines the first of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set just above the noise level. The parameter is only affecting the PSD trigger characteristics if the PSD is commanded into diagnostic mode.
E3630	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8630	A 6346		Low level discriminator for Diagnostic mode LSB: Together with E3631, this parameter defines the second of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set above the global front-end trigger level. The parameter is only affecting the PSD trigger characteristics if the PSD is commanded into diagnostic mode.
E3631	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8631			Low level discriminator for Diagnostic mode MSB: Together with E3630, this parameter defines the second of the two lower threshold levels that characterise the front-end trigger electronics of the PSD sub-assembly. This level is applied globally to all 19 detection chains. It should be set above the global front-end trigger level. The parameter is only affecting the PSD trigger characteristics if the PSD is commanded into diagnostic mode.
E3632	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8632	A 6345		Time window for Diagnostic mode : Defines the time window during which the detector pulse must raise above both the global front-end trigger level and the low-level discriminator level. This time window is applied globally to all 19 detection chains. The parameter is only affecting the PSD trigger characteristics if the PSD is commanded into diagnostic mode.
E3633	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8633	A 6344		Gain Control for Diagnostic mode : Defines the gain range for the detector pulses. This parameter does not affect the trigger characteristics. The parameter is only affecting the PSD if it is commanded into diagnostic mode.
E3634-E3642									Spares

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3643-E3646	63843/6 68843/6	64034 69034	PSD	E/F0325	E/F0305	E8643-E8646			<u>Gain adjustement for converter n°0 to n°3 :</u> (0 ;255) – Units : n/a The gains of the 4 ADCs that digitalise the detector pulse shapes can be adjusted individually to compensate gain variations among them. This adjustment is a pure logic operation in the PSD software, and does not alter the pulse shapes transmitted in the telemetry.
E3647-E3649	63843/6 68843/6	64034 69034	PSD	E/F0325	E/F0305	E8647-E8649			<u>Offset adjustement for converter n°0 to n°2 :</u> (0 ;255) – Units : n/a The offsets of the first 3 ADCs that digitalise the detector pulse shapes can be adjusted individually to compensate offset variations among them. This adjustment is a pure logic operation in the PSD software, and does not alter the pulse shapes transmitted in the telemetry.
E3650-E3668	63843/1 68843/1	64029 69029	PSD	E/F0320	E/F0300	E8650-E8668	A 6322		<u>Disable/Enable for detector n°0 to n°18 for Operational, Calibration, Standby, Configuration modes:</u> – Units : n/a Enables or disables the 19 detection chains individually. Disabled detection chains do not lead to PSD event triggers, neither they are taken into account for multiple detector event suppression. The parameter is only affecting the PSD trigger characteristics if the PSD is either commanded into operational, calibration, standby, or configuration mode.
E3669					E0301	E8669			<u>Overall Low Threshold:</u> deleted
E3670-E3688	63843/2-3 68843/2-3	64030 64031 69030 69031	PSD	E/F0321 E/F0322	E/F0301 E/F0302	E8670-E8688			<u>Low Threshold for detector n°0 to n°18 :</u> (0 ;65535) – Units : n/a Lower energy thresholds that specify the energy range for the events to be processed by the PSD sub-assembly for all 19 detection chains individually. All events falling in this energy range show a processing flag of 1, events outside this energy range have a processing flag of 0.
E3689						E8689			Deleted
E3690-E3708	63843/4-5 68843/4-5	64032 64033 69032 69033	PSD	E/F0323 E/F0324	E/F0303 E/F0304	E8690-E8708			<u>High Threshold for detector n°0 to n°18 :</u> (0 ;65535) – Units : n/a Upper energy thresholds that specify the energy range for the events to be processed by the PSD sub-assembly for all 19 detection chains individually. All events falling in this energy range show a processing flag of 1, events outside this energy range have a processing flag of 0.
E3709	63843/6 68843/6	64034 69034	PSD	E/F0325	E/F0305	E8709			<u>Offset adjustement for converter n°3 :</u> (0 ;255) – Units : n/a The offset of the last (4th) ADC that digitalises the detector pulse shapes can be adjusted individually to compensate offset variations among the 4 ADCs. This adjustment is a pure logic operation in the PSD software, and does not alter the pulse shapes transmitted in the telemetry.
E3710	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8710			<u>Library selection for detector n° 0 :</u> (0 ; 7) range (0 ; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 0.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3711	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8711			Event word decode K5 for detector n° 0: (0; 31) Not used
E3712	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8712			Number of time steps for detector n° 0: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 0.
E3713	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8713			Number of templates for detector n° 0: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 0. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 0.
E3714	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8714			Decode parameter K3 for detector n° 0: (0; 255) range (0; 100) Not used
E3715	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8715			Library selection for detector n° 1: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 1.
E3716	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8716			Event word decode K5 for detector n° 1: (0; 31) Not used
E3717	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8717			Number of time steps for detector n° 1: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 1.
E3718	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8718			Number of templates for detector n° 1: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 1. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 1.
E3719	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8719			Decode parameter K3 for detector n° 1: (0; 255) range (0; 100) Not used
E3720	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8720			Library selection for detector n° 2: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 2.
E3721	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8721			Event word decode K5 for detector n° 2: (0; 31) Not used
E3722	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8722			Number of time steps for detector n° 2: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 2.
E3723	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8723			Number of templates for detector n° 2: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 2. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 2.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3724	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8724			Decode parameter K3 for detector n° 2: (0; 255) range (0; 100) Not used
E3725	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8725			Library selection for detector n° 3: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 3.
E3726	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8726			Event word decode K5 for detector n° 3: (0; 31) Not used
E3727	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8727			Number of time steps for detector n° 3: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 3.
E3728	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8728			Number of templates for detector n° 3: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 3. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 3.
E3729	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8729			Decode parameter K3 for detector n° 3: (0; 255) range (0; 100) Not used
E3730	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8730			Library selection for detector n° 4: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 4.
E3731	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8731			Event word decode K5 for detector n° 4: (0; 31) Not used
E3732	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8732			Number of time steps for detector n° 4: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 4.
E3733	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8733			Number of templates for detector n° 4: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 4. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 4.
E3734	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8734			Decode parameter K3 for detector n° 4: (0; 255) range (0; 100) Not used
E3735	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8735			Library selection for detector n° 5: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 5.
E3736	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8736			Event word decode K5 for detector n° 5: (0; 31) Not used

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E3737	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8737			Number of time steps for detector n° 5: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 5.
E3738	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8738			Number of templates for detector n° 5: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 5. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 5.
E3739	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8739			Decode parameter K3 for detector n° 5: (0; 255) range (0; 100) Not used
E3740	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8740			Library selection for detector n° 6: (0; 7) range (0; 1) Specifies which of the two template libraries that are stored in the PSD EEPROMs is used for the scientific analysis of detector n° 6.
E3741	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8741			Event word decode K5 for detector n° 6: (0; 31) Not used
E3742	63843/7 68843/7	64035 69035	PSD	E/F0326	E/F0306	E8742			Number of time steps for detector n° 6: (0; 255) range (6; 64) Specifies the number of time steps of a library template that are used for the scientific analysis of detector n° 6.
E3743	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8743			Number of templates for detector n° 6: (0; 255) range (0; 50) Specifies the number of library templates that are used for the scientific analysis of detector n° 6. This parameter is required to decode the scientific PSD word that is associated to each event of detector n° 6.
/E3744	63843/8 68843/8	64036 69036	PSD	E/F0327	E/F0307	E8744			Decode parameter K3 for detector n° 6: (0; 255) range (0; 100) Not used
E3745-E3748 E3749-E3752						E8745-E8748 E8749-E8752			Spares Deleted
		N/a	PSD	N/a	E/F0310	E8753			Detector selection : (0 ;255) range (0 ; 18) – Units : n/a For library upload into PSD EEPROM, specifies the detector to which the actual library pulse shape, stored in E3760-E3823, corresponds.
		N/a	PSD	N/a	E/F0310	E8754			Curve Selection : (0 ;255) range (0 ; 255) – Units : n/a For library upload into PSD EEPROM, specifies the template index (or library pulse number) to which the actual library pulse shape, stored in E3760-E3823, corresponds. A value of 255 represents a special case. In this case, parameters E3760-E3823 do not contain a library template, but a set of algorithm configuration parameters that control details of the scientific PSD on-board analysis algorithm.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
		N/a	PSD	N/a	E/F0310	E8755			Set Number : (0 ;255) range (0 ; 1) – Units : n/a For library upload into PSD EEPROM, specifies the set number to which the actual library pulse shape, stored in E3760-E3823, corresponds. There is EEPROM memory for 2 library sets available.
		N/a	PSD	N/a	E/F0310	E8756			Nb of data items : (0 ;255) range (1 ; 64) For library upload into PSD EEPROM, specifies the number of data items that should be copied into EEPROM.
		N/a	PSD	N/a	E/F0310	E8757			CRC : – Units : n/a Checksum for the 64 data items stored in E3760-E3823 for library upload. A library is only written into EEPROM if the checksum specified by this parameter corresponds to the checksum of the 64 data items. The checksum if the sum of all Bytes in the 64 data items.
E3758	63843/2	64030	PSD	E0321	E/F0301	E8758			Number of postprocessed events after 8Hz edge : (0 ; 255) range (0, 10) After the falling 8 Hz clock, the PSD may be allowed to process a couple of events before preparation of the HSL transfer buffer. This parameter specifies the number of events that may be post-processed. Note that for each post processed event an additional time delay of about 1.25 ms is added between the 8 Hz clock falling edge and the preparation of the HSL transfer buffer.
E3758-E3759									Spares
		N/a	PSD		E/F0310- E/F0316	E8760-E8823			Data (64 samples) : (0 ;2**24) – Units : n/a The meaning of these parameters depends on the value of the curve selection parameter E3754. 1. Curve selection (E3754) < 255 : Specifies the library template values for library upload into PSD EEPROM. Each of the 64 values is a 24 Bit signed integer value that is converted internally into a floating-point number before storing into EEPROM. The destination of the library template in EEPROM is derived from the set number (E3755), the detector number (E3753), and the curve number (E3754). 2. Curve selection (E3754) = 255 : Specifies algorithm configuration parameters that control details of the scientific PSD on-board analysis algorithm.
E3824	60060/1 65060/1		PSD				Cc 6352		+ 5 V digital: – Units: V
E3825	60060/1 65060/1		PSD				Cc 6352		+ 5 V analogue: – Units: V
E3826	60060/1 65060/1		PSD				Cc 6353		- 5 V analogue: – Units: V
E3827	60060/1 65060/1		PSD				Cc 6354		A/D global offset: – Units: V
E3828	60060/1 65060/1		PSD				Cc 6411		DSP non memory board temperature – Units: degC
E3829	60060/1 65060/1		PSD				Cc 6411		A/D board temperature:
E3830	60060/1 65060/1		PSD				Cc 6412		Analogue Mux 2 board temperature
E3831	60060/1 65060/1		PSD				Cc 6412		Analogue Max 1 board temperature:

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E3832	60060/1 65060/1		PSD						Command count: – Units: n/a (0; 65535) Rollover counter that counts the number of accepted commands that were received by the PSD sub-assembly.
E3833	60060/1 65060/1		PSD				A 6351		Last received Command Code: – Units: n/a (67; 82) Mirrors the last accepted command code that has been received by the PSD sub-assembly, excluding housekeeping requests.
E3834	60060/1 65060/1		PSD				A 6352		Last received Command Identifier: – Units: n/a (1; 89) Mirrors the last accepted command identifier that has been received by the PSD sub-assembly, excluding housekeeping requests.
E3835	60060/1 65060/1		PSD						Last Identifier sent to DFEE detector number: – Units: n/a (0; 18) Mirrors the detector number of the last DFEE identifier that was sent from the PSD to the DFEE.
E3836	60060/1 65060/1		PSD						8 Hz counter: – Units: n/a (0; 65535) Rollover counter that counts the number of 8 Hz clocks that have been received by the PSD sub-assembly.
E3837-E3838	60060/2 65060/2		PSD						Events in buffer n° 0 and n° 1: – Units: n/a (0; 255) Specifies the number of events that are actually stored in the flip-flop event buffers 0 and 1.
E3839	60060/2 60060/2		PSD						Curves in buffer n° 0: – Units: n/a (0; 255) Specifies the number of curves that are actually stored in the flip-flop curve buffers 0 and 1.
E3840-E3858	60060/2.3 65060/2.3		PSD				Cc 6355		Channel rate for detector n° 0 to n° 18: – Units: number of events per 64 seconds
E3859	60060/1 65060/1		PSD						See E3839 (0; 255)
E3860-E3878	60060/3.4 65060/3.4		PSD				Cc 6355		Nb of SE for detector n° 0 to n° 18: (0; 63488) – Units : counts per 64 seconds Specifies for each detection chain the number of analysed events that were identified as single-site events by the on-board scientific pulse shape analysis. Note that the raw value is an unsigned 16 Bit integer that is compressed into 8 Bits, using a 5 Bit mantissa and a 3 Bit exponent.
E3879	60060/2 65060/2		PSD						Error count since last Power-On: – Units: n/a (0; 255) Rollover counter that counts the number of runtime errors that occurred since the last power-on.
E3880	60060/2 65060/2		PSD				A 6350		Last error type: – Units: n/a (1; 128) Mirrors the last runtime error type that occurred in the PSD sub-assembly.
	240108		IASW						AFEE status:
E/F3881							A 6319	A 6319	Current mode – Units: n/a
E/F3882							A 6381	A 6381	Self-test status – Units: n/a
E/F3883							A 6002	A 6002	All command initiated status

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	240108		IASW						DFEE status:
E/F3884							A 6319	A 6319	Current mode – Units: n/a
E/F3885							A6381	A6381	Self-test status – Units: n/a
E/F3886							A 6002	A 6002	All command initiated status
	240108		IASW						ACS status:
E/F3887							A 6319	A 6319	Current mode – Units: n/a
E/F3888							A 6381	A 6381	Self-test status – Units: n/a
E/F3889							A 6002	A 6002	All command initiated status
	240108		IASW						PSD status:
E/F3890							A 6319	A 6319	Current mode – Units: n/a
E/F3891							A6381	A6381	Self-test status – Units: n/a
E/F3892							A6002	A6002	All command initiated status
E3893	63843/10 68843/10	64038 69038	PSD	E/F0329	E/F0309	E8893			Nb of curves per 8Hz cycle for operational mode : For operational mode, specifies the maximum number of curves that are sent for each 8 Hz cycle on the HSL to the DPE. If the PSD is not commanded into operational mode, this parameter is meaningless.
E3894	63843/10 68843/10	64038 69038	PSD	E/F0329	E/F0309	E8894			Periodicity (in 8 Hz cycles) for searching one curve for operational mode : For operational mode, specifies the periodicity of transmitting a single curve on the HSL to the DPE. If parameter E3893 is non-zero, this parameter is meaningless. Also, if the PSD is not commanded into operational mode, this parameter is meaningless.
E3895	63843/10 68843/10	64038 69038	PSD	E/F0329	E/F0309	E8895			Nb of curves per 8Hz cycle for calibration and diagnostic modes : For calibration and diagnostic mode, specifies the maximum number of curves that are sent for each 8 Hz cycle on the HSL to the DPE. If the PSD is not commanded into calibration or diagnostic mode, this parameter is meaningless.
E3896	63843/10 68843/10	64038 69038	PSD	E/F0329	E/F0309	E8896			Periodicity (in 8 Hz cycles) for searching one curve for calibration and diagnostic modes : For calibration and diagnostic mode, specifies the periodicity of transmitting a single curve on the HSL to the DPE. If parameter E3895 is non-zero, this parameter is meaningless. Also, if the PSD is not commanded into calibration or diagnostic mode, this parameter is meaningless.
E3897-E3899									Spares
E/F3900	63843/13 68843/13	64041 69041	IASW	E/F0525	E/F0500	E/F8900	A 6306	A 6306	AFEE ON/OFF Status: Information given to the IASW to define witch s/a is powered or not: 0 = OFF 1 = ON – Units: n/a
E/F3901	63843/13 68843/13	64041 69041	IASW	E/F0525	E/F0500	E/F8901	A 6306	A 6306	DFEE ON/OFF Status: Information given to the IASW to define witch s/a is powered or not: 0 = OFF 1 = O – Units: n/a
E/F3902	63843/13 68843/13	64041 69041	IASW	E/F0525	E/F0500	E/F8902	A 6306	A 6306	ACS ON/OFF Status: Information given to the IASW to define witch s/a is powered or not: 0 = OFF 1 = O – Units: n/a

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E/F3903	63843/13 68843/13	64041 69041	IASW	E/F0525	E/F0500	E/F8903	A 6306	A 6306	PSD ON/OFF Status: Information given to the IASW to define witch s/a is powered or not: 0 = OFF 1 = O – Units: n/a
					E/F0507- E/F0512	E/F8904			Memory load start address 1 2 3: encoded by 3 bytes – Units: n/a
E3905-E3906						E8905-E8906			Spares
					E/F0507- E/F0512	E/F8907			Nb of bytes to be loaded: (0; 255)
E/F3908-E/F3931		64042- 64044 69042- 69044	IASW	E/F0513 E/F0515	E/F0507- E/F0512	E/F8908-E/F8931			24 data to be loaded: (0; 255) – Units: n/a
E/F3932		64042- 64044 69042- 69044	IASW	E/F0513- E/F0515		E/F8932			Memory dump start address 1 2 3: encoded by 3 bytes – Units: n/a
E3933-E3934									Spares
E/F3935		64042- 64044 69042- 69044	IASW	E/F0513- E/F0515		E/F8935			Nb of bytes to be dumped: (0; 24) – Units: n/a
E/F3936	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8936	A 6317	A 6317	Radiation mode: Mode in which the SPI is automatically put during flare and radiation belts 2 = stand-by 3 = configuration – Units: n/a
E/F3937	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8937	A 6308	A 6308	High background count detection capability : Enable/disable the function that takes into account the radiation monitor information in the broadcast packet. When the function is disabled, the IASW considers that there is no flare 0 = disable 1 = enable – Units : n/a Parameters related to this function are E8938, E8939, E8940, E8941
E/F3938	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8938			Counting threshold for radiation overflow : Flare begins if the radiation monitor counter given in the broadcast packet is higher than this threshold during more than N consecutive BCPs (N is the filter value E8939) Minimum value = 0 Maximum value = 655355 – Units : n/a

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E/F3939	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8939			Counting filter for radiation overflow : Flare begins if the radiation monitor counter given in the broadcast packet is higher than the threshold value (E8938) during more than N consecutive BCPs (N being the value of this filter) Minimum value = 0 Maximum value = 32767 – Units : n/a
E/F3940	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8940			Counting threshold for radiation nominal level : Flare ends if the radiation monitor counter given in the broadcast packet is lower than this threshold during more than M consecutive BCPs (M is the filter value E8941) Minimum value = 0 Maximum value = 65535 – Units : n/a
E/F3941	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8941			Counting filter for radiation nominal level : Flare ends if the radiation monitor counter given in the broadcast packet is lower than the threshold value (E8940) during more than M consecutive BCPs (M being the value of this filter) Minimum value = 0 Maximum value = 32767 – Units : n/a
E/F3942	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8942			Counting filter parameter for cold plate temperature monitoring : If at least two cold plate temperatures are over their thresholds (see E8964, E8965, E8966, E8967) during P or more 640 s cycle the SPI is put in standby mode and the automatic reconfiguration is disabled (P is the filter value) Minimum value = 1 Maximum value = 15 – Units : 640 s cycle
E/F3943	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8943	A 6372	A 6372	AFFE Energy mode : When this parameter is set to automatic, the spectra are built as follows : when energy range bit is 0 the photon is taken into account in low energy spectrum and when energy range bit is 1 the photon is taken into account in high energy spectrum. When this parameter is set to manual, all the photon are taken into account in the low energy spectrum which in this case goes from 0 keV to 8MeV. This parameter is taken into account only at next transition to operationnal mode The ground operation has to guarantee that this parameter and AFEE configuration parameters (E5090..E5108) are consistent. 0 = automatic 1 = manual – Units : n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3944	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8944	A 6308	A 6308	<u>Automatic reconfiguration capability :</u> Enable/disable the automatic reconfiguration after flare, radiation belts, eclipse and esam. When the automatic reconfiguration is enabled the SPI is automatically put in the mode in which it was before the flare, radiation belts or eclipse. The configuration commands and patches are automatically sent on-board to the S/A. In the case of an ESAM, the SPI stays in standby or conf mode according to the mode in which it was before. The configuration commands and patches are not sent to the S/A. When the automatic configuration is disabled, the SPI is left in its current mode at the end of flare, radiation belts, eclipse and ESAM. 0 = disable 1 = enable – Units : n/a
E3945						E8945			Spares
E/F3946	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8946	A 6308		<u>Radiations belts crossing detection capability :</u> Enable/disable the function that takes into account the radiation belts information in the broadcast packet. When the function is disabled, the IASW considers that the SPI is outside the radiation belts 0 = disable 1 = enable – Units : n/a Parameters related to this function are E8947, E8948, E8949, E8950, E8951, E8952
E/F3947	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8947	Cc 6414		<u>Delay before radiation belts</u> IASW enters in radiation belts at time given by BCP radiation belts entry time Minimum value = 0 Maximum value = 4294967295 Eng value = 16777215,9960375 sec – Units : seconds
E3948						E8948			<u>Delay before radiation belts</u> Deleted
E/F3949	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8949	Cc 6329		<u>ACS ROM-RAM delay</u> Delay after sending init command before sending patch command for copying from ROM to RAM of the S/A in order to set up variable areas by default values. Units: nb of 8 Hz cycle Minimum value = 0 Maximum value = 255 –Units: seconds
E/F3950	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8950	Cc 6414		<u>Delay after radiation belts</u> IASW exits out of radiation belts at time given by BCP radiation belts exit time Minimum value = 0 Maximum value = 4294967295 Eng. value = 16777215,99609375 sec – Units : seconds
E3951						E8951			Deleted

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3952	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8952	Cc 6329		PSD ROM-RAM delay Delay after sending init command before sending patch command for copying from ROM to RAM of the S/A in order to set up variable areas by default values. Units = seconds Minimum value = 0 Maximum value = 255
E/F3953	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8953	A 6308	A 6308	Imminent eclipse detection capability : Enable/disable the function that takes into account the eclipse information in the broadcast packet. When the function is disabled, the IASW considers that there is no eclipse 0 = disable 1 = enable – Units : n/a Parameters related to this function are E8954, E8955, E8956, E8957, E8958, E8959
E/F3954	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8954	Cc 6414	Cc 6414	Delay before eclipse IASW enters in eclipse when OBT is included between the time given by BCP eclipse entry time . Minimum value = 0 Maximum value = 4294967295 Eng. value = 16777215,99609375 – Units : seconds
E3955						E8955			Deleted
E/F3956	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8956	Cc 6329		DFEE ROM-RAM delay Delay after sending init command before sending patch command for copying from ROM to RAM of the S/A in order to set up variable areas by default values. Units = seconds Minimum value = 0 Maximum value = 255
E3957 E3958 E3959						E8957 E8958 E8959			Deleted Deleted Deleted
E/F3960	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8960	A 6308	A 6308	Imminent switch off detection capability : Enable/disable the function that takes into account imminent switch off information in the broadcast packet. When the function is disabled, the IASW considers that there is no imminent switch off 0 = disable 1 = enable – Units : n/a
E/F3961	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8961	A 6308	A 6308	ESAM detection capability : Enable/disable the function that takes into account the ESAM information in the broadcast packet. When the function is disabled, the IASW considers that there is no ESAM 0 = disable 1 = enable – Units : n/a

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3962	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8962	A 6308		AFEE LVPS temperature monitoring capability : Enable/disable the AFEE LVPS temperature monitoring on-board When the LVPS temperature monitoring is enabled, if one AFEE LV temperature is higher than the threshold value during P or more 8 s cycle the corresponding AFEE LV is switched off by IASW (P is the filter value) 0 = disable 1 = enable – Units : n/a Parameters related to this function are E8977, E8978
E/F3963	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8963	A 6308		Cold plate temperature monitoring capability : Enable/disable the cold plate temperature monitoring on-board. When the cold plate temperature is enabled, in case of too high temperature, the SPI is put in standby mode and the automatic reconfiguration is disabled. This monitoring should be enabled just after the Ge detector high voltage switching ON. This monitoring should be disabled when the cryocoolers are switched off and especially when an annealing phase is started. 0 = disable 1 = enable – Units : n/a Parameters related to this function are E8942, E8964, E8965, E8966, E8967
E/F3964	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8964	Cc 6330	Cc 6330	Sensor (E0391) temperature threshold : If at least two cold plate temperatures are over their thresholds (see also E8965, E8966, E8967) during P (see E8942) or more 640 s cycle the SPI is put in standby mode and the automatic reconfiguration is disabled (P is the filter value) Minimum value = 0 (raw value) Maximum value = 4095 (raw value) – Units : K (eng value)
E/F3965	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8965	Cc 6330	Cc 6330	Sensor (E0392) temperature threshold : If at least two cold plate temperatures are over their thresholds (see also E8964, E8966, E8967) during P (see E8942) or more 640 s cycle the SPI is put in standby mode and the automatic reconfiguration is disabled (P is the filter value) Minimum value = 0 (raw value) Maximum value = 4095 (raw value) – Units : K (eng value)

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3966	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8966	Cc 6330	Cc 6330	<u>Sensor (E0393) temperature threshold :</u> If at least two cold plate temperatures are over their thresholds (see also E8964, E8965, E8967) during P (see E8942) or more 640 s cycle the SPI is put in standby mode and the automatic reconfiguration is disabled (P is the filter value) Minimum value = 0 (raw value) Maximum value = 4095 (raw value) – Units : K (eng value)
E/F3967	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8967	Cc 6330	Cc 6330	<u>Sensor (E0394) temperature threshold :</u> If at least two cold plate temperatures are over their thresholds (see also E8964, E8965, E8966) during P (see E8942) or more 640 s cycle the SPI is put in standby mode and the automatic reconfiguration is disabled (P is the filter value) Minimum value = 0 (raw value) Maximum value = 4095 (raw value) – Units : K (eng value)
E/F3968	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8968	A 6308	A 6308	<u>Correlation capability :</u> Enable/disable the correlation between DFEE science data information and PSD science data information. It shall be guaranteed on ground that the correlation is always enabled in emergency and calibration mode. 0 = disable 1 = enable – Units : n/a Warning: when there is a correlation failure, the IASW puts #0000# pattern instead of science data in the PE sub-block. The following cases should be considered as correlation failure: - No PSD event matching a DFEE one: this is a single correlation failure, - No event in PSD HSL datablock: there is a correlation failure on all PE events, - If the PSD HSL data block is not readable: there is a correlation failure on all PE events. When PSD is OFF, ground operator has to disable the correlation capability parameter
E/F3969	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8969			<u>HK acquisition rate :</u> Number of technological HK acquisition per 125 ms Minimum value = 0 Maximum value = 1 – Units : n/a
E/F3970	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8970			<u>Length of the block HSL DFEE :</u> Length of the HSL DFEE enable in 16 bits words This parameter is taken into account only at next transition to operational mode Minimum value = 0 Maximum value = 24576 – Units : 16 bits words This parameter has to be consistent with DFEE configuration parameter E7783

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3971	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8971			Cyclic LSL error filter * Number of times a command towards a S/A is repeated when a LSL error occurs. Minimum value = 0 Maximum value = 255 – Units : N/A
E/F3972	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8972	Cc 6325	Cc 6325	Delay before autotest acquisition : Delay (in 8 Hz cycles) between the reception by IASW of a Conf On Off_TC and the sending of HK 0 Command to S/A Minimum value = 0 Maximum value = 32767 (raw value) – Units : seconds (eng value)
E/F3973	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8973	Cc 6325	Cc 6325	Delay before configuration acquisition : Delay (in 8 Hz cycles) between the sending by IASW of the last Conf command in automatic operational status and the sending of HK 0 Command to S/A Minimum value = 0 Maximum value = 32767 (raw value) – Units : seconds (eng value)
E/F3974	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8974	A 6335	A 6335	Constituents of the spectra in Emergency TM mode: This parameter indicates to IASW with which energy the spectra should be built in emergency mode 0 = SP + All PE that can be correlated 1 = SP + multiple PE – Units : n/a In emergency mode the SP must be constituted by single events only therefore the DFEE spectra Mode (E7782) must be set in the right value
E/F3975	63843/12 68843/12	64040 69040	IASW	E/F0524	E/FO519	E/F8975	A6403	A6403	Spectra /photon priority: This parameter indicates which is the higher priority for TM download between spectra and photon Minimum value = 0=photon >spectra (spectra-low/photon-medium) Maximum value=1=spectra>photon (spectra-medium/photon-low) - Units : n/a
E/F3976	63843/12 68843/12	64040 69040	IASW	E/F0524	E/F0519	E/F8976			Spectra accumulation duration : This parameter gives the maximum spectra accumulation duration for IASW in case of long dithering exposure. When this parameter is set to 0 no spectra are built and downloaded. This parameter is taken into account only at next transition to operationnal mode.This value is expressed in seconds (raw value = eng value). This parameter will be adjusted during the commissioning phase. Then, it is not foreseen to modify it , not even during GPS dithering where the pointing duration is 1050s. In this specific case, there may be a lack of telemetry allocation that leads to a loss of data of one pointing every two pointings. This problem is known and the solution is considered as acceptable by the scientists. Minimum value = 0 Maximum value = 65535 seconds – Units : seconds

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3977	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8977	Cc 6326	Cc 6704	AFEE LV monitoring threshold : If one AFEE LV temperature (E0310-E0328) is higher than this value during P (see E8978) or more 8 s cycles the corresponding AFEE LV is switched off by IASW (P is the filter value) Minimum value = 0 (raw value) Maximum value = 255 (raw value) – Units : K
E/F3978	63843/11 68843/11	64039 69039	IASW	E/F0523	E/F0518	E/F8978			AFEE LV monitoring filter : If one AFEE LV temperature is higher than the threshold value during P or more 8 s cycles the corresponding AFEE LV is switched off by IASW (P is the filter value) Minimum value = 1 Maximum value = 15 Unit = 8 s cycle
E/F3979	63843/12 68843/12	64040 69040	IASW	E/F0524	E/F0519	E/F8979	A6404	A6404	Photon Processing: This parameter indicates which type of processing had to be done by IASW on Photon data. Minimum value=0=SE-filtering/ME-reduction 1=ME-reduction-only 2=SE-filtering-olny Maximum value=3=no-special-processing -Units: n/a
E/F3980	63843/11 68843/11	64039 39039	IASW	E/F0523	E/F0518	E/F8980	A6405	A6405	Spectra accumulation factor: This parameter defines the decimation factor applied to the spectra events accumulation. Minimum value=1 Maximum value=19 -Units: spectra events
E3981-E3984	60602/10 65602/10		IASW				Cc 6002		200 K cold box temperature acquisition: – Units: degC
E/F3985	60011/13 65011/13		IASW				Cc 6005	Cc 6005	AFEE I/F TM/TC Low power supply acquisition: $3.5 v \le V \ge 5.0 v$ – Units: V
E/F3986	60602/10 65602/10		IASW				Cc 6001	Cc 6001	DFEE box temperature acquisition: – Units: degC
E/F3987	60011/13 65011/13		IASW				Cc 6005	Cc 6005	DFEE Low power supply acquisition: – Units: V
E/F3988	60602/10 65602/10		IASW				Cc 6001	Cc 6001	PSD box temperature acquisition: – Units: degC
E/F3989	60011/13 65011/13		IASW				Cc 6005	Cc 6005	PSD Low power supply acquisition: – Units: V
E/F3990	60011/13 65011/13		IASW				Cc 6415	Cc 6415	VCU AC voltage monitoring: – Units: V
E/F3991	60602/10 65602/10		IASW				Cc 6001	Cc 6001	VCU temperature acquisition: – Units: degC
E/F3992	60602/10 65602/10		IASW				Cc 6002	Cc 6002	Heat pipes temperatures acquisition: – Units: degC
E/F3993	60602/10 65602/10		IASW				Cc 6002	Cc 6002	Cold link tube temperature acquisition: – Units: degC

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F3994	60602/10 65602/10		IASW				Cc 6001	Cc 6001	Active cooling radiator temperatures acquisition: – Units: degC
E/F3995	60602/10 65602/10		IASW				Cc 6001	Cc 6001	AFEE TM/TC power supply board temperature: – Units: degC
E/F3996	60602/10 65602/10		IASW				Cc 6002	Cc 6002	Heat pipes temperatures acquisition: – Units: degC
E/F3997	60602/10 65602/10		IASW				Cc 6001	Cc 6001	Active cooling radiator temperatures acquisition: – Units: degC
E/F3998	60602/10 65602/10		IASW				Cc 6005	Cc 6005	Reference channel n° 22 acquisition: "0" multiplexers reference for Analog acquisition - Units: V
E/F3999	60602/10 65602/10		IASW						Reference channel n° 23 acquisition: "0" multiplexers reference for PT 500 thermistors - Units: V
E/f4000	60602/10 65602/10		IASW						Reference channel n° 30 acquisition: "0" multiplexers reference for YSI 44908 thermistors - Units: V

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F4001	240108		DFEE						AutoTstASICnok:
E/F4002	240108		DFEE						WarnRunProg:
E/F4003	240108		DFEE						WarnHslClkOp:
E/F4004	240108		DFEE						AlrtCoherTst:
E/F4005	240108		DFEE						AlrtCoherCfg:
E/F4006	240108		DFEE						AlrtPobjPrtcl:
E/F4007	240108		DFEE						AlrtSmNRun:
E/F4008	240108		DFEE						AlrtTimeBase:
E/F4009	240108		DFEE						AlrtHslErr:
E/F4010	240108		DFEE						NoteTimeOut:
E/F4011	240108		DFEE						NoteDrop:
E/F4012	240108		DFEE						NoteItemOvf:
E/F4013	240108		DFEE						NotePobjOvf:
E/F4014	240108		DFEE						NoteDialPrtl:
E/F4015	240108		DFEE						Note8HzProgr:
E/F4016	240108		DFEE						Warn8HzAbsnt:
E/F4017	240108		DFEE						WarnDialPrty:
E4018-E4019	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 8 (odd/even seconds):
E4020-E4021	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 7 (odd/even seconds):
E4022-E4023	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 6 (odd/even seconds):
E4024-E4025	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 5 (odd/even seconds):
E4026-E4027	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 4 (odd/even seconds):
E4028-E4029	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 3 (odd/even seconds):
E4030-E4031	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 2 (odd/even seconds):
E4032-E4033	60000/1.8 65000/1.8		DFEE						Warning HSL Error Time Frame 1 (odd/even seconds):
E4034	60000/1.8 65000/1.8		DFEE						WarnRunProg (odd seconds):
E4035	60000/1.8 65000/1.8		DFEE						WarnHslClkOp (odd seconds):
E4036	60000/1.8 65000/1.8		DFEE						AlrtCoherTst (odd seconds):
E4037	60000/1.8 65000/1.8		DFEE						AlrtCoherCfg (odd seconds):

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4038	60000/1.8 65000/1.8		DFEE						AlrtPobjPrtcl (odd seconds):
E4039	60000/1.8 65000/1.8		DFEE						AlrtSmNRun (odd seconds):
E4040	60000/1.8 65000/1.8		DFEE						AlrtTimeBase (odd seconds):
E4041	60000/1.8 65000/1.8		DFEE						HslErrAct (odd seconds):
E4042-E4043	60000/1.8 65000/1.8		DFEE						WarnSpvWound (odd/even seconds):
E4044-E4045	60000/1.8 65000/1.8		DFEE						WarnStsSerHsl (odd/even seconds):
E4046-E4047	60000/1.8 65000/1.8		DFEE						WarnCoherPe Addr (odd/even seconds)
E4048-E4049	60000/1.8 65000/1.8		DFEE						WarnPobjPrtclWr (odd/even seconds):
E4050	60000/1.8 65000/1.8		DFEE						NoteTimeOut (odd seconds):
E4051	60000/1.8 65000/1.8		DFEE						NoteDrop (odd seconds):
E4052	60000/1.8 65000/1.8		DFEE						NoteItemOvf (odd seconds):
E4053	60000/1.8 65000/1.8		DFEE						NotePobjOvf (odd seconds):
E4054	60000/1.8 65000/1.8		DFEE						NoteDialPrtl (odd seconds):
E4055	60000/1.8 65000/1.8		DFEE						Note8HzProgr (odd seconds):
E4056	60000/1.8 65000/1.8		DFEE						Warn8HzAbsnt (odd seconds):
E4057	60000/1.8 65000/1.8		DFEE						WarnDialPrty (odd seconds):

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4058	60000/1.8 65000/1.8		DFEE						WarnRunProg (even seconds):
E4059	60000/1.8 65000/1.8		DFEE						WarnHslClkOp (even seconds):
E4060	60000/1.8 65000/1.8		DFEE						AlrtCoherTst (even seconds):
E4061	60000/1.8 65000/1.8		DFEE						AlrtCoherCfg (even seconds):
E4062	60000/1.8 65000/1.8		DFEE						AlrtPobjPrtcl (even seconds):
E4063	60000/1.8 65000/1.8		DFEE						AlrtSmNRun (even seconds):
E4064	60000/1.8 65000/1.8		DFEE						AlrtTimeBase (even seconds):
E4065	60000/1.8 65000/1.8		DFEE						HslErrAct (even seconds):
E4066	60000/1.8 65000/1.8		DFEE						NoteTimeOut (even seconds):
E4067	60000/1.8 65000/1.8		DFEE						NoteDrop (even seconds):
E4068	60000/1.8 65000/1.8		DFEE						NoteItemOvf (even seconds):
E4069	60000/1.8 65000/1.8		DFEE						NotePobjOvf (even seconds):
E4070	60000/1.8 65000/1.8		DFEE						NoteDialPrtl (even seconds):
E4071	60000/1.8 65000/1.8		DFEE						Note8HzProgr (even seconds):
E4072	60000/1.8 65000/1.8		DFEE						Warn8HzAbsnt (even seconds):
E4073	60000/1.8 65000/1.8		DFEE						WarnDialPrty (even seconds):
E4074 – E4099									Spares
E4100	240108		IASW						Radiation belts entry time:
E4101	240108		IASW						Radiation belts exit time:
E4102	240108		IASW						Eclipse entry time:
E4103	240108		IASW						Eclipse exit time:
E4104	240108		IASW						Disregard radiation monitor data: Minimum value=0=valid Maximum value=1=disregard
E4105	240108		IASW						Echo of PID in BCP:revolution number:
E4106	240108		IASW						Echo of PID in BCP:pointing number:
E4107	240108		IASW						Pointing duration:
E4108	240108		IASW						SPI TM share:

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4109	240108		IASW						IBIS TM share:
E4110	240108		IASW						JEM-X1 TM share:
E4111	240108		IASW						JEM-X2 TM share:
E4112	240108		IASW						OMC TM share:
E4113	240108		IASW						Imminent switch off:
E4114	240108		IASW						Ground station hand over flag:
E4115	240108		IASW						Radiation monitor count rate 1:
E4116	240108		IASW						Radiation monitor count rate 2:
E4117	240108		IASW						Radiation monitor count rate 3:
E4118	240108		IASW						OTF:
E4119	240108		IASW						AOCS modes:
E4120	240108		IASW						ESAM flag:
E4121	240108		IASW						AOCS submodes:
E4122-E4300									Spares
E4301	60000/8 60001/8 60002/8 60003/8 65000/8 65001/8 65002/8 65003/8		DFEE						Number of Second counter from START (even sec): NsecFrontStart Cf. E3301
E4302									Spare
E4303-E4306									Deleted
E4307	60000/8 60001/8 60002/8 60003/8 65000/8 65001/8 65002/8 65003/8		DFEE						Count Veto Gate (even sec) (CnVetoGate): Cf. E3307
E4308	60000/8 60001/8 60002/8 60003/8 65000/8 65001/8 65002/8 65003/8		DFEE						Count Veto Gate Dead Time (even sec) (CntVetoGateDTime): Cf. E3308

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4309	60000/8 60001/8 60002/8 60003/8 65000/8 65001/8 65002/8 65003/8		DFEE						Count PSD Time Tag (even sec) (CntPsdTT): Cf. E3309
E4310-E4319									Spares
E4320-E4338	60000/8-14 60001/8-14 60002/8-14 60003/8-14 65000/8-14 65001/8-14 65002/8-14 65003/8-14		DFEE						CntAfeeTT (even sec) Cf. E3320-E3338
E/F4339	240108		CSSW				A 6340		On-board S/W maintenance flag: 0 ⇒ no maintenance 1 ⇒ maintenance on progress – Units: n/a
E4340-E4358	60000/8-14 60001/8-14 60002/8-14 60003/8-14 65000/8-14 65001/8-14 65002/8-14 65003/8-14		DFEE						CntAfeeTTSat (even sec) Cf. E3340-E3358
E/F4359	240108		CSSW				A 6341	A 6341	Sub-assembly under maintenance: 3 ⇒ ACS under maintenance 4 ⇒ PSD under maintenance 5 ⇒ DFEE under maintenance – Units: n/a
E4360-E4378	60000/8-14 60001/8-14 60002/8-14 60003/8-14 65000/8-14 65001/8-14 65002/8-14 65003/8-14		DFEE						CntAfeeNveto (even sec) Cf. E3360-E3378

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4379									Spare
E4380-E4398	60000/8-14 60001/8-14 60002/8-14 60003/8-14 65000/8-14 65001/8-14 65002/8-14 65003/8-14		DFEE						CntAfeeDTime (even sec) Cf. E3380-E3398
E4399-E4499									Spares
E4500	60004/16 65004/16		DFEE						Count Veto Gate Below (sec 2) Cf. E3500
E4501-E4510									Spares
E4511-E4518	60004/16 65004/16		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 2) Cf. E3511-E3518
E4519									Spare
E4520	60004/17 65004/17		DFEE						Count Veto Gate Below (sec 3) Cf. E3500
E4521-E4530									Spares
E4531-E4538	60004/17 65004/17		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 3) Cf. E3511-E3518
E4539									Spare
E4540	60004/18 65004/18		DFEE						Count Veto Gate Below (sec 4) Cf. E3500
E4541-E4550									Spares
TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4551-E4558	60004/18 65004/18		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 4) Cf. E3511-E3518
E4559									Spare
E4560	60004/19 65004/19		DFEE						Count Veto Gate Below (sec 5) Cf. E3500
E4561-E4570									Spares
E4571-E4578	60004/19 65004/19		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 5) Cf. E3511-E3518
E4579									Spare
E4580	60004/20 65004/20		DFEE						Count Veto Gate Below (sec 6) Cf. E3500

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4581-E4590									Spares
E4591-E4598	60004/20 65004/20		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 6) Cf. E3511-E3518
E4599									Spare
E4600	60004/21 65004/21		DFEE						Count Veto Gate Below (sec 7) Cf. E3500
E4601-E4610									Spares
E4611-E4618	60004/21 65004/21		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 7) Cf. E3511-E3518
E4619									Spare
E4620	60004/22 65004/22		DFEE						Count Veto Gate Below (sec 8) Cf. E3500
E4621-E4630									Spares
E4631-E4638	60004/22 65004/22		DFEE						TimeClkMonTF_1 to TimeClkMonTF_8 (sec 8) Cf. E3511-E3518
E4638-E4780									Spares
E4781-E4812	60060/2.3 65060/2.3		PSD						LLD rate for 1st interval to 32nd interval – Units : counts per 2 seconds For 32 intervals of 2 seconds each, specifies the total number of lower level discriminator triggers that were registered on any of the 19 enabled detection channels.
E4813	60602/6 65602/6	64664 69664	PSD	E/F0343					RAM parameter checksum – Units: n/a Not used
E4814	60602/6 65602/6	64664 69664	PSD	E/F0343					Number of thrown away events – Units: n/a Specifies the number of events that have been accepted, but that were not processed by the PSD sub-assembly during the last 64 seconds.
E4815-E4820			PSD						Spares
E4821-E4852	60060/2.3 65060/2.3		PSD						ULD rate for 1st interval to 32th interval – Units : counts per 2 seconds For 32 intervals of 2 seconds each, specifies the total number of upper level discriminator triggers that were registered on any of the 19 enabled detection channels. Events that triggered the ULD will not be presented for scientific analysis to the PSD.
E4853-E4859									Spares
E4860-E4878	60602/5.6 65602/5.6	64663 64664 69663 69664	PSD	E/F0342 E/F0343			Cc 6357		Average baseline for detector n°0 to n° 18 – Units : digitalisation units ⇒ counts Snapshot of the average baseline value for each of the 19 detection chains.
E4879									Spares
E4880-E4898	60060/3.4		PSD				Cc 6355		Nb of ME for detector n°0 to n° 18 – Units : counts per 64 seconds Specifies for each detection chain the number of analysed events that were identified as multiple-site events by the on-board scientific pulse shape analysis. Note that the raw value is an unsigned 16 Bit integer that is compressed into 8 Bits, using a 5 Bit mantissa and a 3 Bit exponent.

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E4899									Spare
E4900-E4918	60602/5.6 65602/5.6	64663 64664 69663 69664	PSD	E/F0342 E/F0343			Cc 6356		Noise for detector n° 0 to n° 18 Not used
E4920-E4938	60000/1.8 65000/1.8		PSD				A 6322		Disable/enable for detector n° 0 to n° 18 for current configuration: Mirrors the selection of enabled and disabled detection chains that is implemented in the actual sub-assembly mode.
E4939	60602/6 65602/6	64664 69664	PSD	E/F0343			A 6347		Global Front End trigger Current configuration: Mirrors the global front-end trigger level that is implemented in the actual sub-assembly mode.
E4940	60602/6 65602/6	64664 69664	PSD	E/F0343			A 6346		Low Level discriminator Current configuration LSB: Mirrors the LSB of the low level discriminator level that is implemented in the actual sub-assembly mode.
E4941	60602/6 65602/6	64664 69664	PSD	E/F0343					Low Level discriminator Current configuration MSB: Mirrors the MSB of the low level discriminator level that is implemented in the actual sub-assembly mode.
E4942	60602/6 65602/6	64664 69664	PSD	E/F0343			A 6345		Time Window Current configuration: Mirrors the length of the time window of the front-end trigger system that is implemented in the actual sub-assembly mode.
E4943	60602/6 65602/6	64664 69664	PSD	E/F0343			A 6344		Gain Control Current Configuration: Mirrors the gain switch value that is implemented in the actual sub-assembly mode.
E9018	240108		CSSW						SPI DPE1 Number of CSSW ICB TC sub-buffer: Elts occupied:
E9019	240108		CSSW						SPI DPE1 Number of ICB Science TM sub-buffer: Elts occupied:
E9020	240108		CSSW						SPI DPE1 Nb of ICB On-request TM sub-buffer: Elts occupied:
E9021	240108		CSSW						SPI DPE1 Nb of ICB On-Event Message sub-buffer: Elts occupied:
E9022	240108		CSSW						SPI DPE1 Minimum percentage CPU margin in previous TM cycle:
E9023	240108		CSSW						SPI DPE1 Maximum percentage CPU margin in previous TM cycle:
E9024	240108		CSSW						SPI DPE1 BCP 4 Frozen Time (Most Significant word):
E9025	240108		CSSW						SPI DPE1 BCP 4 Frozen Time (Mid Significant word):
E9026	240108		CSSW						SPI DPE1 BCP 4 Frozen Time (Least Significant word):
E9027	240108		CSSW				Cc 351		SPI DPE1 DC 5 V Secondary Voltage:
E9028	240108		CSSW				Cc 352		SPI DPE1 DC RAM 5 V Secondary Voltage:
E9029	240108		CSSW				Cc 355		SPI DPE1 DC 15 V Relay Secondary Voltage:
E9030	240108		CSSW				Cc 353		SPI DPE1 DC 15 V Secondary Voltage:
E9031	240108		CSSW				Cc 354		SPI DPE1 DC -15 V Secondary Voltage:
E9032	240108		CSSW				Cc 356		SPI DPE1 DPE Hot Point Temperature:
E9033	240108		CSSW				A 301		SPI DPE1 BIT ANALOG channels:
E9034	240108		CSSW				A 301		SPI DPE1 BIT MMU registers:
E9035	240108		CSSW				A 301		SPI DPE1 BIT CPU Registers:
E9036	240108		CSSW						SPI DPE1 Microprocessor Configuration Register:
E9037	240108								SPI DPE1 PCC Control Register: Which is divided into:

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E9220									SPI DPE1 PCC Control Registerv bit 0: Enable Cf. alias table n° 2
E9221									SPI DPE1 PCC Control Register bit 1: Enable Cf. alias table n° 2
E9222									SPI DPE1 PCC Control Register bit 2: Enable Cf. alias table n° 2
E9223									SPI DPE1 PCC Control Registerv bit 3: Enable Cf. alias table n° 2
E9224									SPI DPE1 PCC Control Registerv bit 4: Enable Cf. alias table n° 2
E9225									SPI DPE1 PCC Control Registerv bit 5: Console Cf. alias table n° 321
E9226									SPI DPE1 PCC Control Registerv bit 6: Single Cf. alias table n° 322
E9227									SPI DPE1 PCC Control Registerv bit 7: Enable Cf. alias table n° 2
E9228									SPI DPE1 PCC Control Registerv bit 8-11 Cf. alias table n° 2
E9229									SPI DPE1 PCC Control Registerv bit 12-15: RTC Cf. alias table n° 323
E9038	240108		CSSW						SPI DPE1 RBI Status Word: which is divide into:
E9240									SPI DPE1 RBI Status Word bit 0: ICU (DPE) Cf. alias table n° 310
E9241									SPI DPE1 RBI Status Word bit 1: ICU (DPE) Wait Cf. alias table n° 311
E9242									SPI DPE1 RBI Status Word bit 2: DMA Busy Cf. alias table n° 312
E9243									SPI DPE1 RBI Status Word bit 3: ICU (DPE) Cf. alias table n° 313
E9244									SPI DPE1 RBI Status Word bit 4: Interrogation Cf. alias table n° 314
E9245									SPI DPE1 RBI Status Word bit 5: Interrogation Cf. alias table n° 315
E9247									SPI DPE1 RBI Status Word bit 7: Wrong Cf. alias table n° 316
E9248									SPI DPE1 RBI Status Word bit 8: Output transfer Cf. alias table n° 317
E9249									SPI DPE1 RBI Status Word bit 9-10: RBI chip flag Cf. alias table n° 318
E9250									SPI DPE1 RBI Status Word bit 11: TC source Cf. alias table n° 319
E9251									SPI DPE1 RBI Status Word bit 12-15: RTC Cf. alias table n° 320
E9039	240108		CSSW						SPI DPE1 RBI Configuration Register:
E9040	240108		CSSW						SPI DPE1 On-Event Message Counter:
E9041	240108		CSSW						SPI DPE1 Nb of OEM that DPE SW has attempted to generate with or without success:
E9042									
E9043	240108		CSSW						SPI DPE1 accepted on Ground TCP counter:
E9044	240108		CSSW						SPI DPE1 accepted On-Board TCP counter:
E9045	240108		CSSW						SPI DPE1 rejected TCP counter:
E9046	240108		CSSW				A 302		SPI DPE1 last TCP rejection reason:
E9047	240108		CSSW						SPI DPE1 8 LS Bits of the APID in the Last received TCP:
E9048	240108		CSSW				A 309		SPI DPE1 Command Source Identifier (0 = Ground; 1 = On-Board):
E9049	240108		CSSW						SPI DPE1 Source Sequence Control of the Last received TCP:
E9051	240108		CSSW						SPI DPE1 computed CRC:
E9053	240108		CSSW						SPI DPE1 Number of IASW ICB TC sub-buffer: Elts occupied:
E9099	240108		CSSW						Number of SPI TM packets sent to OBDH for downlink:
E9101-E9107 E9113-E9119 E9125-E9131 E9137-E9143	240108		CSSW						On-Event Message n° 1 to 8 Generation Time:
E9102-E9108 E9114-E9120 E9126-E9132 E9138-E9144	240108		CSSW						Extension of On-Event Message n° 1 to 8 (Param Id):

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E9103-E9109 E9115-E9121 E9127-E9133 E9139-E9145	240108		CSSW						On-Event Message n° 1 to 8 Class:
E9104-E9110 E9116-E9122 E9128-E9134 E9140-E9146	240108		CSSW						On-Event Message Identifier n° 1 to 8:
E9105-E9111 E9117-E9123 E9129-E9135 E9141-E9147	240108		CSSW						On-Event Message body first param n° 1 to 8:
E9106-E9112 E9118-E9124 E9130-E9136 E9142-E9148	240108		CSSW						On-Event Message body sd param n° 1 to 8:
E/F9750	240108						A 6850	A 6850	OEM 6100: Mode Change – Cause of change
E/F9751	240108						A 6851	A 6851	OEM 6100: mode change - old mode
E/F9752	240108						A 6851	A 6851	OEM 6100: mode change – new mode
E/F9753	240108						A 6852	A 6852	OEM 6101: on-board events - Begin/End
E/F9754	240108						A 6853	A 6853	OEM 6101: on-board events – type of events
E/F9755	240108						A 6854	A 6854	OEM 6102: state change – old state
E/F9756	240108						A 6854	A 6854	OEM 6102: state change – new state
E/F9757	240108						A 6855	A 6855	OEM 6103: mRTU error – error type
E/F9758	240108						A 6856	A 6856	OEM 6103: mRTU error – chanel concerned
E/F9759	240108						A 6857	A 6857	OEM 6104: LSL error – error type
E/F9760	240108						A 6858	A 6858	OEM 6104: LSL error - channel
E/F9761	240108								OEM 6104: LSL error – received nack
E/F9762	240108						A 6859	A 6859	OEM 6104: LSL error – type of telecommand
E/F9763	240108								OEM 6104: LSL error – HK or command n°
E/F9764	240108								OEM 6105: HSL error – HSL busy
E/F9765	240108						A 6860	A 6860	OEM 6106: Autotest or configuration status error – subassembly concerned
E/F9766	240108								OEM 6106: Autotest or configuration status error – high byte
E/F9767	240108								OEM 6106: Autotest or configuration status error – medium byte
E/F9768	240108								OEM 6106: Autotest or configuration status error – low byte
E/F9769	240108						A 6861	A 6861	OEM 6107: Automatic reconfiguration error – automatic step
E/F9770	240108								OEM 6108: TC not executed – source sequence count of the TC
E/F9771	240108						A 6862	A 6862	OEM 6108: TC not executed – reason of the reject
E/F9772	240108						A 6863	A 6863	OEM 6109: LVPS switch OFF – channel
E/F9773	240108						A 6864	A 6864	OEM 6110: Cold plate temperature onverflow - sensor 1
E/F9774	240108						A 6864	A 6864	OEM 6110: Cold plate temperature onverflow - sensor 2
E/F9775	240108						A 6864	A 6864	OEM 6110: Cold plate temperature onverflow - sensor 3
E/F9776	240108						A 6864	A 6864	OEM 6110: Cold plate temperature onverflow - sensor 4
E/F9777	240108								OEM 6111: Software error – Faulty task identifier
E/F9778									Deleted
E/F9779	240108								OEM 6113: Patches area overflow – patch TC source sequence count
E/F9780	240108								OEM 6119: Detector identifier

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
E/F9781									Deleted
E/F9782									Deleted
E/F9783	240108						A 6865		OEM 6116: Subblock identifier
E/F9784	240108						A 9866		OEM 6117: Spectra building – sprectra phase
E/F9785	240108						A 6867		OEM 6117: Spectra building – Revolution or pointing identifier for start or stop building
E/F9786	240108						A 6868		OEM 6118: Failure in analysing HSL data – HSL line
E/F9787	240108						A 6869		OEM 6118: Failure in analysing HSL data – Synchro word error
E/F9788	240108						A 6870		OEM 6118: Failure in analysing HSL data – error level
E/F9789									
E/F9790	240108						A 6871		OEM 6121: Packet number max per 8s exceeded – packet type
E/F9791									Deleted
E/F9792	240108						A 6872		OEM 6122: Photon/Photon buffer reading error – error type
E/F9793	240108								OEM 6122: Photon/Photon buffer reading error – new physical page
E/F9794	240108								OEM 6122 Photon/Photon buffer reading error – error type: Photon/Photon buffer reading error – new index
E/F9795-E/F9800									Spares
E/F9801	200500		RTU						DPE Relay 0 Status: – Units: n/a
E/F9802	200500		RTU						DPE Relay 1 Status: – Units: n/a
F9960	200000		SRTU						CDE 1 Compressor 1 drive amplitude
F9961	200000		SRTU						CDE 1 Compressor 2 drive amplitude
F9962	200000		SRTU						CDE 1 Temperature 1
F9963	200000		SRTU						CDE 1 Temperature 2
F9964	200000		SRTU						CDE 1 Displacer 1 drive amplitude
F9965	200000		SRTU						CDE 1 Displacer 2 drive amplitude
F9966	200000		SRTU						CDE 1 Temperature 3
F9967	200000		SRTU						CDE 1 Temperature 4
F9968	200001		SRTU						CDE 1 Compressor 1 demand signal
F9969	200001		SRTU						CDE 1 Compressor 2 demand signal
F9970	200000		SRTU						CDE 1 Relay status
F9971	200000		SRTU						CDE 1 Stand-by/operational mode status
F9972	200000		SRTU						CDE 1 Launch lock mode status
F9980	200000		SRTU						CDE 2 Compressor 1 drive amplitude
F9981	200000		SRTU						CDE 2 Compressor 2 drive amplitude
F9982	200001		SRTU						CDE 2 Temperature 1
F9983	200001		SRTU						CDE 2 Temperature 2
F9984	200001		SRTU						CDE 2 Displacer 1 drive amplitude
F9985	200001		SRTU						CDE 2 Displacer 2 drive amplitude
F9986	200001		SRTU						CDE 2 Temperature 3
F9987	200001		SRTU						CDE 2 Temperature 4
F9988	200001		SRTU						CDE 2 Compressor 1 demand signal
F9989	200001		SRTU						CDE 2 Compressor 2 demand signal
F9990	200001		SRTU						CDE 2 Relay status
F9991	200001		SRTU						CDE 2 Stand-by/operational mode status
F9992	200001		SRTU						CDE 2 Launch lock mode status

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
P1061	200000		SRTU						CDE 1 6 Amp line A LCL1 current
P1060	200000		SRTU						CDE 1 6 Amp line A LCL2 current
P1063	200000		SRTU						CDE 2 6 Amp line B LCL1 current
P1062	S/C pkt		SRTU						CDE 2 6 Amp line B LCL2 current
P1161	200000		SRTU						CDE 1-A LCL1 Status
P1160	200000		SRTU						CDE 1-A LCL2 Status
P1163	200000		SRTU						CDE 2-B LCL1 Status
P1162	S/C pkt		SRTU						CDE 2-B LCL2 Status
P2008	200500		RTU						Compressor heater A LCL Current
P2011	200500		RTU						Camera heating-A LCL Current
P2012	200500		RTU						AFEE 2 TM/TC Line A LCL Current
P2013	200500		RTU						DPE1 LCL Current
P2014	200500		RTU						ACS A LCL Current
P2015	200500		RTU						DFEE A LCL Current
P2016	200500		RTU						PSD line A LCL Current
P2017	200500		RTU						AFEE2 Detector line A LCL Current
P2018	200500		RTU						Thermal Control line 4A2 Current
P2058	200500		RTU						Compressor heater B LCL Current
P2061	200500		RTU						Camera heating-B LCL Cuurent
P2062	200500		RTU						AFEE 2 TM/TC Line B LCL Current
P2063	200500		RTU						DPE2 LCL Current
P2064	200500		RTU						ACS B LCL Current
P2065	200500		RTU						DFEE B LCL Current
P2066	200500		RTU						PSD line B LCL Current
P2067	200500		RTU						AFEE2 Detector line B LCL Current
P2068	200500		RTU						Thermal Control line 4B2 Current
P2115	200500		RTU						AFEE 2 TM/TC Line A LCL Status
P2116	200500		RTU						DPE1 LCL Status
P2117	200500		RTU						ACS A LCL Status
P2119	200500		RTU						DFEE A LCL Status
P2120	200500		RTU						PSD line A LCL Status
P2121	200500		RTU						AFEE2 Detector line A LCL Status
P2122	200500		RTU						Thermal Control line 4A2 Status
P2165	200500		RTU						AFEE 2 TM/TC Line B LCL Status
P2166	200500		RTU						DPE2 LCL Status
P2167	200500		RTU						ACS B LCL Status
P2169	200500		RTU						DFEE B LCL Status
P2170	200500		RTU						PSD line B LCL Status
P2171	200500		RTU						AFEE2 Detector line B LCL Status
P2172	200500		RTU						Thermal Control line 4B2 Status
P2219	200500		RTU						All heaters 4A2 Status
P2269	200500		RTU						All heaters 4B2 Status
T500	S/C pkt		RTU						Thermistor CDE 1
T501	S/C pkt		RTU						Thermistor CDE 2

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
T5001 T5019	200500		RTU				Cc 6008		Mask temperature: – Units: degC
T5002 T5020	200500		RTU				Cc 6008		LSA temperature: – Units: degC
T5003	200500		RTU				Cc 6008		ACS UCR tube temperature: – Units: degC
T5004	200500		RTU				Cc 6008		ACS LCR (+Z) temperature: – Units: degC
T5005	200500		RTU				Cc 6008		Mask assembly structural ring temperature (+Z): – Units: degC
T5006 T5024	200500		RTU				Cc 6008		Compressors A temperatures: – Units: degC
T5007 T5025	200500		RTU				Cc 6008		Compressors B temperatures: – Units: degC
T5008 T5026	200500		RTU				Cc 6008		Displacers A and B temperatures: – Units: degC
T5009 T5027	200500		RTU				Cc 6008		Active cooling radiator temperatures: – Units: degC
T5010	200500		RTU				Cc 6008		AFEE I/F TM/TC box temperature: – Units: degC
T5011	200500		RTU				Cc 6008		AFEE converter box temperature: – Units: degC
T5012	200500		RTU				Cc 6008		DFEE box temperature: – Units: degC
T5013	200500		RTU				Cc 6008		PSD box temperature: - Units: degC
T5021	200500		RTU				Cc 6008		ACS SSA (-Z) temperature: – Units: degC
T5022	200500		RTU				Cc 6008		VCU side wall temperature: (-y box housing side) – Units: degC
T5023	200500		RTU				Cc 6008		Mask assembly structural ring temperature (-Z): – Units: degC
T5031	200500		RTU						SDPE1 temp. monitoring
T5041	200500		RTU						SDPE2 temp. monitoring
T5042	200500		RTU				Cc 6007		Thermistor TCS SPI CDE 1 –
T5048	200500		RTU				Cc 6007		Thermistor TCS SPI CDE 2 –
T5049	200500		RTU						Thermistor TCS SPI Temp. ref. point
T5102-T5109	200500		RTU				Cc 6006		Adiabatic area temperatures: – Units: deg C

TM parameter identifier	Present in Cyclic TM n°	Present in OR TM pkt n°	S/A	Present in OR TC pkt n°	Present in CONF TC pkt n°	TC parameter identifier	Curves/alias Main	Curves/alias Redundant	Parameter Description
T5103-T5110	200500		RTU				Cc 6006		Evaporator temperatures: – Units: deg C
T5104-T5111	200500		RTU				Cc 6006		Passive radiator temperatures: – Units: deg C
T5105-T5112	200500		RTU				Cc 6006		Cold box temperatures: – Units: deg C
T5106-T5113	200500		RTU				Cc 6006		Heat pipes NGC temperatures: – Units: deg C
T5107-T5114	200500		RTU				Cc 6007		Cold plate temperatures: – Units: deg C
T8004	200500		RTU						TCS SPI I/F heater A TSW Status
T8014	200500		RTU						TCS DPE 2 (-Y) heater A TSW Status
T8015	200500		RTU						TCS CDE (+ Y) heater A TSW Status
T8104	200500		RTU						TCS SPI I/F heater B TSW Status
T8114	200500		RTU						TCS DPE 2 (-Y) heater B TSW Status
T8115	200500		RTU						TCS CDE (+ Y) heater B TSW Status
T8500	200500		RTU						Compressor heater A LCL Status
T8501	200500		RTU						Camera heating-A LCL Status
T8502	200500		RTU						Heat pipe thaw A TSW Status
T8503	200500		RTU						Annealing thermal system A TSW Status
T8504	200500		RTU						Antifreeze 1 A TSW Status
T8505	200500		RTU						Antifreeze 2 A TSW Status
T8507	200500		RTU						ACS-Mask heater A TSW Status
T8600	200500		RTU						Compressor heater B LCL Status
T8601	200500		RTU						Camera heating-B LCL Status
T8602	200500		RTU						Heat pipe thaw B TSW Status
T8603	200500		RTU						Annealing thermal system B TSW Status
T8604	200500		RTU						Antifreeze 1 B TSW Status
T8605	200500		RTU						Antifreeze 2 B TSW Status
T8607	200500		RTU						ACS-Mask heater B TSW Status
X3132									LCL CDE 1 4.5 A Status
X3133									LCL CDE 2 4.5 A Status
X3148									LCL CDE 1 8.5 A Status
X3150									LCL CDE 2 8.5 A Status

3.7.13. Nominal/redundant packets list

Nominal Telecommand Packets		Redundant Telecommand Packets	
APID (dec)	MF n°	APID (dec)	MF n°
1024	E9023 E9024	1152	F9023 F9024
1025	E0001-E0004	1153	F0001-F0004
1025	E0011-E0014	1153	F0011-F0014
1025	E0020-E0031	1153	F0020-F0031
1025	E0101-E0113	1153	F0101-F0103
1025	E0111-E0113	1153	F0111-F0113
1025	E0201-E0222 E0224	1153	F0201-F0222 F0224
1025	E0251-E0273	1153	F0251-F0273
1025	E0280-E0290	1153	F0280-F0290
1025	E0300-E0316	1153	F0300-E0316
1025	E0320-E0329	1153	F0320-E0329
1025	E0342-E0343	1153	F0342-E0343
1025	E0500-E0519 E0523-E0525	1153	F0500-F0519 F0523-F0525
1025	E0555-E0557	1153	F0555-F0557
1025	E0563-E0567 E0573-E0575	1153	F0563-F0567 F0573-F0575
1025	E0581-E0586 E0591-E0596	1153	E0581-E0586 E0591-E0596

Total TC packets 178

Nominal HK Telemetry Packets		Redundant HK Telemetry Packets	
APID (dec)	MF n°	APID (dec)	MF n°
1024	240108	1152	240108
1025	60011	1153	65011
1025	60060	1153	65060
1025	60601	1153	65601
1025	60602	1153	65602
1025	63841	1153	68841
1025	63842	1153	68842
1025	63843	1153	68843
1025	63844	1153	68844
1029	64000-64041 64046	1157	69000-69041 69046
1029	64640-64664 64700	1157	69640-69664 69700
1029	64901-64906	1157	69901-69906
1030	64042-64044	1158	69042-69044

Total HK TM packets 87

Nominal Science Telemetry Packets		Redundant Science Telemetry Packets	
APID (dec)	MF n°	APID (dec)	MF n°
1088	61000	1216	66000
1089	61001	1217	66001
1090	61002	1218	66002
1091	61003	1219	66003
1104	61100	1232	66100
1105	61101	1233	66101
1120	60000	1248	65000
1121	60001	1249	65001
1122	60002	1250	65002
1123	60003	1251	65003
1124	60004	1252	65004
1136-1147	61136-61147	1264-1275	66264-66275

Total science packest 23

3.7.14. Memory budget

3.7.14.1. PROM

The total size of the PROM is 80 kwords.

The PROM memory budget is:

32 kwords for IASW including 30 % of margin
32 kwords for CSSW

3.7.14.2. RAM

The total RAM is 1 Mwords. The PROM is transferred into RAM for execution.

CSSW code size:	512 kbits
IASW code size:	512 kbits
CSSW data size:	512 kbits
IASW data size:	14848 kbits

This allocation of 14848 kbits for IASW data is used as follows:

Margins (15 %)	2228 kbits
19 spectra:	4864 kbits
19 compressed spectra (factor 2):	2432 kbits
Units conf. tables:	64 kbits
Miscellaneous: (stacks, TM tables...)	631 kbits
I/F DPEE (flip/flop):	752 kbits
I/F PSD (flip/flop):	16 kbits
I/F CSSW: (6 TM packets + mailboxes)	20 kbits
Internal buffers:	10 kbits
Sub-total	*11017 kbits*
Burst buffer	3831 kbits
Total	***14848 kbits***

Note 1: The factor 2 for compression seems difficult to be reached. A factor 1.5 implies a burst buffer size of 3 Mbits.

Note 2: The I/F buffer size for CSSW communication needs to be assessed by the exchange protocol between the two parts of the software.

3.7.14.3. CPU budget

Allocation given by ESA (within a cycle of 125 ms):

CSSW:	30 ms
IASW:	83 ms
DMA transfers:	12 ms

This leads to an IASW CPU time allocation of 58.10 ms at IBDR (with 30 % margin).

The most sizing mode is the photon/photon mode where the good events and spectra data processing are the main processings. Two cases must be considered: burst and no burst.

The CPU time evaluations are made considering a processor running at 13 MHz with one wait state on memory access.

The allocation is used as follows when there is no burst:

Miscellaneous	12200 µs
Good events processing	924 µs
Spectra data processing	30940 µs

In this case the scientific specification is fulfilled.

The allocation is used as follows when there is a burst:

Miscellaneous	12200 µs
Good events processing	28368 µs
Spectra data processing	17532 µs
	58100 µs

3.8. GSE INTERFACES

N.A.

3.9. GROUND SEGMENT DELIVERIES

3.9.1. ISDC specific S/W

See Annex 19 Volume 3.

3.9.2. Deliveries to ISOC

N.A.

3.9.3. Deliveries to ESOC/MOC simulators

N.A.