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Draft-A	20/11/2013	All	Document created
Draft-B	14/04/2014	All	Science Intro added
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Draft E	15/08/2014	Page 21	Added more IRs
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		Sections 2.6 to 5.3	Updated these with either best information available or links to other documents.
Draft F	16/08/2014	Page 72 to 76	Added PAS and HIS Thermal Interface
		Section 3.3	Added Power details form BKH

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- Gethyn Lewis (editor)
- Chris Owen
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CONTENTS

1 Introduction

The Solar Wind Plasma Analyzer (SWA) for Solar Orbiter (SO) consists of a suite of 3 sensors, the Electron Analyser System (EAS), the Proton-Alpha Sensor (PAS) and the Heavy Ion Sensor (HIS), together with a common DPU, which serves all 3 sensors. The measurement priorities for these sensors are summarized in Table 1.1 below. The designs of these sensors have been optimized to tackle the science objectives set out in the Solar Orbiter Definition Study Report (the 'Red Book') submitted for the Cosmic Vision M-Class down selection in July 2011. SWA suite is critical to underpinning the unique ability of Solar Orbiter to make the direct link between the remotely-sensed observations on the Sun with the phenomena observed in the solar wind in the inner heliosphere. The SWA data will be unprecedented in many ways. The SWA will sample the heliosphere at distances that thus far are poorly explored, with a modern and comprehensive suite of plasma sensors. Due to the unique orbit of the Solar Orbiter spacecraft, the SWA, together with the other *in situ* and remote sensing sensors, will provide the best and most direct constraints for the physical processes that control the properties of the corona, and its connections into interplanetary space.

Sensor	Acronym	Measurement
Electron Analyser System	EAS	High temporal resolution determination of the solar wind core, halo and strahl electron velocity distributions and their moments.
Proton Alpha Sensor	PAS	The velocity distribution of protons and alpha particles at a time resolution equivalent to the ambient proton cyclotron period.
Heavy Ion Sensor	HIS	Determination of the characteristics of populations of the major charge states of C, O and Fe; measurement of the 3-D velocity distribution of prominent heavy solar wind ions, suprathermal ions, and pick-up ions of various origins, such as weakly-ionized species (He^+, O+ etc)

Table 1.1: Solar Wind Plasma Analyser Sensors and their Measurements

1.1 Scope

This document provides an overview of the design and functionality of the SWA as an instrument. It describes in detail how the instrument is to be operated and what will be delivered from the instrument during its different telemetry, modes and mission phases. The SO-SWA User Manual covers the whole of the Solar Orbiter SWA instrument. Documentation.

This document is a requirement of the Solar Orbiter EID-A [IR02] and the Solar Orbiter Operations Requirements Document [IR03]. It has been prepared, written and edited in accordance with the Design Requirements Document (DRD) template for Solar Orbiter User Manuals as defined in the Solar Orbiter Instrument User Manual DRD [IR01].

1.2 Normative References (NR)

This document incorporates, by dated or undated reference, provisions from other publications. These applicable references are cited at appropriate places in the text and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these apply to this document only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies

Ref.	Document Description	Document Title
NR-01	Solar Orbiter Definition Study Report (Red Book)	ESA/SRE(2011)14
NR-02	Solar Orbiter TM-TC and Packet Structure ICD	SOL.S.ASTR.TN.00079, issue 6
NR-03	EAS MICD	SWA-EAS-1009-SO-SWA-MSSL-IF-002_SWA_FM_MICD_Issue_A
NR-04	PAS MICD	SWA_PAS_FM_100614_SWA-MD-22300-IRAP-043-GEN_5-0
NR-05	HIS MICD	HIS_MICD_15164_1002A_non-itar
NR-06	DPU ICD	SO-SWA-DPU_CD-IC-002

1.3 Informative Documents (IR)

The following documents, although not a part of this user manual, amplify or clarify its contents

Ref.	Document Description	Document Title
IR01	Solar Orbiter Instrument User Manual	
IR02	Solar Orbiter EID-A	

IR03	Solar Orbiter Operations Requirements Document	
IR04	Electron density images of the middle- and high-latitude magnetosphere in response to the solar wind, Tu et al., 2005	DOI: 10.1029/2005JA011328
IR05	Solar Wind Scaling Law, Schwardon & McComas, 2003	DOI:10.1086/379541
IR06	SO-SWA-MSSL-RP014	Solar Orbiter SWA EAS Design Report
IR07	15164-IDR-01 R0 draft.doc	Solar Orbiter SWA HIS Design Report
IR08	SWA-RP-22341-IRAP-039-GEN, SWA-RP-22300-IRAP-037-GEN	Solar Orbiter SWA PAS Design Report
IR09	SO-SWA-DPU_CD-RP-012	Solar Orbiter SWA DPU Design Report
IR10	SO-SWA-MSSL-RP-009	Solar Orbiter SWA Harness Design Report
IR11	SO-SWA-MSSL-RP-013	Solar Orbiter SWA Operational Concept Report
IR12	SO-SWA-MSSL-EDIB	Solar Orbiter SWA EIDB
IR13	SO-SWA-DPU-RS-0041	SWA DPU Flight SW Requirement Document
IR14	SO-SWA-MSSL-SP-012	SWA EAS to DPU Interface Document
IR15	TBI	SWA PAS to DPU Interface Document
IR16	130-0220	HIS On-Board Science Processing and Instrument Operations
IR17	SO-SWA-MSSL-RQ-010	Solar Orbiter SWA Scientific Operations, Algorithms and Processes Requirements Document
IR18	SO-SWA-MSSL-AN-002	Solar Orbiter SWA FDIR

1.4 Acronyms

Acronym	Definition
ACK/NACK	Acknowledgement / Negative Acknowledgement
AQM	Assembly Qualification Model
AR	Acceptance Review
ASW	Application Software
AU	Astronomical Unit
BM	Burst Mode
Bps	Bits per second
BSP	Basic Support Package
CCSDS	Consultative Committee for Space Data Systems
CEM	Channel Electron Multiplier
CME	Coronal Mass Ejection
CPU	Computer processing Unit
CSP	Communication and Scientific data Processing
DPM	Data Processing Module
DPU	Data Processing Unit
EA	Electrostatic Analyser
EAH	Electrostatic Analyser Head
EAS	Electron Analyser System
EDAC	Error Detection And Correction
ExOS	Extended Operating System
FCIL	Fracture Critical Item List
FDIR	Failure Detection Isolation and Recovery
FIP	First Ionisation Potential
FLLI	Fracture-Limited Life Item
FLLIL	Fracture-limited Life Items List
FM	Flight Model
FPGA	Field Programmable Gate Array
HIS	Heavy Ion Sensor
HK	House Keeping
HPC	High Performance Computer

HV	High Voltage
HW	Hardware
I/F	Interface
I/O	In / Out
Lsb	Least Significant Bits
MAG	Magnetometer Instrument
MCP	Micro-Channel Plate
MI	Monitoring Item
MRAM	Magnetoresistive Random Access Memory
Msb	Most Significant Bits
Msec	Mili Second
MSSL	Mullard Space Science Laboratory
MSSW	Machine Services Software
NA	Not Applicable
NCR	Non Conformance Report
NM	Normal Mode
NRB	NCR Review Board
OBDH	On Board Data Handler
PAD	Pitch Angle Distribution
PAS	Proton-Alpha Sensor
PCDM	Power Conditioning and Distribution Module
PCMSW	Process Control Management Software
PFCI	Potential Fracture Critical Item
PFCIL	Potential Fracture Critical Item List
PHA	Pulse Height Analyser
PID	Process Identifier
PROM	Programmable Read Only Memory
PUS	Packet Utilization Standard
RAM	Random Access Memory
RPW	Radio Plasma Wave
RTOS	Real Time Operating Software
S/C	Space Craft
SCET	Space Craft Ephemeris Time

SEP	Solar Energetic Particles
SO	Solar Orbiter
SpW	Space Wire
SS	Service Subtype
SSD	Solid State Detectors
SSMM	Solid State Mass Memory
ST	Service Type
SW	Software
SWA	Solar Wind Analyser
TBC	To be confirmed
TBD	To be defined
TC	Tele Command
TM	Triggered Mode
TM	Telemetry
TOF	Time of Flight
TRB	Test Review Board
TRR	Test Readiness Review
UART	Universal Asynchronous Receiver/Transmitter
VDF	Velocity Distribution Function
WDT	Watch Dog Timer

1.5 Conventions

Commands to the instrument shown in this document will be written in a typewriter font using mnemonics to aid reading where possible and with the database numbers also indicated for clarity.

SI units are used throughout, however other units may be used where necessary, like minute, hour, day, degree and arcmin.

For some memory terms, kibi (Ki), mebi (Mi) and gibi (Gi) will be used as defined by the International Electrotechnical Commission (IEC) to distinguish the true kilo (1000) from the often-used 1024 for memory. These prefixes (and abbreviations) are as follows:

- kibi (Ki) to denote 1024
- mebi (Mi) to denote 1024^2
- gibi (Gi) to denote 1024^3

In parts of the text, the unit “deg C” may be used to mean “degree Celsius”.

Dates will be shown in the UK format of dd/mm/yyyy with 4 digits for the year or in the ISO format of yyyy-mm-dd or yyyy-mm-ddThh:mm:ss, where yyyy is the year number, mm is the “month” number, dd is the “day” number in that month, hh is the “hour” number, mm is the “minute” number and ss is the “second” number.

2 INSTRUMENT DESCRIPTION

2.1 Scientific Objectives

2.1.1 Summary of Solar Orbiter Science Objectives

Understanding the connections and the coupling between the Sun and the heliosphere is of fundamental importance to addressing one of the major scientific questions of the Cosmic Vision 2015-2025 program: “How does the Solar System work?” The heliosphere also represents a uniquely accessible domain of space, where fundamental physical processes common to solar, astrophysical and laboratory plasmas can be studied under conditions impossible to reproduce on Earth, or to study at astronomical distances. The results from previous missions have formed the foundation of our understanding of the solar corona, the solar wind, and the three-dimensional heliosphere. However, an important aspect has yet to be implemented. No previous mission has been able to fully explore the interface region where the solar wind is born and heliospheric structures are formed with sufficient instrumentation to link solar wind structures back to their source regions at the Sun. With previously unavailable observational capabilities provided by the powerful combination of in-situ and remote sensing instruments on Solar Orbiter, and the unique mission design specifically tailored to take the spacecraft into the inner heliosphere and to positions in which it can observe the Sun at high latitude, Solar Orbiter will address the central question of heliophysics: *How does the Sun create and control the heliosphere?*

The detailed Solar Orbiter umbrella objectives are documented in the Solar Orbiter Definition Study Report (NR-01) submitted for the Cosmic Vision M-Class down selection in July 2011. The four top-level scientific questions that will be addressed by Solar Orbiter, each together with 3 key targetted sub-questions, are:

- How and where do the solar wind plasma and magnetic field originate in the corona?
  - What are the source regions of the solar wind and heliospheric magnetic field?
  - What mechanisms heat and accelerate the solar wind?
  - What are the sources of solar wind turbulence and how does it evolve?
- How do solar transients drive heliospheric variability?
  - How do CMEs evolve through the corona and inner heliosphere?
  - How do CMEs contribute to solar magnetic flux and helicity balance?
  - How and where do shocks form in the corona?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
  - How and where are energetic particles accelerated at the Sun?
  - How are energetic particles released from their sources and distributed in space and time?
  - What are the seed populations for energetic particles?
- How does the solar dynamo work and drive connections between the Sun and the heliosphere?

- How is magnetic flux transported to and re-processed at high solar latitudes?
- What are the properties of the magnetic field at high solar latitudes?
- Are there separate dynamo processes acting in the Sun?

To answer these questions, it is essential, in coordination with other observations, to make in-situ measurements of the solar wind plasma close enough to the Sun that it is still relatively pristine and has not had its properties modified by subsequent transport and propagation processes. This is one of the fundamental drivers for the Solar Orbiter mission, which will approach as close to the Sun as ~0.28 AU. Providing these in-situ measurements of solar wind plasma, is the specific role of the SWA investigation. As is clear from the discussion of the above mission science objectives in the Red Book (NR-01), very few of the science objectives can be met without the combined SWA measurements.

2.1.2 Summary of SWA Science Objectives

The overarching objective of SWA is to provide the comprehensive in situ measurements of the solar wind, which are critical if we are to establish the fundamental physical links between the Sun's highly dynamic and inhomogeneous magnetised atmosphere and the solar wind in all its quiet and disturbed states.

This critical step requires comprehensive in-situ measurements of the various constituents of the solar wind plasma including high time resolution velocity distributions of solar wind ions and electrons and composition up to suprathermal energies – for example, the measurement of heavy ion charge states reflect coronal temperatures at their source. These measurements are vital if we are to discover the fundamental links between e.g. solar eruptions, shocks and the suprathermal ions that are the seed populations of hazardous solar particle events.

The SWA investigation is capable of meeting all of the mission goals requiring in situ solar wind plasma measurements set out in the Red Book (NR-01).

The SWA sensors will sample comparatively pristine solar wind plasma at the closest ever distances to the Sun, but also assess their radial evolution. This will provide key information on the evolution of the solar wind with distance from the Sun, providing a separation of those processes which are inherent in the solar wind itself from those which play a role in the formation of the wind near to the Sun. Furthermore, the SWA will for the first time measure the near-Sun solar wind at higher latitudes revealing the latitudinal dependence of these near-Sun phenomena as the spacecraft climbs out of the ecliptic. Solar Orbiter will thus extend our direct measurements of space plasmas into a new realm that will transform our view of the connections from the solar atmosphere into the solar wind, and help us project this understanding to other stellar environments.

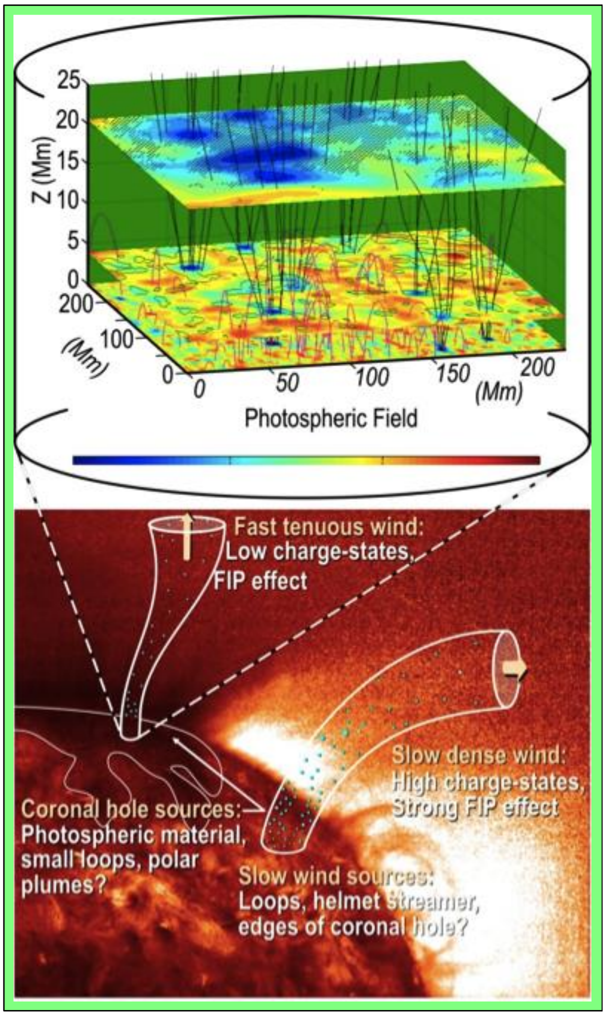


Figure 2.1: Illustration of the observed fast and slow wind properties

A central goal of Solar Orbiter is to establish the physical links between the observed solar wind and its sources back on the Sun. **Error! Reference source not found.** illustrates some of the observed properties of fast wind from coronal holes and slow wind that may emanate from coronal hole edges, from loops beyond the coronal or helmet streamer. The upper figure of **Error! Reference source not found.** illustrates the complex magnetic structure modelled at the base of a fast wind flux tube that rapidly expands out of the Chromosphere and into the Corona. Understanding the dynamics of the solar magnetic atmosphere, and its signatures in the measured solar wind holds the key to understanding the sources of all solar wind (adapted from Tu et al., 2005 and Schwardon and McComas, 2003).

The solar wind particle distributions that will be obtained by SWA, contain remnants of the plasma state (e.g. First Ionisation Potential (FIP)) in the coronal source regions. These remnants are not altered with increasing heliocentric distance, and thus provide invaluable diagnostics on coronal conditions. In particular, the particle velocity distribution functions (VDFs) are sensitive tracers of the microstate of the coronal and solar wind plasmas, which, from Helios and Ulysses results, are known to be imprinted mostly in the corona. Furthermore, the solar wind ionic composition is, according to modelling and spectroscopic evidence, highly dependent (e.g., resulting in substantial alpha-particle enhancements in CMEs) on the solar magnetic field topology, and thus the relative abundances and charge states of the in situ measured ions give ample testimony of this property of the solar sources. Thus SWA will provide critical clues into the processes that determine the solar wind origin and control heating and acceleration of steady streams and transient flows.

Other aspects of the solar wind particle distributions also show a distinct evolution with heliospheric distance, latitude and longitude. Each particle species plays a unique and prominent role, for example electrons in heat conduction, protons and alpha particles in the mass flux and linear as well as angular momentum transport, and heavy ions especially in turbulence dissipation. Solar wind internal energy is shared between all ions and electrons by wave-particle interactions, turbulence and weak but unavoidable Coulomb collisions.

SWA will be fully capable of resolving details within the particle populations relating to the coronal state, for example by identifying invariant particle signatures such as FIP. We will also address wave-particle interactions, turbulence and other kinetic plasma processes initiated at the Sun and/or controlling the evolution of the solar wind, mainly through provision of high resolution solar wind VDFs, including global features like the electron strahl and more locally generated signatures such as ion temperature anisotropies and differential streaming.

Microphysical processes are essential to the radial evolution of macroscopic phenomena such as solar wind streams and CMEs. Small-scale kinetic processes also act together with large-scale fluid processes in the acceleration of particles at reconnection sites and shocks. The comprehensive SWA sensor suite will enable the investigation of the cross-scale couplings that constitute the Sun-heliosphere connections, from the global MHD scales of the Sun's corona down to the local kinetic scales of wave-particle interactions in the solar wind.

The following three sub-sections illustrate the contributions that SWA will make to three of the four top level questions that were posed in the Red Book (NR-01) and listed in Section 2.1 above:

2.1.2.1 How and where do the solar wind plasma and magnetic field originate in the corona?

During those intervals when Solar Orbiter is close to co-rotation with the Sun, SWA will measure the solar wind plasma, electrons, composition, and plasma turbulence in magnetic flux tubes that can be traced back to their solar source regions, whose morphology, structure, and variability can be determined from Solar Orbiter's simultaneous remote-sensing observations. These observations will allow us to resolve several outstanding questions about the solar sources of fast and slow wind, the distribution of open magnetic flux, and the sources of solar wind turbulence and its dissipation to heat and accelerate the wind. These questions include:

- How is the nature of the fast solar wind related to the three-dimensional structure of coronal holes?
- Does slow solar wind originate from the over-expanded edges of coronal holes?
- Does slow solar wind originate from coronal loops outside of coronal holes?
- What is the distribution of open magnetic flux?
- What are the sources of solar wind turbulence and how does turbulence dissipate to heat and accelerate the solar wind?

2.1.2.2 How do solar transients drive heliospheric variability?

When Solar Orbiter is located close to the Sun and near co-rotation occurs, it will be possible to examine the evolution of plasma, suprathermal electrons and ions within structures driven by solar transients in unprecedented detail. For example, SWA measurements of CME properties will advance our understanding of CME structure, the physical mechanisms of CME initiation, and the global influence of CMEs on the coronal and heliospheric magnetic fields. SWA measurements provide tests of CME initiation, by utilizing plasma signatures to differentiate between models, and will allow us to assess the impacts of CMEs on the magnetic configuration of the inner heliosphere. These will be used, for example, to answer the following questions:

- What are the global structure, initiation, and evolution of CMEs?
- How do CMEs contribute to the global evolution of magnetic flux in the heliosphere?

2.1.2.3 How do solar eruptions produce energetic particle radiation that fills the heliosphere?

As Solar Orbiter traverses the inner heliosphere, approaching as close as 48 R_S to the Sun, SWA will measure the structure and evolution of shocks characterized completely down to kinetic scales and determine the properties, composition, and evolution of suprathermal ions that seed higher-energy solar energetic particles (SEP). These measurements will contribute to answering the following questions:

- What are the properties and distribution of heliospheric shocks?
- What are the properties and distribution of suprathermal seed populations from which SEP populations develop?
- What are the sources and acceleration mechanisms of the so-called large gradual SEPs?

The above science goals are focussed SWA topics that fit under the first 3 objectives of the Red Book (NR-01). The SWA suite is designed and built and will be operated in such a way that it is fully capable of making all the *in-situ* solar wind plasma measurements that are required in order meet the science goals of the Solar Orbiter Mission.

2.1.3 Summary of SWA Performance Characteristics

The comprehensive and coordinated plasma measurements provided by SWA are achieved by the deployment of 3 separate sensors on the spacecraft:

i. The Electron Analyser System (SWA-EAS). This consists of a pair of top-hat electrostatic analysers with aperture deflection plates mounted in the shadow of the spacecraft at the end of a boom. Orthogonal mounting of the 2 sensors and the ±45° aperture deflection provides a full 4π field of view subject only to blockage by the spacecraft, its appendages and its electrostatic and magnetic fields. The sensor will measure electron fluxes in the energy range from ~1 eV to ~5 keV with ΔE/E ~12% and an angular resolution ≤10°. Moments of the electron distribution will be returned with a cadence of 4s, although the sensor will be capable of returning full 3-D distributions at lower cadence and/or over short durations, and 2-D electron pitch angle distributions at ~0.125s cadence during short periods of burst mode.

ii. The Proton-Alpha Sensor (SWA-PAS). PAS comprises a top-hat electrostatic analyzer (EA) designed to measure the full 3-D velocity distribution functions of major solar wind species, protons and alpha particles in the energy range ≤0.2 – 20 keV/q, with ΔE/E

~7.5%, an angular resolution ≤ 2° across a field of view of -17.5° to +47.5° by ±22.5° about the solar direction and a cadence of 4 s. The PAS system will also be able to measure the reduced distribution functions of the solar wind protons and alpha particles at higher cadence (10-60 Hz) by reducing the angular and or energy coverage of the scans.

iii. The Heavy Ion sensor (SWA-HIS). This consists of an electrostatic analyser module with ion steering (EA-IS) to achieve the required extent of the HIS field-of-view (-33° to +63° x ±18°), coupled with a time-of-flight (TOF) telescope with solid state detectors (SSD) for total ion energy measurements. HIS will measure five key properties for all ions: mass in the range 2-56 amu/q, charge (q), energy in the range 0.5 – 600 keV/q (for azimuth) and 0.5 – 16 keV/q (for elevation), ΔE/E ~8% and direction of incidence *(θ, φ)* with 6° x 6° pixel resolution. The time resolution for 3-D distribution measurements is 5 minutes for a full scan in normal mode and 30 s for heavy ions or 4 s for alphas in burst mode.

The HIS and PAS sensors require fields of view containing the Sun-direction and therefore require apertures in the spacecraft heat shield.

A summary of the target characteristics of the 3 sensors is given in Table 2.1.

Note also that the value of the science data returned from the SWA suite is significantly enhanced with direct operational support from two other instruments on the spacecraft. The SWA DPU will receive this data through service 20 packets distributed by the spacecraft SpaceWire (SpW) interface. To support burst mode operations, EAS requires magnetic field vectors from the magnetometer. These are updated every 125 ms to allow the DPU to select the correct sensor elevation angle so the EAS can rapidly collect 2-D electron pitch angle data along the measured magnetic field line. To allow accurate moment calculations in the SWA DPU on board the spacecraft, it may be necessary to exclude low-energy electron measurements contaminated by spacecraft photoelectrons. The Radio Plasma Wave instrument (RPW) provides a value of the spacecraft potential. An updated value of this parameter is provided to the SWA-DPU with a cadence of at least once every 4 s in order to support each moment calculation. In addition, the SWA suite DPU has the capability to receive trigger signals from an external instrument and to command the SWA sensors into burst mode data acquisition and/or to freeze instrument buffers within the SWA DPU to capture event data.

Parameter	**Range/resolution**	**EAS**	**PAS**	**HIS**
Sensors		2 x EA	1 x EA	1 x EA, 1 x TOF-SSD
Mass	Species	Electrons	H, He	^{3}He – ^{56}Fe
	Resolution (*m/*Δ*m*)	-	-	4
Energy	Range	1 eV – 5 keV	0.2 – 20 keV/q	0.5 – 60 keV/q (Az) 0.5 – 20 keV/q (El)

	Resolution ($\Delta E/E$)	12%	7.5% for 3-D VDF, (5% for 1.5-D)	6 - 10 %
	Analyzer constant (eV/V)	6	10.1	15.2
Angle	Range (AZ)	360°	-24 - +42° - EA	-30° - +66°
	Range scan (AZ)	32 steps	11 steps	16 steps
	Range (EL)	±45°	±22.5º - EA	-17° - +22.5º
	Range scan (EL)	16 steps	9 steps	6 steps
	Pixel Field of view	11.25º x 3º - 8º	5° x 5°	3.5° x 6°
Temporal Resolution	Normal mode	4 s moments / 100 s full 3D VDFs	4 s	≤ 30 s
	Burst mode	0.125 s	1/54 s	30 s (heavy ions) 4 s (alphas)
Sensitivity	Per pixel (cm^2 sr eV/eV)	Variable, < 2.6 x 10^{-4}	4.6 10-6 cm2 sr eV/eV, per pixel	Variable, <2 x 10^{-5}

Table 2.1. Summary of the Target Parameters for the 3 SWA Sensors

2.2 Measurement Principle

The SWA suite of instruments consists of 3 separate sensors together with a central DPU box, which is critical to their scientific operation, as well as providing all interface functions to the spacecraft. The three sensors are designed and tuned to measure different particle populations (electrons, proton and alpha particles, and heavy ions) within the solar wind outflow. However, each is based around the selection of particle energies and determination of arrival directions through the well understood measurement technique involving the deployment of an ‘Electrostatic Analyser Head’. Given the disparate characteristics of the target populations listed above, each sensor in the SWA suite employs a unique variant of the traditional electrostatic analyser head as well as deploying unique additional electrostatic front-end elements and back end electronics, although commonalities between sensors have been used as and where appropriate.

A brief summary of the measurement chain for each of the 3 sensors, plus that within the SWA DPU, is given below:

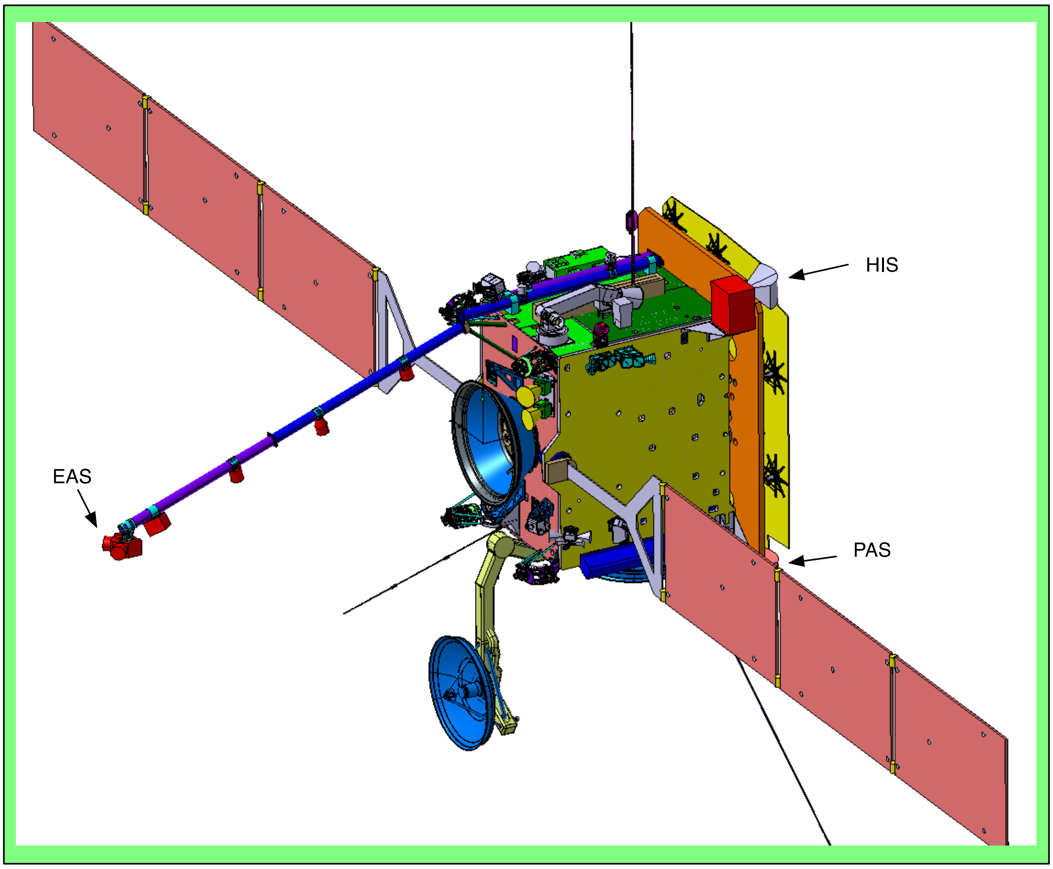


Figure 2.2 Illustration showing the positions of the SWA sensors

2.2.1 SWA-Electron Analyser System (SWA-EAS)

Fast moving electrons of scientific interest to the mission can essentially arrive at the spacecraft from any direction. Thus a valid characterisation of the electron population in the solar wind must involve sampling electrons arriving from as much of the full sky (4π steradians) as possible. To achieve this, SWA-EAS consists of 2 electrostatic analyser heads (EAH) mounted orthogonally to each other on a common electronics box at the end of the spacecraft boom, (see Figure 2.2). The large distance from the spacecraft body (~4.3 metres) minimises the physical blockage to the SWA-EAS field-of-view as well as distancing the sensors from perturbing electromagnetic and electrostatic fields of spacecraft origin. In addition, each EAH is equipped with a novel set of electrostatic aperture deflection plates, which, through the application of appropriate potential differences across the plates, control the admission to the EAH of electrons from a narrow range (~5°) of angles from within ±45° of the EAH aperture plane. Since the aperture itself allows the instantaneous admittance of electrons from 0-360° around the central axis of the EAH, the orthogonal mounting of the 2 heads with these aperture deflection plates allows field of view coverage of the entire sky, with some degree of overlap between sensors. The EAH itself is a traditional analyser which, by applying an appropriate voltage between the 2 hemispherical plates, selects energies from a desired narrow range between ~0 and 5 keV. These are then detected by a segmented analyser microchannel plate (MCP) which then is able to partition the detected electrons into angle of arrival bins from 0-360° around the central axis of the EAH. In this manner, each of the 2 sensors of the SWA-EAS is able to return to the SWA-DPU, with a cadence of once per second in normal mode, electron counts in 64 energy bins (~0-5 keV) × 16 elevation bins (±45°) × 32 azimuthal bins (0-360°), representing a full 3D sampling of the raw (count rate) electron velocity distribution function over these energies. A variant of this instrument operation mode is deployed in SWA-EAS burst mode in which the measurement is made over only 2 of the possible 16 elevation directions, but at a cadence which is a factor of 8 faster than in normal mode. The selection of the 2 elevations is made within the SWA-DPU with reference to the magnetic field direction supplied by the MAG instrument over the Service 20 packet system.

2.2.2 SWA-Proton Alpha Sensor (SWA-PAS)

Protons and alpha particles of scientific interest to the mission essentially arrive at the spacecraft only from directions within a few tens of degrees from the solar direction, offset slightly (a few degrees) by the aberration effect due to the relative orbital motion of the spacecraft. Thus a valid characterisation of the proton and alpha particle populations in the solar wind can be achieved by sampling ions arriving from a relatively localised field of view around the solar direction. To achieve this, SWA-PAS consists of a single EAH and electronics box mounted on a forward corner of the spacecraft, with a cut-out in the heat shield to allow ions arriving from the near-Sun direction to enter the sensor aperture (see Figure 2.2). The SWA-PAS system also deploys a set of aperture deflection plates, which, through application of appropriate voltages, act to steer ions arriving from one of a number of narrow ranges (~5°) of angles from within ±22.5° of the EAH aperture plane, while allowing sunlight to pass straight through the aperture and sensor structure and leave from the rear of the instrument without impinging on any part of the structure. Within the EAH itself, ions are selected, by applying an appropriate voltage between the 2 spherical section plates, from a desired narrow range between 0.2 – 20 keV/q. The selected ions are then detected by one of 11 Channel Electron Multipliers (CEM's), providing an azimuthal coverage of -24 to +42° with respect to the solar direction. In this manner, the SWA-PAS is able to return to the SWA-DPU, with a cadence of once per second in normal mode, ion counts in 32 energy bins (0.2 – 20 keV/q) × 9 elevation bins (±22.5°) × 11 azimuthal bins (-24 to +42°), representing a full 3D sampling of the raw (count rate) ion velocity distribution function over these energies. A number of variants of this sensor operation mode are deployable in order to make the measurement over reduced ranges of energy, elevation and/or azimuth at higher cadences than in regular normal mode.

2.2.3 SWA-Heavy Ion Sensor (SWA-HIS)

Heavy ions of scientific interest to the mission also essentially arrive at the spacecraft only from directions within a few tens of degrees from the solar direction, again with a slight offset (a few degrees) due to the aberration effect of the relative orbital motion of the spacecraft. Thus, as for protons and alpha particles, a valid characterisation of the heavy ion populations in the solar wind can be achieved by sampling ions arriving from a relatively localised field of view around the solar direction. To achieve this, SWA-HIS is mounted on a second forward corner of the spacecraft, with a cut-out in the heat shield to allow ions arriving from the near-Sun direction to enter the sensor aperture (see Figure 2.2). The SWA-HIS system uses a very similar design for the EAH system to that of the SWA-PAS described in the previous subsection. This also deploys a set of aperture deflection plates to steer heavy ions arriving from one of a number of narrow ranges (~5°) of angles from, in this case, within -17° - +22.5º of the EAH aperture plane. Again, sunlight is allowed to pass straight through the aperture and sensor structure and leave from the rear of the instrument without impinging on any part of the structure. Within the EAH itself, application of an appropriate voltage between the 2 spherical section plates allows heavy ions to be selected from a desired narrow energy-per-charge range over solar wind and suprathermal energy ranges between 0.5 – 60 keV/q (for azimuth, up to 20 keV/q in elevation). The selected ions are then passed into a TOF section of the sensor in which incoming ions are accelerated so that they penetrate a piece of ultra-thin carbon-foil, thus producing electrons. These electrons are directed toward a MCP, which provides the start signal for the TOF analysis as well as information on the azimuth position of the incident ion over the range -30° to +66° around the solar direction. The ion continues down the length of the telescope, striking the SSD array at the other end, emitting another set of electrons. These electrons are deflected toward a second MCP, providing the stop signal and thus completing the TOF measurement. Electronics for the TOF Telescope are located within an inner shell maintained at a high voltage inside the Detector Section, and provide an analysis of the signals related to each incoming ion to determine its mass (^{3}He – ^{56}Fe), energy (0.5 – 60 keV/q), charge state and arrival direction. Information is accumulated within the SWA-HIS electronics box over a sampling period of 300 seconds (30 secs for helium) in the default Normal Mode (NM). NM will be used for the majority (~99%) of the cruise and prime mission phases. HIS data products will be: PHA words, Matrix rates, Rate-based velocity distribution functions, Basic rates and Sensor rates. These data products are compressed, packetized and sent to the SWA-DPU for transmission to the spacecraft SSMM. In HIS burst mode (BM), which will last 30s and will be activated no more than once per hour on average, these data products will be produced at a cadence of 30 seconds (4 seconds for alpha particles). HIS will also deploy a low-resolution mode, in which the data rate will be reduced by a factor of 10, which will be used to control the overall data volume generated by the sensor and remain within the HIS orbit averaged allocation of 5500 bps. HIS will provide the DPU with 2 values of charge state ratios for selected elements at a 300 second cadence to be included as a low-latency data product.

The SWA-HIS data groups and cadences are summarised in Table 2.2 below.

Data Groups	Species
0	He2+
1	C4+-6+, O5+-8+
2	Fe6+-20+

Data Groups	Time (mins)	Mode
0	0.5	Normal
1-3	5	Normal
4-6	60	Normal

3	Mg6+-12+, Ne6+-	0	0.05	Burst
4	Pick up He+, 3He	1-3	0.5	Burst
5	Single charged ions (C+, O+, etc)	0-3	5	Minimum
6	Surathermal H+, 3He, He2+ and heavies			

Table 2.2. Different data groups produced by HIS during NM and BM.

2.2.4 SWA-Data Processing Unit (SWA-DPU)

The SWA-DPU provides a critical part of the measurement path for 2 of the 3 SWA sensors, EAS and PAS, while acting primarily as an interface to the spacecraft for the third, HIS. In particular, EAS and PAS science modes are based on operating repetitive cycles which mix, in appropriate ways, NM and BM requiring different types of data processing from the DPU.

For SWA-EAS, the DPU will receive the raw data (electron counts as a function of angle, angle and energy) from the 2 sensor heads.

In EAS normal mode, the DPU will:

i) receive the raw data from the two EAS sensors at a cadence equivalent to 1s for a complete 3D angle-angle-energy scan;

ii) perform compression of a full 3D raw distribution from EAS every 100s and transmit the result to the SSMM;

iii) perform compression of a single energy raw angle-angle distribution from EAS every 100s (offset by 50s from (ii) above) and transmit the result to low-latency store of the SSMM;

iv) hold in a rolling buffer ~5 minutes of full 3D raw distribution data recorded by EAS at a cadence of 1s, and freeze, compress and transmit the data in the buffer to the SSMM in the event that SWA receives a valid shock trigger notification from another instrument (limited to 1 or 2 such triggers per day);

v) apply gain and deadtime corrections and other onboard calibration factors to the raw data from the two EAS sensors;

vi) perform the computation of a set of partial moments from calibrated EAS 3D distributions and transmit the results of these to the SSMM with a cadence of 4s;

In EAS burst mode, the DPU will:

vii) manipulate the data within the service 20 packet transmitted from the MAG instrument, in order to select the EAS sensor, and its elevation scan setting, which contains the magnetic field direction, and transmit this information to the EAS at 0.125 second cadence;

viii) receive, compress and transmit to the SSMM ~1 min of 2D 'pitch angle distributions' (PADs) sampled at 8Hz by a single EAS sensor with reference to the magnetic field direction (described in (vii) above) once per hour (or limited to an average duty cycle equivalent to an average of 12 minutes per day).

The data products produced from EAS data by the DPU are summarised in Table 2.3 below.

Products	Data Groups	Mode	Sensor, En, Az, El	Cadence (sec)
Electron Moments	0	NM	2 x (64 x 32 x16)	4
Electron 3D VDF	1	NM	2 x (64 x 32 x16)	100
Electron 2D (AA) VDF	3	NM	2 x (1 x 32 x16)	100 (offset 50s to above)
Electron 2D VDF (PAD)	2	BM	1 x (64 x 32 x 2)	0.125 (for limit of ~12 minutes per day)
Electron 3D VDF (triggered)	1	TM	2 x (64 x 32 x16)	1 (for 300 sec, limit ~ once per day)

Table 2.3 Different data groups produced by the DPU using EAS data during NM, BM and TM

SWA-PAS has a normal mode operating cycle which repeats every 300s. In PAS normal mode, the DPU will:

i) receive the raw data representing reduced 3D distributions (ion counts as a function of angle, angle and energy measured over reduced ranges) from the PAS sensor head at a cadence equivalent to 4s;

ii) perform compression of the raw reduced 3D distributions from PAS every 4s and transmit the result to the SSMM;

iii) receive the raw data representing a full 3D distribution (ion counts as a function of angle, angle and energy over the full range) from the PAS sensor head at a cadence equivalent to 100s;

iv) perform compression of the raw full 3D distributions from PAS every 100s and transmit the result to the SSMM;

v) if power restrictions allow continuous PAS operation, hold in a rolling buffer ~5 minutes of reduced/full 3D raw distribution data recorded by PAS at a cadence of 1s, and freeze, compress and transmit the data in the buffer to the SSMM in the event that SWA receives a valid shock trigger notification from another instrument;

vi) apply gain and deadtime corrections and other onboard calibration factors to the raw data from the PAS sensor;

vii) perform the computation of moments from calibrated PAS reduced/full 3D distributions and transmit the result to low-latency store of the SSMM with a cadence of 4s;

viii) In addition, each 300s, PAS operates in snapshot mode, for a typical duration of 8s centred on the measurement of (iii) above. This provides coordination with high resolution snapshot modes of other in-situ measurements. During this snapshot operation, PAS may be operated in a variety of ways, depending on the particular scientific topic to be addressed. Examples are

- 8 full 3D distributions sampled at frequency of 1 Hz;
- 32 reduced 3D distributions sampled at frequency of 4 Hz;
- 1 full 3D and 7x8 reduced 3D distributions sampled at frequency of 8 Hz.

For these cases, the DPU is required to compress and transmit the different products, no moments computation is required.

In PAS burst mode, the DPU will:

ix) receive the raw data representing a variety of reduced 2D and 3D distributions from PAS, depending on the particular scientific topic to be addressed, from the PAS sensor head at higher cadences, up to several 10s of Hz;

x) perform compression of these raw reduced 2D and 3D PAS distributions and transmit the result to the SSMM;

The data products produced from PAS data by the DPU are summarised in Table 2.4 below.

Products	Data Groups	Mode	En, Az, El	Cadence (sec)
Proton Moments and 3D VDF compression	0-A	NM	96 x 9 x 11	100
	0-B	NM	48 x 9 x 7	4
VDF compression (snapshot or BM)	1	Snap, BM	96 x 9 x 7	1
	2	Snap, BM	48 x 5 x 7	0.25
	3	Snap, BM	24 x 5 x 7	0.125
Ion 3D VDF (triggered, power allowing)	0-A	NM	96 x 9 x 11	1 (for 300 sec, limit ~ once per day)
	0-B	NM	48 x 9 x 7	

Table 2.4 Different data groups produced by the DPU using PAS data during NM, Snapshot, BM and TM.

2.3 Instrument Overview

2.3.1 EAS

The design for EAS is based on experience and designs from Cluster PEACE and the MSSL IPA development programme.

The Solar Orbiter EAS is mounted in the shadow of the spacecraft at the end of the instrument boom. The EAS consists of two identical mounted sensors and a common electronics enclosure. Each sensor head contains:

- Electron Optics system: consisting of the top-hat electrostatic analyzer system (EA), aperture deflection system (ADS) and top-cap variable geometric factor system (VGFS)
- Detector and readout element: consisting of a pair of Micro-Channel Plates (MCP) mounted onto an anode and readout board, including HV coupling capacitors and readout electronics .

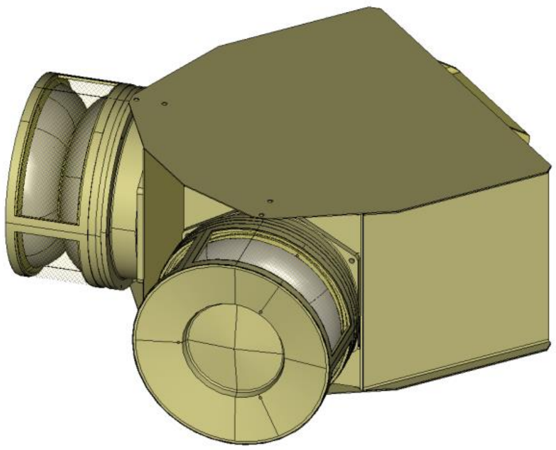


Figure 2.3 - Solar Orbiter EAS solid model showing the twin sensor units and electronics enclosure

The electronics enclosure contains low voltage and high voltage electronics boards and FPGA-based electronics for sensor control, interfaces, counters and electrical interfaces to the DPU and IEL.

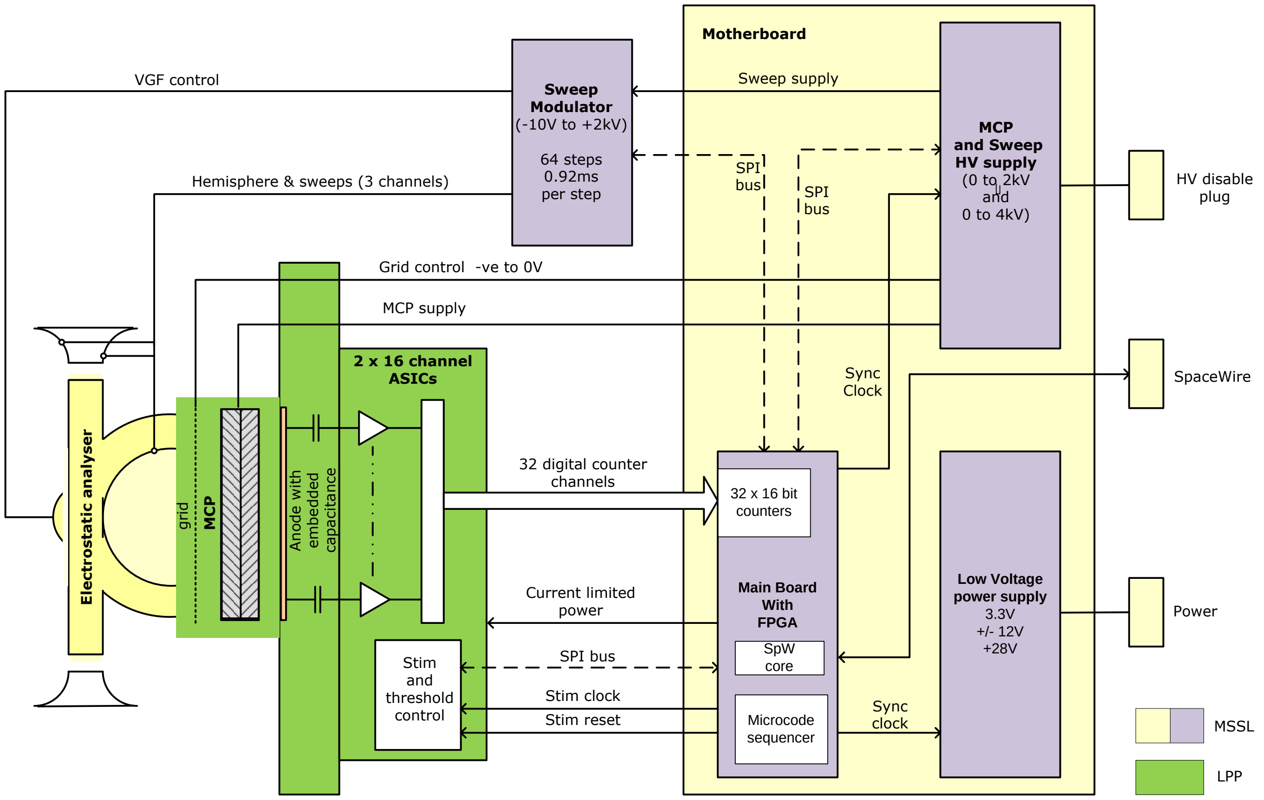


Figure 2.4 EAS Block Diagram

EAS consist of two identical sensor heads, which when mounted orthogonally to each other, will provide the all-sky, 4π steradian field-of-view required to fully measure the electron VDFs and thereby enable provision of moments and/or full pitch angle coverage at all times. Each sensor consists of four key elements with simple interfaces, as described below.

Key Element	Comments	Responsibility
Electron Optics System	Consists of the top-hat electrostatic analyser system (EA), aperture deflection system (ADS) and top-cap variable geometric factor system (VGF)	MSSL
Housing	Consists of the boom mechanical interface and the electronics enclosure	MSSL
Detector and readout	Consists of a micro-channel plate (MCP) mounted onto an anode and readout board, including HV coupling capacitors and readout electronics.	LPP, Saint-Maur
LV and HV supplies	Consists of an HV generator, an HV modulator and a LV DC-DC converter	MSSL

Key Element	Comments	Responsibility
FPGA-based control	Consists of a single PCB for instrument control, interfaces, counters and electrical interfaces to the DPU	MSSL
	Instrument integration, calibration and test	MSSL

Table 2.5 SWA EAS Breakdown

2.3.2 HIS

The Heavy Ion Sensor (HIS) is a component of the Solar Wind Analyzer (SWA) instrument suite. It consists of a Thermal Shield, an Electrostatic Analyzer (EA) with Ion Steering (IS), a Micro-channel Plate (MCP) Time-of Flight (TOF) Telescope that incorporates solid-state detectors (SSDs), electronics for the TOF Telescope located within the Detector Section, and a Main Electronics module containing high voltage power supplies, sensor control, command and data handling, and the interface to the SWA data processing unit (DPU).

This instrument will be used to detect and identify ions as light as helium and as heavy as iron in the inner heliosphere. Over the solar wind and suprathermal energy ranges (0.5-100 keV/q), it will measure the charge state, energy, and arrival direction of ions. These measurements provide information about how the ions were accelerated and where they came from on the sun. Figure 2.5 shows a block diagram for the HIS instrument.

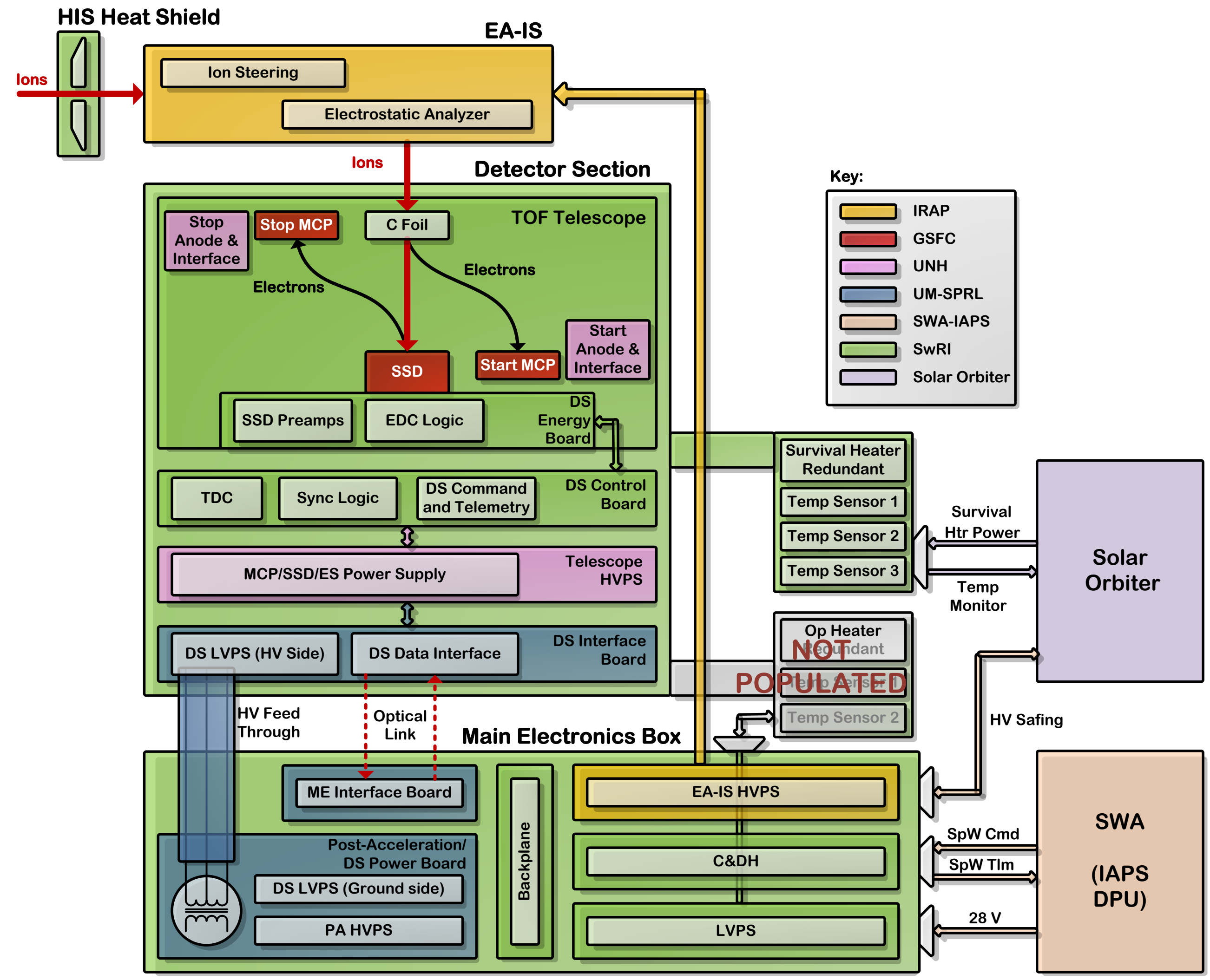


Figure 2.5 HIS Block Diagram

Solar wind ions that enter a small aperture in the thermal shield are steered by the IS system into a top hat analyser which aligns their trajectories with the entrance of the EA. The EA selects ions within the appropriate E/Q range to pass into the TOF Telescope. Incoming ions are accelerated so that they penetrate a piece of ultra-thin carbon-foil, producing electrons. These electrons are directed toward a MCP, which provides the start signal for the TOF analysis as well as the azimuth position. The ion continues down the length of the telescope, striking the SSD array at the other end, emitting another set of electrons. These electrons are deflected toward a second MCP, completing the TOF measurement. The TOF Telescope will provide measurements of azimuth, time-of-flight, and total energy.

2.3.3 PAS

The PAS instrument is a long-life ion spectrometer especially dedicated to work at the very wide solar wind plasma dynamic range expected along the Solar Orbiter orbit. Another principal driver of the PAS design is its protection against a very strong solar light and solar heat flux at the minimal distances to the Sun. PAS design is well adopted to its location on the Solar Orbiter spacecraft. In such terms the instrument design is almost unique.

PAS main design elements are shown in Figure 2.6 and its block-scheme is shown in Figure 2.7.

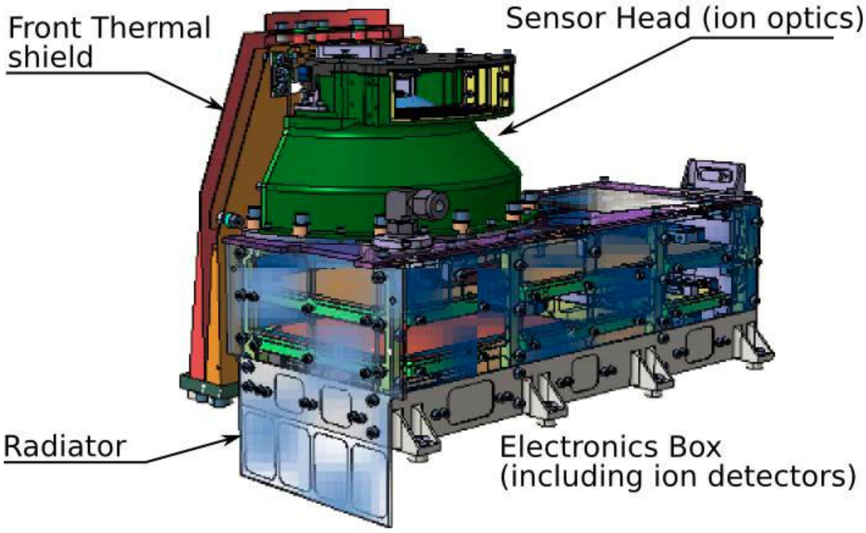


Figure 2.6 PAS Sensor

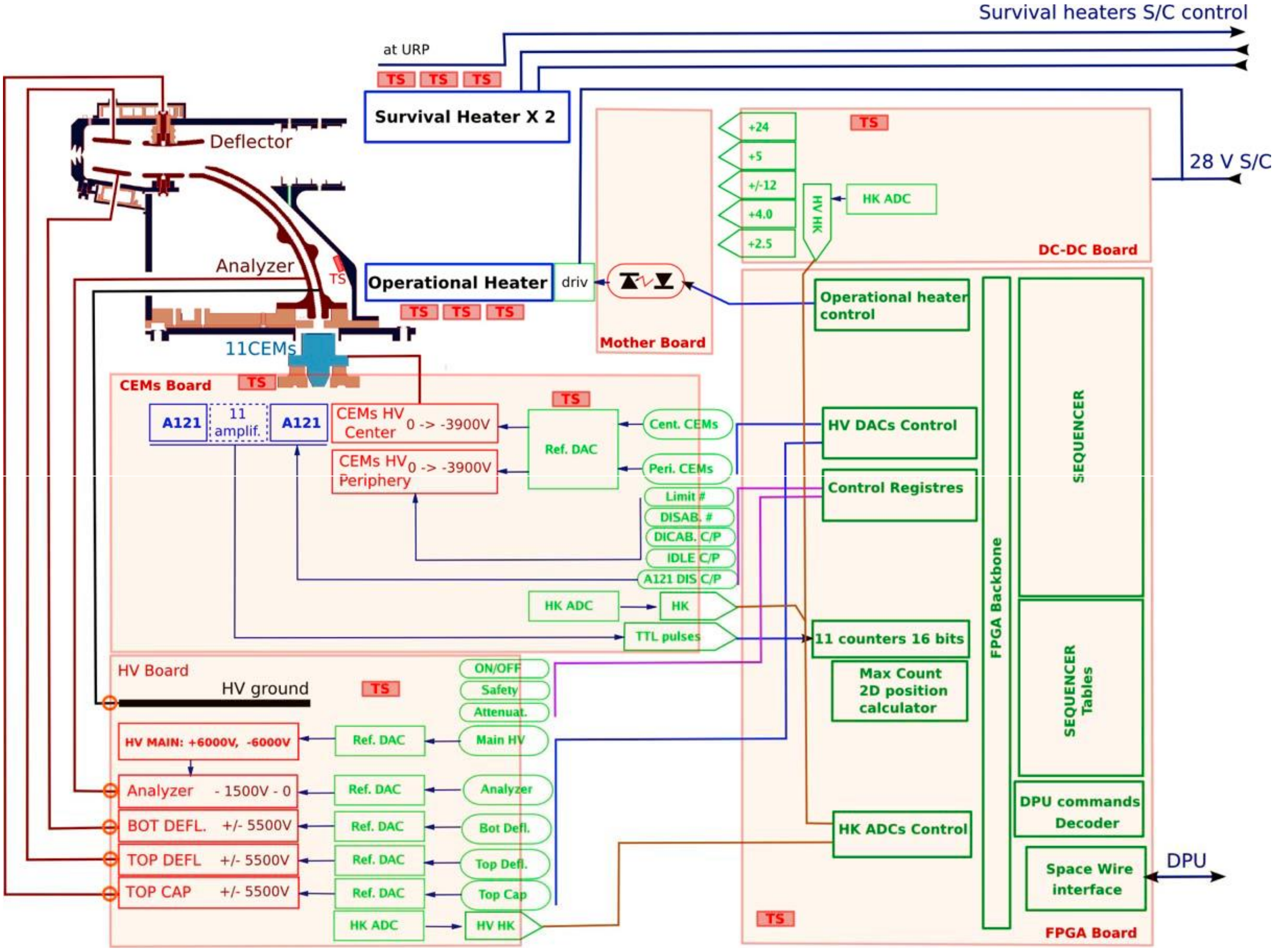


Figure 2.7 PAS Block Diagram

2.3.4 DPU

The DPU is described in Section 2.5

2.4 Instrument Units Detailed Description

The detailed description of each of the units is individually given in the following documents:

	Document
EAS	IR06
HIS	IR07

PAS	IR08
DPU	IR09
Harness	IR010

Table 2.6: SWA Unit Design reports

2.5 Instrument On-board Software

The SWA on board management and processing of data is performed by a combination of processing resources (CPUs and FPGA based HW accelerators)

The DPU overall HW architecture comprises:

- 1x Backplane (Rigid-Flex) including six “SpW Splitters”
- 2x DPMs (Data Processing Module) each composed of:
  - 1x Communication & Scientific Data Processing (CSP) board
  - 1x CPU (Computer Processing Unit) board
- 2x PCDM (Power Conditioning and Distribution Module)

Figure 2.8 shows the overall block diagram of the DPU at unit level.

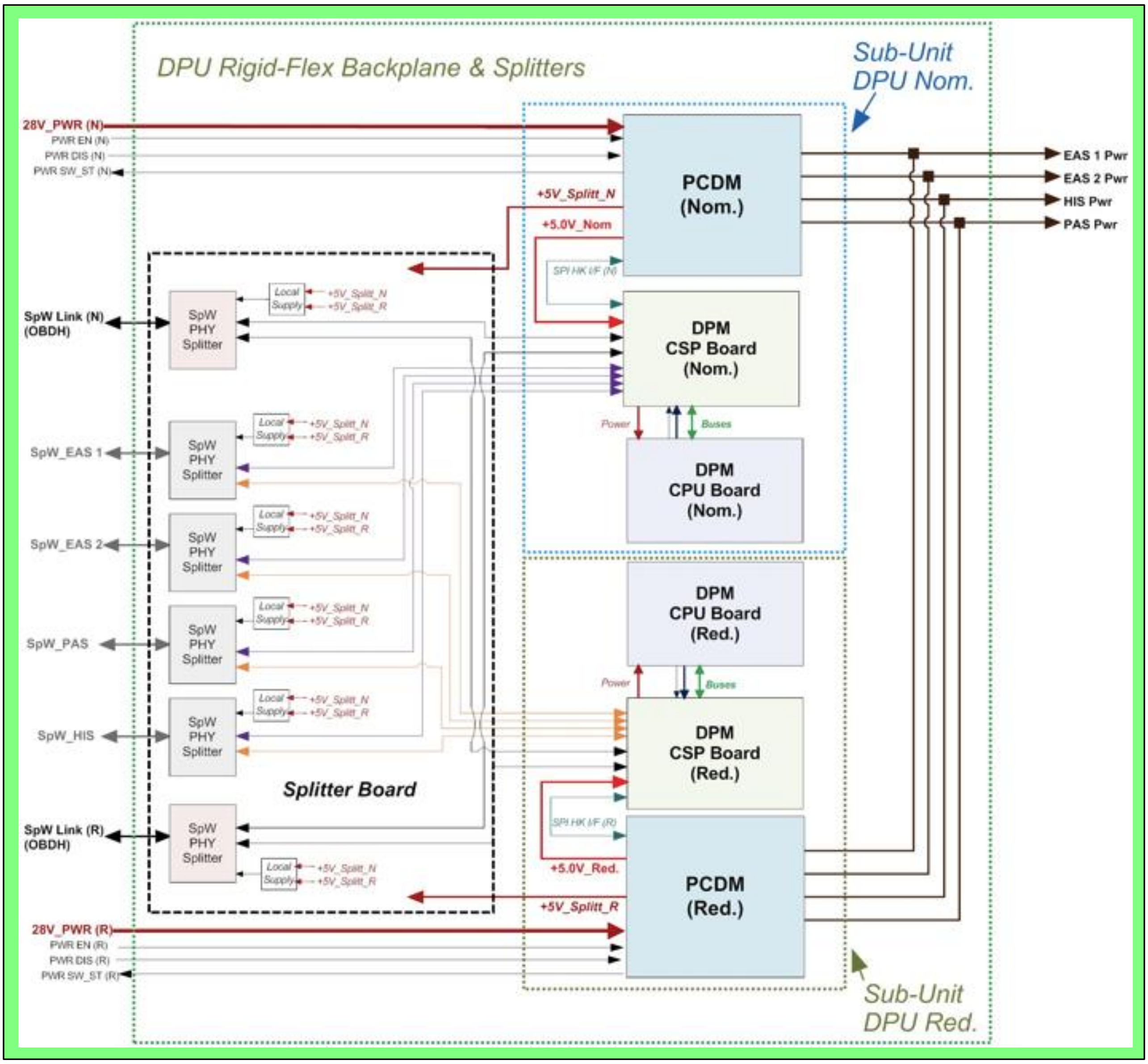


Figure 2.8 DPU Block diagram and interfaces

The main role of the DPMs is to implement the following:

- Overall DPU control tasks
- Data communication tasks with the sensors
- Data communication tasks with the S/C
- Algorithm for the scientific data

The main role of the PCDMs is to implement:

- Interface with the external power input and HV-HPC commands from S/C
- Power conditioning, distribution and protections for the internal DPU electronics

- Power distribution and protections for the SWA Sensors
- Housekeeping (HK) data collection

The SWA-DPU Application Software (ASW) will provide the following tasks:

- Communication with the Solar Orbiter OBDH in terms of:
  - Reception of TC coming from ground (both directed to the instrument or for ASW itself) to modify/upgrade the configuration data
  - Transmission (if enabled) of Scientific Telemetry Source Packet to report raw and/or processed scientific acquired data
  - Transmission of all HK/Event TM data to report both the DPU and Sensors Heads status
- Communication with the Sensor Heads (EAS-1, EAS-2, PAS and HIS) in terms of:
  - Transmission of TC (both for Sensor configuration data and Scientific Operative Modes handling)
  - Acquisition of Scientific data
  - Acquisition of HK data
  - Switching ON/OFF
  - Buffer 5 minutes of EAS-1, EAS-2 and PAS high time resolution data in local scratch memory, for transmission when an event trigger is received by the DPU
- Limited subsystem parameters processing
- DPU Diagnostic mode handling
- Performing Scientific Data Processing (i.e.: Moment Calculation) and Compression
- Time Synchronization Management
- Interact with other Solar Orbiter instrument by means of the Packet Utilization Standard Library Software (PUS) Service 20 with the aim to handle external event condition and communicate some useful data

In particular the ASW will be able to:

- Handle the ASW Offline/Online startup phase (BOOT Phase)
- Handle the SpW Communication links with S/C OBDH and the suite Sensors
- Turn ON/OFF the EAS-1 and EAS-2 sensors
- Initialize the EAS-1 and EAS-2 sensors configuration (parameters and sequence tables)
- Manage the EAS-1 and EAS-2 sensors HK/Scientific data acquisition, processing (e.g. data compression and moments calculation) and forwarding
- Manage EAS-1 and EAS-2 sensors limited HK data monitoring for FDIR purposes (TBC)
- Turn ON/OFF the PAS sensor
- Initialize the PAS sensor configuration (parameters and sequence tables)
- Manage the PAS sensor HK/Scientific data acquisition, processing (e.g. data compression and moments calculation) and forwarding
- Manage PAS sensor limited HK data monitoring for FDIR purposes (TBC)
- Buffer 5 minutes of EAS-1, EAS-2 and PAS high time resolution data in local scratch memory, for transmission when an event trigger is received by the DPU

- Turn ON/OFF the HIS sensor
- Manage the HIS sensor configuration (parameters)
- Manage the HIS sensor HK/Scientific data acquisition and forwarding
- Manage the Time Synchronization protocol

The SWA DPU software is divided into three Software Layers providing, at least, the following functionalities:

- Application Software (ASW) layer including
    - DPU TC/TM and Process Control Management SW (PCMSW)
    - Scientific Data Processing Software (SDPSW)
- Application Service Software (ASSW) layer including
    - Packet Utilization Standard Library Software (PUS)
    - Extended Operating System Standard Library Software (ExOS)
- Machine Services (MSSW) layer including
    - Real Time Operating System (RTOS) kernel
    - Low Level Drivers (BSP)
    - Bootstrap Software (BOOT)

These software layers are illustrated in Figure 2. and described further below.

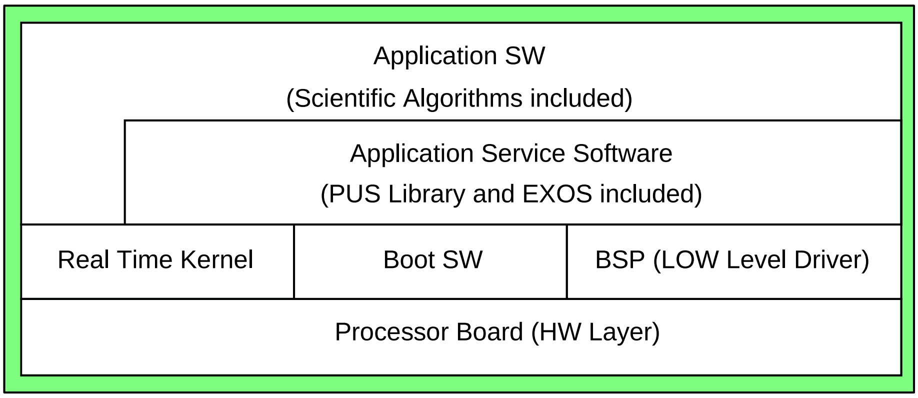


Figure 2.9 Functional scheme of SWA DPU software

The Application Layer (ASW) consists of the following components:

- The PCMSW (Process Control Module SW) is the ASW part providing the following functionalities:
    - TC Validation and Execution
    - DPU State management
    - Failure Detection Isolation and Recovery (FDIR)
    - Time Management
    - SWA Sensors (EAS 1, EAS 2, PAS and HIS) management

- The SDPSW (Scientific data processing software) is the ASW part providing, at least, the following functionalities for on-board EAS and PAS data processing:

  - Moment Calculation services, providing a compact scientific characterization of the Solar wind flux
  - Raw data compression services, processing the collected data to prepare the compressed stream to be downlinked
  - They aim to meet mission scientific goals with the limited bandwidth available to data downlink; transmitted data are reduced alternating compressed full solar wind samples (data distributions) at low frequencies and concise measurements, characterizing wind's flux, at a higher rate

The Application Services Layer consists of the following PUS and Mission services for ASW:

- PUS (Packet Utilization Standard) and Mission Specific Services: it provides the set of libraries and autonomous functions implementing the PUS services tailoring defined for the SWA DPU Application Software (NR-02)
- ExOS (Extended Operating System): it provides a library used by the application Software layer components to get access to the DPU HW resources (memory, registers, time, SpW, sensors etc.)

The Machine Services Layer consists of the following components:

- Real Time Kernel Operation System (VxWorks RTOS): it provides the DPU PM run-time resources management and the basic mechanisms for tasks execution and inter process communication
- BSP SW (Basic Support Package SW): it provides the access services to all DPU internal HW and physical interfaces of the system to the above software layers
- BOOT SW: it will be in charge of performing EEPROM and RAM memory area checks by performing a sequence of tests on them before the RAM ASW Loading and start execution

All the SWs will run on LEON2 CPU. The SDPSW will also use a RTAX2000 FPGA, as a HW accelerator for implementation of the algorithms or of parts of them, in order to reduce the overhead on the CPU and to maintain a significant margin in the processing capabilities.

2.5.1 ASW Architectural Context

This section presents the SWA DPU SW application, high level software architecture in the form of a Unified Modelling Language (UML 2.0) model used to allocate the SWA DPU Flight Software requirements to the identified software components. For sake of readability the architectural and design approach is based on concept of class. This solution is also applicable in the case where the source code language is pure C.

The ASW applications interface a set of external entities (PUS Services and ExOS depicted in Error! Reference source not found.

Figure 2. and described below:

- PCMSW is a logical composition of components to manage the SW initialization, cyclic activation, command management, mode management, Sensor Science and HK data handling, DPU HK data handling and FDIR

- SDPSW is a library containing a set of functionalities useful to post-process the acquired science data and compress them according to the proper DPU mode information

- PUS Services is a library of Standard and Mission Specific Services providing a set of services and autonomous functions implementing the PUS services tailoring defined for the SWA DPU Application Software (NR-02)

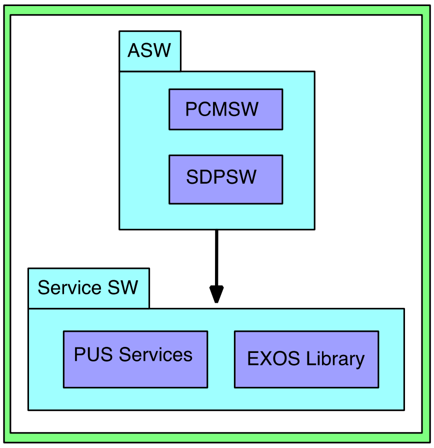


Figure 2.10 ASW Applications Context

- ExOS is a library of services used by the application Software layer components to get access to the DPU HW resources (memory, registers, time, SpW, sensors, etc). A subcomponent of ExOS is the BOOT SW that is in charge of performing MRAM and RAM memory area checks by performing a sequence of tests on them before the RAM ASW Loading and start execution

Figure 2.11 illustrates the main software elements that constitute the ASW and its logical de-composition in PCMSW and SDPSW applications, and other components useful both to PCMSW and SDPSW. Furthermore it describes only the main relationship among each class constituting the ASW to provide a graphical representation of the functionalities activation.

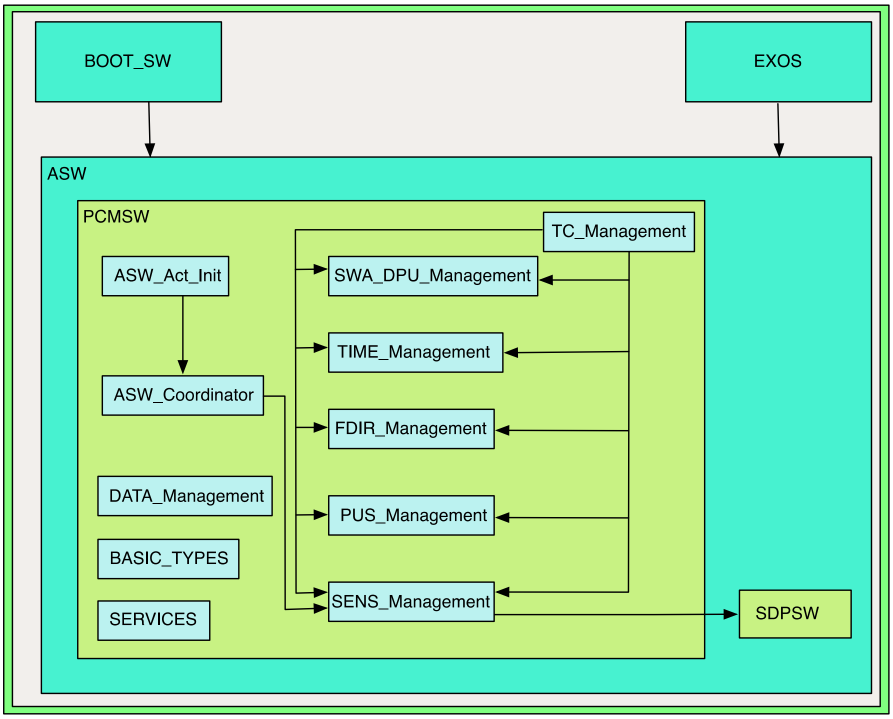


Figure 2.11 The constituent software elements of the ASW

2.5.1.1 BOOT SW Description

The BOOT SW will be in charge of performing:

- HW checks on the processing resources (Memories checking and initialization) before the RAM Software Loading
- MRAM checks and contents patching (SW update when BOOT SW is configured in Maintenance mode)
- EDAC device check
- Uploading the SW from non-volatile memory (MRAM) to RAM and subsequently to trigger its execution

The DPU BOOT SW is resident in the PROM and it is executed in PROM. It is not allowed to be patched or upgraded. Its purpose is to check the MRAM and RAM memory area by performing a sequence of tests on them.

The sequence works as follows:

i.) RAM memory is divided in blocks of 128 Kword that will be checked one by one, sequentially
ii.) The first block is selected and filled with the same value (0x55 or 0xAA)
iii.) At the end of the writing sequence, the bank is read and compared with the reference value
iv.) If the check returns a negative match, the block is marked with the value 1 (0 otherwise)

This procedure is repeated over all the RAM memory twice. 0x55 and 0xAA are the two values used to check the odd or even bits of a byte, respectively. If the RAM check fails, the Boot SW enables the processor to use the flight SW in Diagnostic Mode running it directly on the PROM where it is stored.

If the RAM memory check has been completed successfully, the DPU Boot SW performs the MRAM check. In the MRAM there are at least two images of the Flight software. The test checks each image comparing the CRC-Checksum with a pre-stored value. If this check returns a positive match, the first positive checked image is copied in RAM and executed in normal Mode.

If all the image checks fail, the Boot SW enables the processor to use the flight SW in Diagnostic Mode running it directly on the PROM where it is stored.

The BOOT check sequence is illustrated in left panel of Figure 2.1212. The middle and right panels of Figure 2.1212, illustrate the RAM Memory and MRAM Memory check sequences respectively.

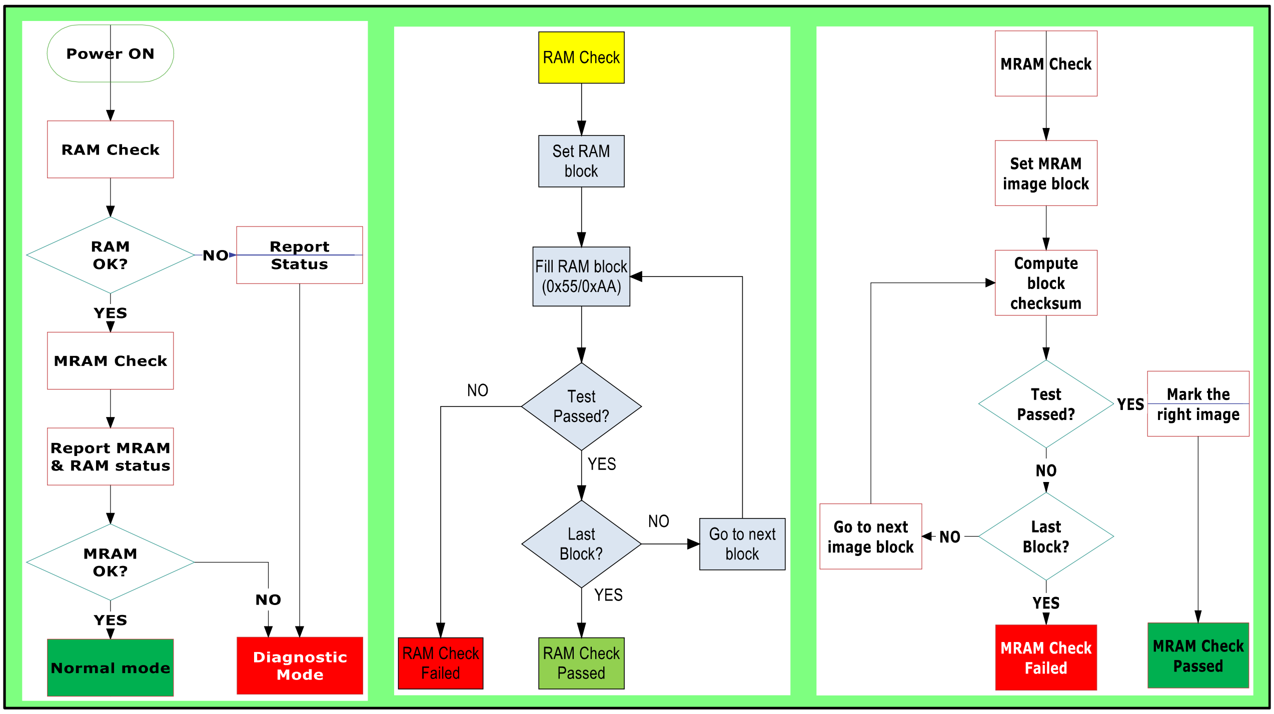


Figure 2.12 Left panel: Boot Sequence Check. Middle panel: RAM Memory check sequence. Right panel: MRAM Memory check sequence

2.5.1.2 ExOS SW Description

The ExOS package is composed of three main components:

- The Real Time Operating System that is a COTS component ad hoc configured to be run onto the selected platform
- The Board Support Package that is customized for the CPU board
- The ExOS SW

The ExOS SW will implement a set of services in order to allow the DPU ASW to manage the DPM HW components. It executes efficiently some basic functions for the configuration and management of the system and the various subsystems and appropriate functionalities in order to support the exchange of information between the DPU and the SWA's Sensors, and between the DPU and the OBDH.

The services fall into the following categories:

- OBDH SpW management services in terms of link initialization, tele-command (TC), telemetry (TM) and time code reporting services (time code management is implemented by the DPM FPGA)
- EAS1 SpW management services in terms of link initialization, TC, TM
- EAS2 SpW management services in terms of link initialization, TC, TM
- PAS SpW management services in terms of link initialization, TC, TM
- HIS SpW management services in terms of link initialization, TC, TM
- DPU Services in terms of DPU boards configuration, heal-check execution, boards reset, time management (spacecraft ephemeris time (SCET), System clock, timer and watch dog timer (WDT)) and data management (HK acquisition, CRC/Checksum on memory areas and rolling buffer management for science data processing)

The ExOS SW architecture is illustrated in Figure 2.13. At its core is a high level interface between the ASW and RTOS subsystems device drivers. Also shown are the subsystems device drivers used to interface the ExOS SW to the DPM devices, in particular the SpW I/O, the memory I/O (MRAM and PROM), and the UART debug interface.

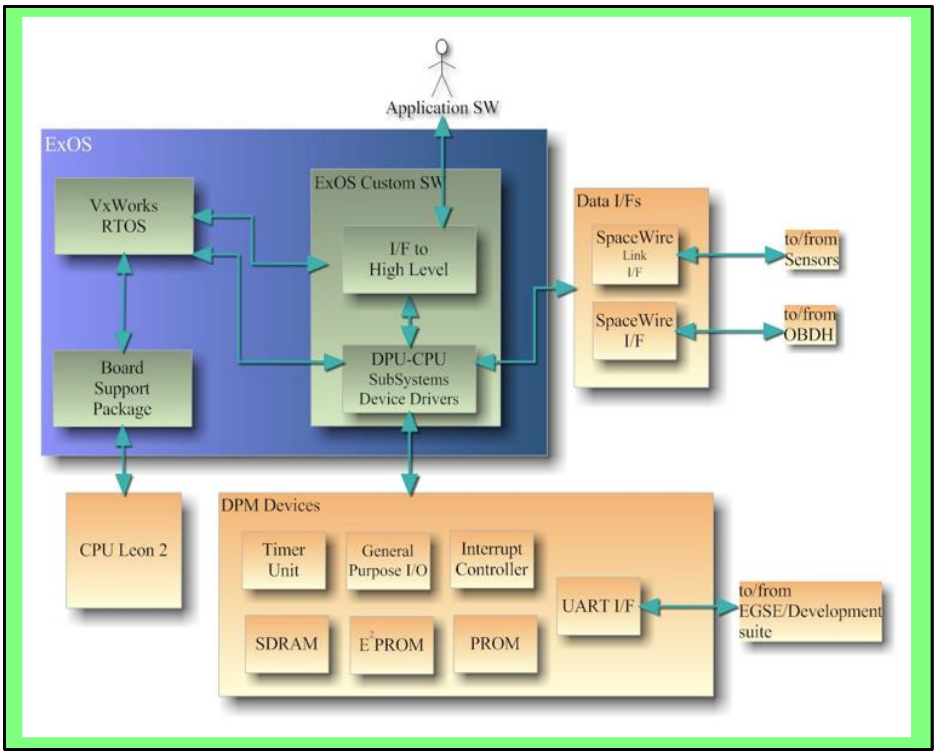


Figure 2.13 ExOS SW Architecture

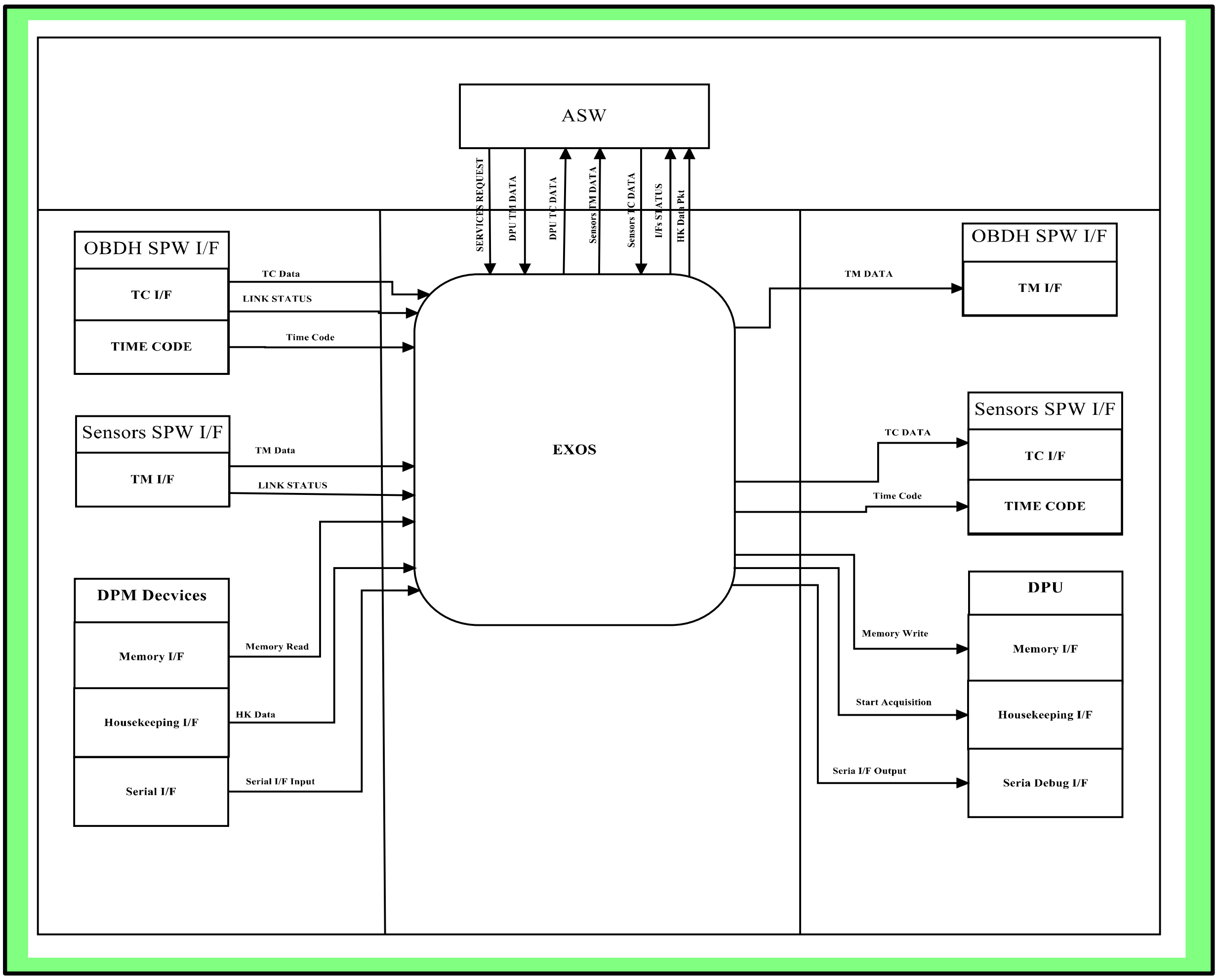


Figure 2.14 ExOS SW Context

The ExOS SW context is shown in Figure 2. illustrating the flow into and out of the ExOS SW. The architecture modules shown include:

- EXOS SW
- Interface I/F Processing
    - ASW
- Input Processing:
    - OBDH SpW interface
    - Sensors SpW interface
    - Memory interface
    - Serial debug interface
- Output Processing:
    - OBDH SpW interface
    - Sensors SpW interface

- Memory interface
- Serial debug interface

The OBDH SpW interface services will be developed as part of the EXOS SW. This SW object will provide the following functionalities to permit the communication between the OBDH and DPU by means of a SpW interface link. In particular it offers the following services:

- SpW configuration and initialization
- SpW reset
- SpW link enable/disable
- SpW link status
- Transmission of TM data to OBDH (TM data are packetized by the ASW)
- Reception of TC data from OBDH
- Time Code Management (counter of number of time code received acquisition of last time code received)

2.5.1.3 PCMSW Description

The PCMSW is a logical composition of SW elements needed to manage the SW initialization, cyclic activation, command management, mode management, Sensor Science and HK data handling, DPU HK data handling and FDIR. It is made up of the following main items:

- ASW_ACT_Init, to start the application, initialize HW boards and software structures
- ASW_Coordinator, exports the entry points for the initialization of both SW and HW, and the cyclical activation of the periodic activities according to a scheduling table containing the information about the manager to be activated in the current activation cycle
- TC_Management, to properly manage the incoming TC from the S/C (acquired via services provided by ExOS) and dispatching them to the related manager
- SWA_DPU_Management, to properly manage the set of TC to be executed on board the DPU and not to be routed to the Sensors (mode management included)
- FDIR_Management, to properly manage the anomalies in the SW and activities related to HW/SW parameter monitoring
- Time_Management, to maintain on-board timing reference and to propagate it to the sensors
- SENS_Management: this meta class results from the composition of other classes named EAS1_Mngr, EAS2_Mngr, PAS_Mngr and HIS_Mngr each abled to:
    - Manage TCs/TMs related to the proper controlled Sensor
    - Collect and process HK and science data from the sensor
- PUS_Management, to offer the PUS Standard Required Services to the above

mentioned components. This is also an active class in charge of scheduling the HK TM Packets formatting and sending
- BASIC_TYPES, to offer a common set of types definition
- SERVICES: to offer a shared set of services in order to handle the Macro Execution and VxWorks Message Queue message exchange (mainly for TC dispatching)
- DATA_Management, to properly manage all the shared configuration parameters to be used in sensors control, HK generation rate, monitoring items, data processing and compression, updatable via dedicated TCs

The significant components of the above list are described in detail below.

2.5.1.3.1 TC_Management

The TC_Management class is in charge of handling the TC received from S/C in terms of:
- Checking the presence of TC
- Acquiring all the received TC Packet from ExOS queue
- Checking the acquired TC Packet validity (i.e. Checksum, TC Header, TC Data header and TC plausibility with respect the actual SWA mode)
- Forwarding the valid TC packets to the proper ASW TC executor manager

The TCs are received from the S/C OBDH via the main and redundant SpW links. The ASW will check their correctness and expand them if addressed to the DPU itself, or else route them to the correct target (one of the SWA sensors: EAS1, EAS2, PAS or HIS).

Each received TC packet is characterized by the following data:
- Process Identifier (PID)
- PUS Service Type (ST) set to one of the mission-specific service types implemented by the ASW managers
- PUS Service Subtype (SS) set to one of the mission-specific service subtypes implemented by the ASW managers.

The TC_Management uses the ST and SS information to dispatch the received TC packets to the respective ASW assembly/subsystem manager. When a TC packet is received, it is made available to the destination manager during the same activation, provided that it is not processing another TC; hence, its processing can begin immediately (during the same time slice).

To avoid possible delay in TC(9,129) and TC(20,128) execution due to ‘BUSY’ state of an ASW TC executor Manager, all the ExOS received TCs will always be acquired, checked and queued on an internal TC_Mngr message queue in order to preserve the correct TC sequencing. Nevertheless a valid TC(9,129) or TC(20,128) will not be queued but instantly executed by means of a dedicated set of services.

For the EAS and PAS sensor's TCs, the ASW will transform the received and validated CCSDS standard TCs into dedicated SpW format messages supported by the sensor (typically a memory write/read message), while for the HIS sensor addressed TCs, the ASW will route them without any specific validation and transformation.

Note: The execution/routing of TCs will be conditioned to the current ASW Operative State (e.g. sensor configuration commands could not be routed if in Science Mode).

2.5.1.3.2 SWA_DPU_Management,

The SWA_DPU_Management class is in charge of handling the TCs to be executed on board the DPU and not to be routed to the sensors. These TCs are needed to control the SWA DPU experiment in terms of:

- SWA DPU state management (forbidden transition between states will be checked and avoided)
- SWA DPU Boot report reporting to S/C
- Dump/Reset the error log
- SWA DPU configuration parameters management (both the scientific algorithms and sensor configuration parameters). It will be possible to:
  - Upload new parameter values
  - Discard the just uploaded parameters values
  - Make the just uploaded parameter values permanent in RAM
  - Restore the default parameter values
  - Report the actual configuration parameters values. A local default copy of the parameters default value will be stored on-board the DPU as constant
- Modify macro
- Enable/Disable scientific algorithms activation
- Enable/Disable RPW trigger handling
- Enable/Disable book-keeping algorithm

The SWA_DPU_Management class is activated once during the ASW offline initialization phase by triggering the DPU_Mngr.Init operation. It is activated once per time slice during the ASW online by triggering the DpuMngr_class.Activate operation. Every time the SWA_DPU_Management class.Activate operation is called (following the completion of the online initialization phase), the following actions are executed:

- Process_Tc, to process an incoming TC
- updateDpuHkMngrInfo, to supply the ASW HK TM Packet with the DPU Manager contribution

The current SWA DPU state info will be used by the other subsystem manager to check that the incoming TCs are valid versus the current SWA DPU state.

2.5.1.3.3 FDIR_Management

The FDIR_Management class is in charge of the configuration, detection and proper handling of the DPU SWA failures and monitoring activities. The DPU ASW will be able to monitor a limited set of DPU and sensors parameters and take autonomous actions in case of limit violation (internal configuration tables will define the enabled surveillance and related recovery action). The objectives of increasing autonomy are to allow the ASW to take decisions on the activities to be performed when unplanned events are detected with the aim to reduce or suppress their impacts. If this will not be possible, the ASW will put the SWA Instruments in a safe configuration where all the nominal operations are suspended. This configuration can only be exited from a ground command.
The applicable failure detection, isolation and recovery strategies implemented by the ASW result from the combination of direct actions performed by the ASW and the services provided by the PUS Library services (Application Service Software layer). For further details on the just identified surveillance see section 4.5.3.

The FDIR_Management class will manage the identified monitoring with reference to a configurable table (Monitoring_Configuration updatable via dedicated TC) in which the following information will be defined:

- An overall monitoring status
- For each monitoring item (MI) will be reported:
  - The Enable/Disable status of the monitoring
  - The Identifier of the parameter to be monitored
  - The Identifier of the validity parameter
  - The type of parameter among the following:
    - UNSIGNED SHORT
    - FLOAT
  - The valid low threshold value for the specified parameter
  - The valid high threshold value for the specified parameter
  - The filter value to be used as failure confirmation
  - The identifier of the event to be generated if the parameter is lower than the low threshold value for more than "filter" times
  - The identifier of the event to be generated if the parameter is greater than the high threshold value for more than "filter" times

Each monitoring parameter has two different, associated event identifiers needed to address the software recovery actions to be executed in case of a confirmed fault condition (both lower and higher fault conditions). The FDIR_Management class also implements some mission specific services in order to configure (i.e.: ENABLE/DISABLE/RESET) the event error action handling.

The FDIR_Management class will manage the identified event error with reference to a configurable table (named “eventHandlerConfiguration”) defined as follows:

- An overall event error status
- For each identified event error the following will be reported:
  - eventEnabledStatus: This flag enable/disable the handling of the actions (both TM issuing and recovery action activation) related to the event
  - RecoveryLevel: For each of the two recovery level the following info are specified:
    - filter: The threshold value used to consider the event, "confirmed"
    - recoveryId: The logic identifier of the software recovery action to be activated
    - suspensionTime: The timeout value for current event identifier suspension handling

The following FDIR configuration TCs will be handled:

- ENABLE_MONITORING_ITEMS: To enable the overall monitoring activity or the single monitoring item
- DISABLE_MONITORING_ITEMS: To disable the overall monitoring activity or the single monitoring item
- CONFIGURE_MONITORING_ITEMS: To change the configuration parameter values related to the addressed monitoring items
- REPORT_MONITORING_CONFIGURATION: To report the actual monitoring items configuration parameter values
- ENABLE_EVENT_ID: To enable the specified event identifiers handling
- DISABLE_EVENT_ID: To disable the specified event identifiers handling
- RESET_EVENT_ID_CNTR: To reset the error condition counters for the specified enable the specified event identifiers

The FDIR_Management class is activated once during the ASW offline initialization phase by triggering the FDIR_Mngr.Init operation. It is activated once per time slice during the ASW online by triggering the FdirMngr_class.Activate operation.

Every time the FDIR_Management class.Activate operation is called (following the completion of the online initialization phase), the following actions are executed:

- Process_Tc: To process an incoming TC
- ExecMonitoring: To perform the scheduled monitoring activity
- HandleErrHandlerSuspension: To handle the suspension period related to the single event recovery action execution

The monitoring activity is performed by means of an activity table (named fdirActivityTable). This table contains, for each time slice (minor cycle), the list (of max “MAX_ACTIVATION_MON_ITEMS“) of the monitoring items to be managed. This table can be modified only by means of memory load (PUS 6 Service) commands.

2.5.1.3.4 Time_Management

The Time_Management class is in charge of keeping updated the time information inside the SWA-DPU ASW, by propagating the received S/C time information to the sensors. Furthermore it will process the TC 9 (time synch') coming from the spacecraft, and use it to update the internal SCET time.

The synchronization will use the following information:

- SCET time received from the S/C via TC(9,129) , at least 300 ms before the SpW time code reception
- SpW time code sent by S/C each second

The low level SPW handler (ExOS) is responsible for updating the SWA DPU local SCET value. The update is performed as follows:

i.) The 'fine time' part of the local SCET will be updated by means of an internal DPU clock. The three most significant bits (Msb) of the 'fine time' will count a single 125 msec interval (time slice counter).

ii.) The 'coarse time' part of the local SCET will be updated with the info contained both in the SpW time code and TC(9,129). At each new second start, the 'fine time' part will be zeroed.

iii.) If a TC(9,129) is received and validated, the ASW will notify ExOS of the newly received SCET value by means of a dedicated service call
    a. ("EXOS_ASW_DPM_SetSCETRequest").

Note, the generation of a TC(9,129) to the HIS, or the equivalent 'register write' command to EAS and PAS will be commanded to the ASW.

iv.) When ExOS receives the next SpW time code message it will update the local SCET value as follows:
    a. If available, it will use the SCET value communicated with the "EXOS_ASW_DPM_SetSCETRequest" service call, otherwise it will;
    b. use the SpW time code info (this contains the 6 least significant bits of the 'coarse time' part).

v.) The local SCET time will also be updated in the following case:
    a. No SpW time code received or;
    b. Wrong SpW time code received.

In any case ExOS will send a SpW time code message to all the SWA sensors.

2.5.1.3.4.1 SENS_ Management

This is a set of SW managers each devoted to the management of a specific sensor. The four classes are:In particular, four classes are foreseen:

- EAS1_Mngr
- EAS2_Mngr
- PAS_Mngr
- HIS_Mngr

These classes manage the routing of commands to the relevant sensors. They receive HK and Science data from the sensors and process the acquired data according to the sensor operative mode and the SWA DPU status information.

They perform their activities according to a table driving approach, defining the activities to be performed during each Time Slice. The single activity execution depends on the Sensor and SWA DPU Manager states.

In this way, every time the Activate procedure is activated, the sensor manager will be in charge of performing the following activities:

- Process the sensor manager specific TCs (i.e. switch sensor mode, etc)
- Execute the activities table (activation) activity

To synchronize all the sensor entering their burst mode, a common sensor manager is used in order to send a specific command to all the sensors (EAS1, EAS2, PAS and HIS).

2.5.1.3.4.2 EAS1_Mngr and EAS2_Mngr

The EASMngr1_class and EASMngr2_class are in charge of controlling the EAS sensors in terms of:

- TC processing
- EAS states & modes management
- EAS data acquisition according to the particular EAS state/mode
- EAS moment computation triggering
- EAS rolling buffer management (sampling collection and data transmission in case of a RPW triggering)
- EAS data nominal data compression (full 3D at 100 Hz)
- EAS contribution to HK and Science products (via PUS services)
- EAS HK data monitoring

The EASMngr1_class and EASMngr2_class are activated once during the ASW offline initialization phase by triggering the related “Init” operation.

The EASMngr1_class and EASMngr2_class are activated once per time slice during the ASW online by triggering the related “Activate” operation.

Every time the Activate operation are called (following the completion of the online initialization phase), the following actions are executed:

For each activity in the activity table for the current time slice

- Retrieve the current activity from the activity table
- Send the command to execute the activity
- Process the resulting code associated with the current executed activity

After these actions, the following takes place:

- a "ProcessBurstMode" internal service is called in order to process an EAS burst mode request. This maintains the sensor in burst mode for the relevant time and passes information received from MAG related to the selected EAS and elevation to the EAS burst processing.

- the "updateEasHkMngrInfo" service is called in order to keep the EAS manager internal SW HK data updated.

The following activities are cyclically executed:

i.) TcProc: To execute a received TC. For a complete list of EAS managers handled TCs see 6.2.1 .

ii.) DataAcq: To perform the following actions:
   a. Retrieve the data packet coming from the sensor
   b. Classify the received data according to the packet header
   c. Process the classified data in order to handle:
      1) A ACK/NACK in response to a command sent to the sensor
      2) Read data generated from a DUMP command
      3) A science data block
      4) HK data
   d. Handle a heartbeat counter in order to implement the EAS communication protocol surveillance

iii.) RollBuff: To retrieve and correctly manage the compression and delivery to S/C of the 5 minutes rolling buffer, following a reception of the relevant trigger from RPW. The function can be enabled/disabled by means of a dedicated TC.

iv.) EasMon: To analyse the monitoring items related to the EAS heartbeat management. This verifies that during the observation time (missingTmTime) at least a TM is received from the sensor.

2.5.1.3.4.3 PAS_Mngr

The PASMngr_class is in charge of controlling the PAS sensors in terms of:

- TC Processing
- PAS states & modes management
- PAS data acquisition according to the particular PAS state/mode

- PAS moment computation triggering
- PAS rolling buffer management (sampling collection and data transmission in case of a RPW triggering)
- PAS data nominal data compression and peak tracking computation
- PAS contribution to HK and science products (via PUS services)
- PAS contribution to “information distribution services” (PUS Service 20: Inter Instrument Information Distribution),
- PAS HK data monitoring

The PASMngr_class behaviour is similar to that of the EAS manager classes. The only differences being how the sensor is controlled to perform its science data production (i.e. sweeping algorithm programming via parameter table handling).

Further details will be provided when detailed PAS information documents are available.

2.5.1.3.4.4 HIS_Mngr,

The HISMngr_class is in charge of controlling the HIS sensor in terms of:

- TC processing
- HIS HK and scientific data acquisition
- HIS contribution to HK and science products (via PUS services)

The HisMngr_class is activated once during the ASW offline initialisation phase by triggering the related “Init” operation.

The HisMngr_class is activated once per time slice during the ASW online by triggering the related “Activate” operation.

Every time the Activate operation is called (following the completion of the online initialisation phase), the following actions are executed:

For each activity in the activity table at the current time slice

- Retrieve the current activity from the activity table
- Send the command to execute the activity
- Process the resulting code associated with the currently executed activity

When all the current time slice address activities have been executed, the “updateHisHkMngrInfo” service is called to keep updated the HIS manager internal SW HK data.

The following activities are cyclically executed:

i.) TcProc: To handle the S/C OBC received TC to the HIS. Two kind of TCs are handled:

a. HIS Manager TCs: These TCs are directed to the HIS manager in order to execute activity at HIS manager level (e.g.: Switch On/Off HIS sensor or perform HIS safe reset).
b. HIS Internal TCs: These TCs are directed to the HIS sensor and non checks are performed on their content. Although the HIS manager only acts as a pass-through to the sensor, the related ACK/NACK messages from the HIS are checked and forwarded to the S/C OBC without interpreting their content.
c. For a complete list of HIS manager handled TCs see Appendix 6

ii.) DataAcq: To perform the following actions:
   a. Retrieve the data packet coming from the sensor
   b. Classify the received data according to the packet header
   c. Process the classified data in order to handle:
      1. A ACK/NACK in response to a command sent to the sensor
      2. Read data generate from a DUMP command
      3. A science data block
      4. HK data
   d. Handle a heartbeat counter in order to implement the HIS communication protocol surveillance

iii.) HisMon: To analyse the monitoring items related to the HIS heartbeat management. This verifies that during the observation time (missingTmTime) at least a TM is received from the sensor

iv.) HisTcCheck: To handle the reception of ACK/NACK CCSDS message from HIS if a private HIS TC has been sent. If no ACK/NACK message is received after a configurable timeout, a monitored item error counter is incremented in order to be considered a communication lost condition (see 4.5.3.1 for details)

v.) HisRec: To execute the recovery action started as a consequence of a confirmed failure (both by FDIR Management or internally by the HIS Manager)

2.5.1.3.5 PUS Services SW

The Packet Utilization Standard and Mission Specific Services, provide a set of libraries and autonomous functions. They implement the PUS services defined for the SWA DPU Application Software in NR-02.

The following services have been implemented:

- TC packets verification PUS 1 service
- Cyclic housekeeping TM packets definitions (PUS 3 service),
- Asynchronous events TM packets definition (PUS 5 service),
- PROM/EEPRO/RAM memory management (PUS 6 service),
- Time management (PUS 9 service),

- Monitoring management (PUS 12 Service),
- Test connection (PUS 17 service),
- Information distribution management (PUS 20 service),
- Science data transfer management (PUS 21 service).

2.5.1.3.5.1 TC packets Verification (PUS 1 service)

These exported services are used to generate reports to the TC command source in order to verify the identified commands at acceptance and/or execution. The reports are from the TC destination application managers.

By setting the relevant two bits in the ACK field of the TC packet header, the command source can ask for an acceptance report and/or an execution report.

The two bits can be set to any value and are used to generate the required reports.

The acceptance report is generated immediately after completion of checks on validity of the TC packet content (header, data header and data field).

The execution report is generated after internal verification of TC execution.

For SWA-DPU the response required has been restricted to the following:

- 0000: Both acceptance/execution success reports are not generated. This is not applicable to acceptance and execution failure reports
- 0001: Only acceptance success or failure reports (service report sub-type 1 or 2) are generated (sub-type 7 or 8 are not generated)
- 1000: Only execution success or failure reports (service report sub-type 7 or 8) are generated (sub-types 1 or 2 are not generated)
- 1001: Both acceptance and execution success or failure reports are generated

The following common Services are provided:

- ExecuteTvsSendTmTars: to format and issue an acceptance success report
- ExecuteTvsSendTmTarf: to format and issue a failure acceptance report
- ExecuteTvsSendTmTecs: to format and issue an execution success report
- ExecuteTvsSendTmTecf: to format and issue an execution failure report

2.5.1.3.5.2 Cyclic Housekeeping TM packets definitions (PUS 3 service)

These exported services are used by the SWA-DPU to generate the HK TM packet

The following Services are provided:

- Activate: Used by the PusMnger class to handle the issuing of the HK TM packets to the OBC
- executeHdrsEnableDisableHkSid: To enable/disable the issuing of the single HK TM packet
- executeHdrsModifyHkRate: To modify the issuing rate of the specified TM packet

2.5.1.3.5.3 Asynchronous Events TM Packets definition (PUS 5 service)

These exported services are used by the SWA-DPU to generate the event TM packet. This service is also used by the ASW Components in order to issue an event TM packet to the OBC.

The following services are provided:

- executeErsSendReport: To format (with data supplied by the caller) and issue a single event TM Packet to the OBC. The following event TM Packet can be generated:
  - TM (5,1) Normal event - progress report
  - TM (5,2) Warning event - low severity anomaly
  - TM (5,3) Error - medium severity anomaly - ground action requested
  - TM (5,4) Error - high severity anomaly - on-board action requested

- executeErsEnableDisableEvntId: Used to enable/disable the handling (i.e. issuing) of a set of an event TM packet.

2.5.1.3.5.4PROM/EEPRO/RAM Memory Management (PUS 6 service)

These exported services are used by the SWA-DPU to access the Memory Management.

The following Services are provided:

- Activate: To perform the cyclic action in order to schedule a requested DUMP or CHECKSUM activity
- executeMmsLoadMemoryArea: To check and execute the TC related to a LOAD_MEMORY request
- executeMmsDumpMemoryArea: To check and execute the TC related to a DUMP_MEMORY request
- executeMmsCheckMemoryArea: To check and execute the TC related to a CALCULATE_CHECKSUM_MEMORY request
- executeMmsAbortDump: To stop an on-going long DUMP activity

2.5.1.3.5.5 Time Management (PUS 9 service)

This service is implemented by a dedicated class named TIME Manager (see 2.5.1.3.4)

2.5.1.3.5.6 Monitoring Management (PUS 12 Service)

This service is implemented by a dedicated class named FDIR Manager (see 2.5.1.3.3)

2.5.1.3.5.7 Test Connection (PUS 17 service)

These exported services are used by the SWA-DPU when a connection test is requested by the OBDH.

The following Service is provided:

- ExecuteTestConnection: To format and send an empty/dummy TM packet to the OBDH.

2.5.1.3.5.8 Information Distribution Management (PUS 20 service)

Service (20,128) packets are sent from the OBC to all the Solar Orbiter payload instruments in order to:

- Act as an OBC heartbeat to the payload instruments so that they can perform a controlled shut down in case the spacecraft enters survival mode
- To distribute inter-instrument communication data

The exported services are used by the SWA-DPU to handle the OBC distributed inter experiment data. The same message is received by all the Solar Orbiter experiments in order to share a common set of information.

The following Service is provided:

- ProcessInterExperimentData: To extract from the received message the data needed by EAS and PAS sensors managers (from MAG and RPW) and save this in dedicated structures. This service also activates the EAS/PAS rolling buffers, freezing (and compressing) activity.

2.5.1.3.5.9 Science Data Transfer Management (PUS 21 service)

These services are used to handle the data transfer TCs received from OBDH.

The following Service is provided:

- executeSdtrEnableDisableScienceTmPcktGen: To enable/disable the issuing of the generic scientific TM packet
- executeFormatScienceTmPkt: Used by all sensor managers to perform the formatting and issuing of the a Scientific TM Packet.

2.5.1.4 Scientific Data Processing Software Description

The Scientific data processing software (SDPSW) performs both the calculation of the moments of a distribution and the proper raw data compression. The following subsections briefly describe, from a functional point of view, the way the collected scientific data is processed in order to achieve the scientific goals of the mission.

2.5.1.4.1 Data Compression

The lossless data compression SW performs the removal of the redundancy in a sampled distribution function while preserving the source data accuracy, in order to give a more compact representation of the input data. A CCSDS 121 compliant algorithm has been assumed for lossless data compression purposes.

Inputs required are:

- Raw data, collected by the sensors in their specific operational modes, i.e. the sampled distribution functions
- Auxiliary data, used to identify and properly manage the data product to compress, and a set of configuration parameters of the algorithm

The outputs of this procedure are:

- Compressed data packets, representing the un-redundant raw data

- Header containing the data description
- Information necessary to recover the original data source

Data compression functionalities are common to both EAS and PAS data. Compression can also take place during normal mode and triggered mode. However the data compression is performed in a different manner depending on the sensor mode.

According to ASW architecture, in the normal mode, compression tasks are performed inside a determined slot (spanning over more slots) while compression tasks during triggered mode are managed using a separate, parallel, task with a low priority level.

This functional scheme is sketched in Figure 2.15.

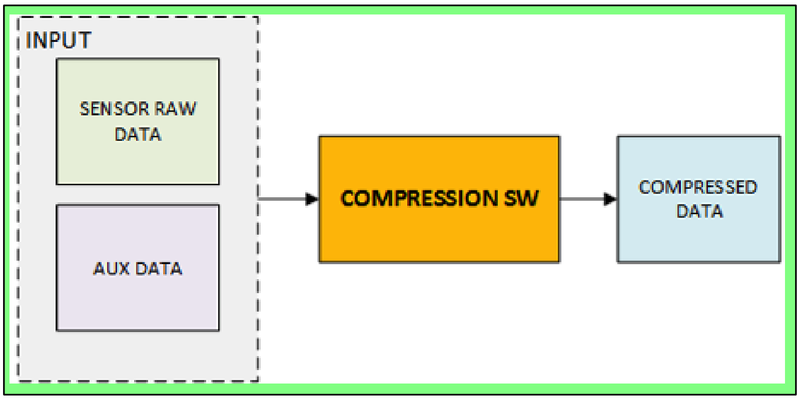


Figure 2.15 Compression SW block diagram.

2.5.1.4.2 Moments Calculation

The moments calculation module calculates a set of statistically meaningful parameters corresponding to the moments of the distribution function. Its execution is split into two phases:

- Initialisation phase, performed only once when sensors are powered-on
- Run time phase, performed each time moments data is required

The initialization uses configuration data as inputs and produces processing coefficients for the run time phase.

At run time, moments computation needs as input:

- Raw data, collected by the sensors in their specific operational modes, e.g. sampled distribution functions
- Auxiliary data (“Spacecraft Potential” received by RPW, etc, the full list is described in next section), used to configure algorithm flow

The output is a set of statistical parameters:

- The zero-order moment, called *number density*;
- The first-order moment, called *number flux density vector*;
- The second-order moment, called *moment flux density tensor*;

- The third-order moment, called *energy flux density vector* (only for EAS data).

The moments calculation is based on slightly different algorithms in EAS and PAS cases.

According to ASW architecture and the required computational load, the execution of this module has to be spanned over different slots (saving the state until the task is completed).

The “offline” initialization phase is performed only once at sensors power-on, and whenever the set of constant configuration parameters is updated.

For these reasons, management of the memory is required. Most is allocated at initialization and cannot be freed until sensors are acquiring data (or initialization has to be repeated). At run time, each time the module is invoked, additional memory has to be allocated to input and output data within the first slot and can be freed only when last of the moments is evaluated in the last slot.

This functional scheme is illustrated in Figure 2.16.

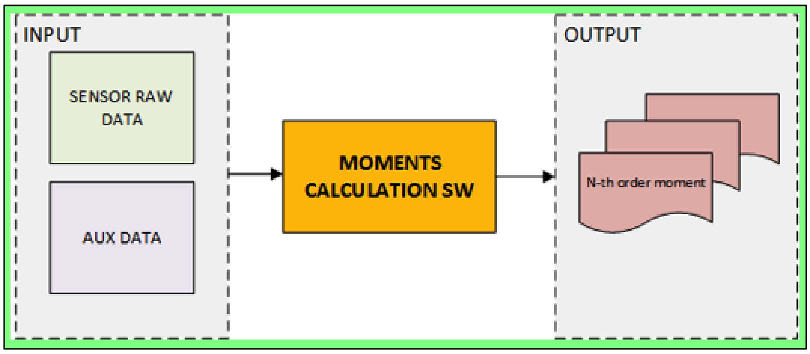


Figure 2.36 Moments Calculation SW block diagram.

2.6 Payload Data Definition

The user manual for the FM will, for each operational mode of the payload, describe the following.

• sensor output data, the conditions under which it is generated, its contents, and data rate;

• the on-board processing performed on the sensor data and the algorithms used for this;

• the data management concept (including storage and transfer), both at instrument and platform (SSMM) level;

• a reference to the data processing algorithms necessary to interpret the payload telemetry on- ground (referenced documents provided separately);

• for each data type (at packet level) the susceptibility to loss of single packets shall be stated, in terms of the impact on data quality.

The current operational plan is given in IR11and intereperimental details are given in the EID-B [IR12].

Table 2-7 below shows the summary of data products for the individual sensors.

Sensor	Science Mode	Destination Packet Store (see Section 4.2)	Data Product
EAS	Normal Mode	Low-latency (priority download)	Single Energy 2D VDF (≥100s TBC)
		Regular (all downloaded)	Electron Moments (4s)
			Full 3D VDF (≥100s TBC)
		Selective	Trigger buffer freeze (on event)
	Burst Mode	Regular (all downloaded)	Scheduled Burst (5 mins core)
		Selective	Scheduled Burst (selectable)
	Low Cadence Mode	Low-latency (priority download)	Single Energy 2D VDF (much reduced cadence, ≥400s TBC)
		Regular (all downloaded)	Moments (4s)
			Full 3D VDF (much reduced cadence, ≥400s TBC)
		Selective	Trigger buffer freeze (v limited use)
HIS	Normal Mode	Low-latency	2x Charge State Ratios
			Start rates
		Regular (all downloaded)	NM Rates
			NM PHA's
	Low Resolution Mode		Low Res Rates
			Low Res PHA's
	Burst Mode		BM Rates
			BM PHA's
PAS	Normal Mode	Low-latency	Ion Moments (4s)

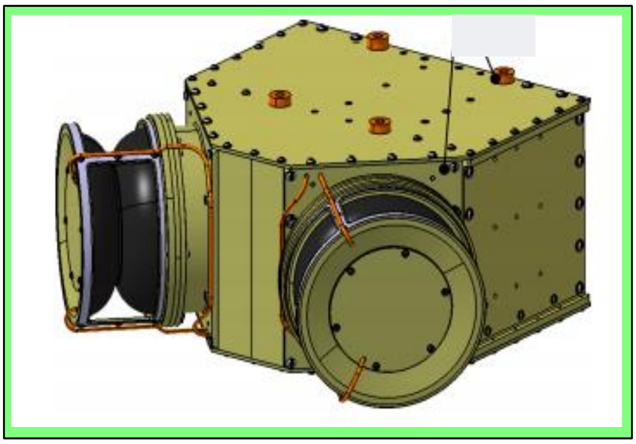
		Regular (all downloaded)	3D VDFs (4 sec cadence)
			Options for PAS reduced 3D VDF’s at higher time resolution during the 8 secs of RPW snapshot every 300 secs
		Selective	Trigger buffer freeze (per event)
	Burst Mode	Regular (all downloaded)	Options for 2D/3D VDFs at high cadence during scheduled burst (core)
		Selective	Options for 2D/3D VDFs at high cadence during scheduled burst (selectable)
	Low Cadence Mode	Low-latency	Ion Moments (4s)
		Regular (all downloaded)	3D VDFs (> 16 sec cadence)
			Options for PAS reduced 3D VDF’s at higher time resolution during the 8 secs of RPW snapshot every >1200 secs

Table 5 Sensor data products, compression rates and priority

3 INSTRUMENT INTERFACES

3.1 Mechanical

SWA-EAS Mechanical Interface:

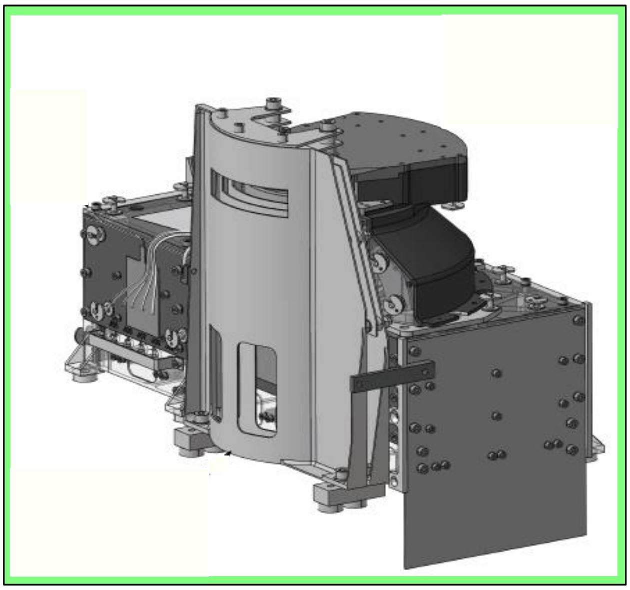


The SWA-EAS is bolted to a bracket on the extreme outboard end of the spacecraft boom such that it hangs below the outboard end of the boom (see Figure 2.2).

Full details of the mechanical interface is given in the EAS Mechanical Interface Document [NR-03].

Figure 3.1 Illustration of the EAS sensor

SWA-PAS Mechanical Interface:

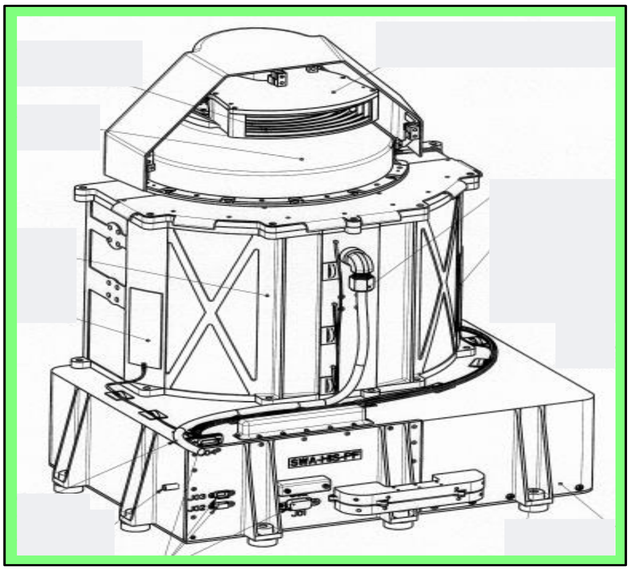


The SWA-PAS is bolted to a corner of the main spacecraft body such that it faces the Sun through the solar radiation shield (see Figure 2.2).

Full details of the mechanical interface is given in the PAS Mechanical Interface Document [NR-04].

Figure 3.2 Illustration of PAS

SWA-HIS Mechanical Interface:

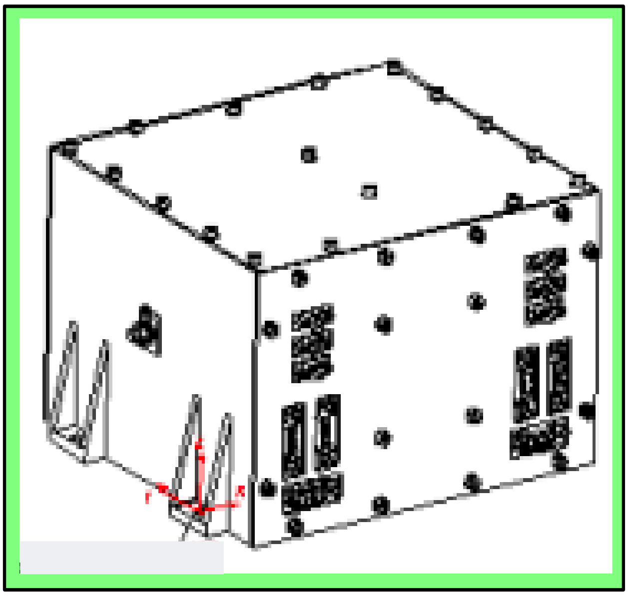


The SWA-HIS is bolted to a corner of the main spacecraft body such that it faces the Sun through the solar radiation shield (see Figure 2.2).

Full details of the mechanical interface is given in the Mechanical Interface Document [NR-05].

Figure 3.3 Illustration of the HIS sensor

SWA-DPU Mechanical Interface:



The SWA-DPU is housed in the main spacecraft body (see Figure 2.2).

Full details of the mechanical interface is given in the DPU Electrical Interface Document [NR-06].

Figure 3.4 Illustration of the DPU

3.2 Thermal

SWA-EAS thermal interface:

The SWA-EAS is wrapped in a multilayer thermal blanket each section of which has dual grounding leads that run to an M4 x 0.7 x 8 long grounding stud on the back face of the instrument. A grounding lead from the boom attaches to the same stud.

The SWA-EAS thermal blanket is designed to function independently from the boom and it is important that the MLI does not make any hard contact with the boom bracket that would cause a thermal short.

It is vital that the outer surface of the MLI is electrically conductive and that no non-conductive fixings or other external surfaces that could charge up are present in the region of the analysers.

SWA-PAS thermal interface:

PAS thermal control (see Figure 25) consists of:

1. Multiscreen thermal shield coated with Solar Black on the front surface
2. Two radiators located on the top (-Zsc) and on the –Ysc sides
3. Rest of instrument surface (except –Zsc sensor site) is coated with MLI. The instrument is thermally insulated from the SC with insulating washers (TBD, post-CDR action)

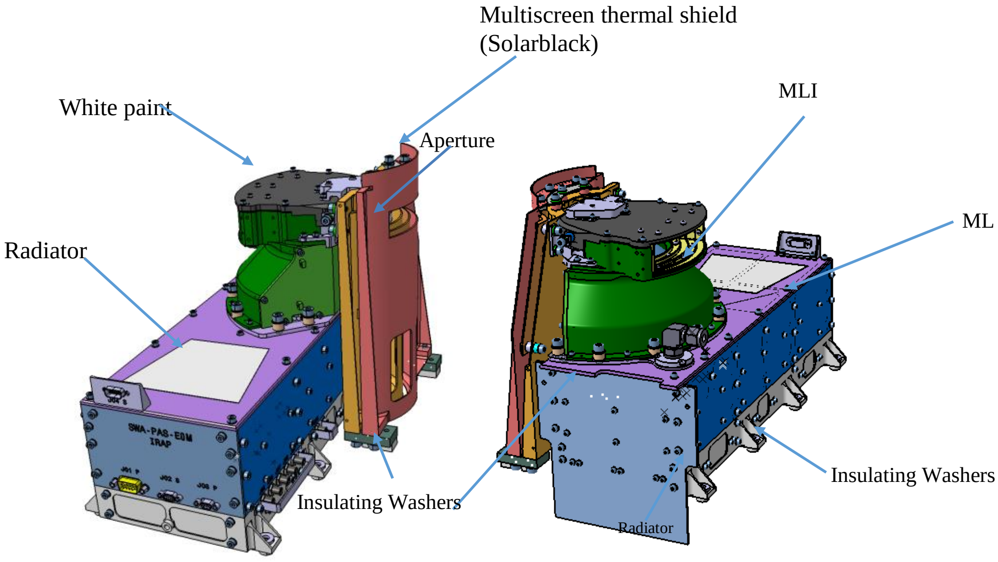


Figure 3.5 - PAS thermal design

SWA-HIS thermal interface:
The principle of the thermal protection and a detailed thermal model with its results are discussed below. The model is intended to determine the feasibility of the instrument design with the large variation in the external heat flux (solar flux) of the SO mission and to determine required thermal control surfaces (radiators) and hardware (heaters).

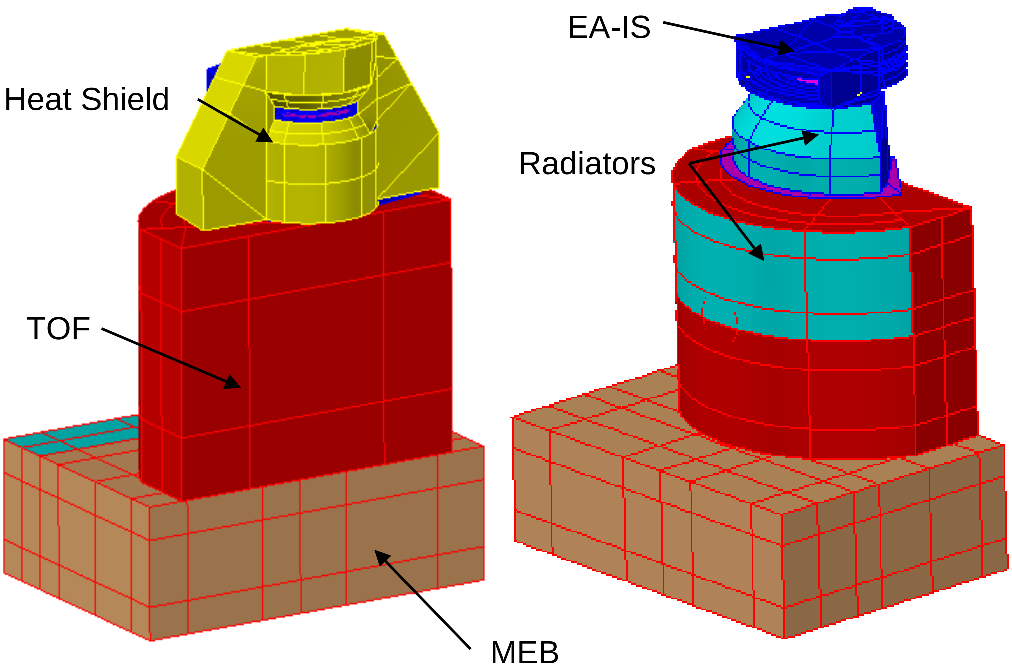


Figure 3-6 HIS Thermal Control Systems

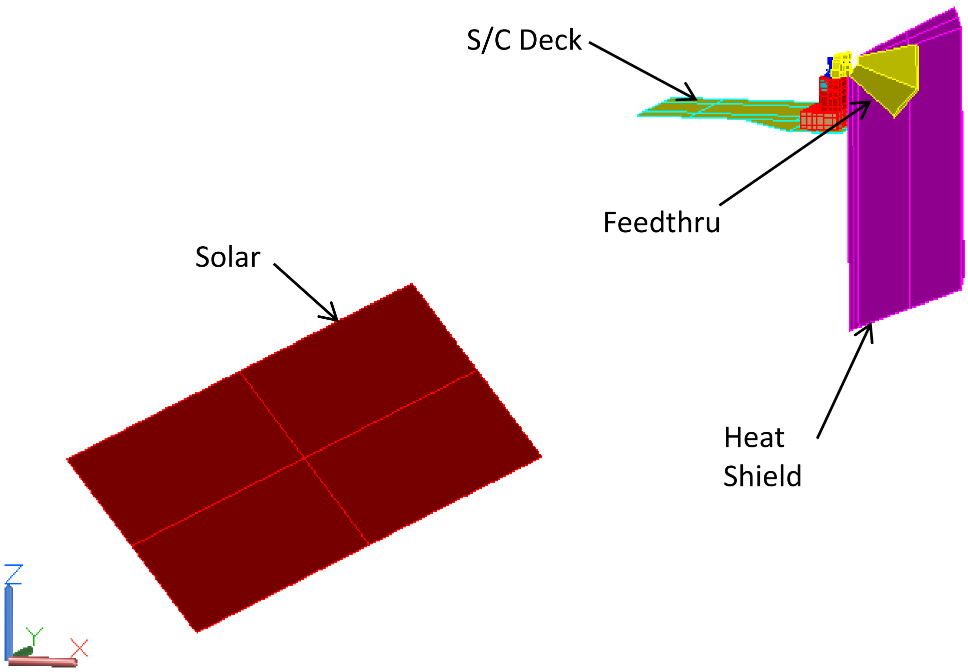


Figure 3-7 HIS Spacecraft Thermal Accommodation

The illuminated EA-IS part is mostly covered by a shield with a front surface illuminated by the Sun. Its z face is used as a radiator and it is conductively isolated from the instrument housing with the use of ceramic spacers and titanium bolts. The heat shield surface reaches an equilibrium temperature of ~ 225°C.

MLI will be used on all external surfaces with the exception of heat shield, aperture, and radiators to isolate the HIS box from the radiative environments of the heat shields, spacecraft, and space. The instrument is also conductively isolated from the spacecraft at the nine mounting feet with the use of Ultem 1000 spacers and titanium bolts. In addition, the EA-IS is conductively isolated from the TOF section by an Ultem interface plate.

The majority of the direct solar flux crossing the entrance slit of the HIS system does not intersect any electrode and freely escapes the box through an adapted aperture in the -x side. However, a part of the entrance aperture is illuminated by the sun. Taking into account the irradiated flux from the backside of the heat shield and the incident solar on the entrance aperture, the total thermal load on the HIS box (at perihelion) would be typically 8.5 W. The internal dissipation from electronics in the HIS box is ~8 W during operation.

A part of the surfaces on the EA-IS and TOF housings will be exposed and used as radiators. The radiating surfaces are coated with high emissivity conductive paint (the same paint system is used for the EA-IS and TOF radiators). A survival temperature of ~ –45°C is obtained if an average power of 5 W can be provided to HIS. In conclusion, this model shows that with realistic constraints and relatively simple design, using well tested materials, the sensors and electronics temperatures are maintained in an acceptable range. To optimize the design, detailed modeling and testing in realistic conditions will be done at a solar furnace facility.

The isolation at two interfaces is also a necessary part of the design. The EA-IS to TOF interface is isolated by using an Ultem attachment plate. The conductance here should be less than 0.0035 W/C per attachment. Isolation between the MEB and S/C is also required and should be less than 0.0045 W/C per attachment (9X).

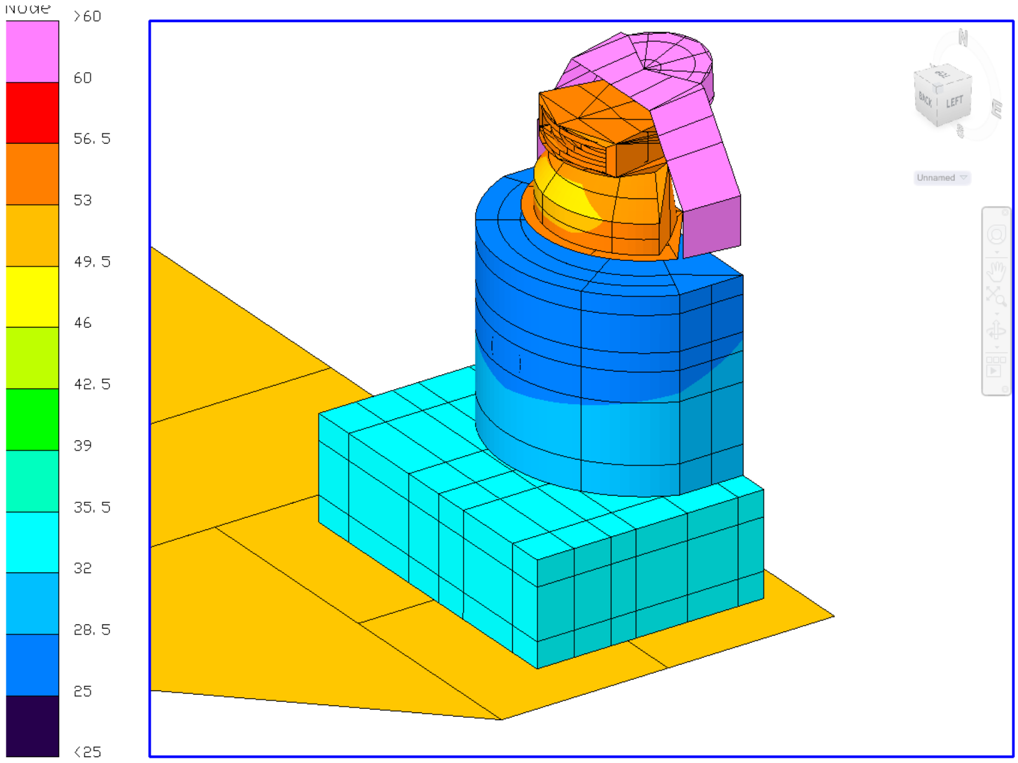


Figure 3-8 HIS Thermal Model (Hot Operating)

Survival (non-operational) heaters are required for the HIS instrument. They are mounted on the side walls of the HIS electronics enclosure structure. The required average heater power to maintain the instrument within allowable flight temperature range for the cold non-operating condition is the requested 5.0 W. The allowed instantaneous power is 10 W at 27 V per the EID-A. This results in an equivalent heater circuit resistance of 73 Ohms. There are two heaters combined in parallel (one on each side of the TOF housing) so the individual heater resistance is 146 Ohms. To meet the density requirement of <.27 W per sq cm the heater patch size is specified to be at least 25 sq cm so at nominal voltage of 28 V the Watt density will be 0.21 W per sq cm.

3.3 Power

SWA is powered by a 2A LCL and is powered on and off by HVPC. The status is monitored by a standard BSM. SWA may be powered using the Nominal or the redundant power service.

Unit	Normal Mode nominal power (mW) including contingency		
	short peak[3]	long peak[2]	average[1]
EAS1 and 2	7293	6607	6213
PAS	5800	4700	3800
HIS	10076	10076	9009
DPU	13987	13170	11145
Total	37156	34552	30168
Current at 26V	**1.4291**	**1.3289**	**1.1603**

Table 3-1 SWA Peak and Average Power Consumption

The DPU routes and switches primary power to each SWA sensor. In the event of the loss of the primary power to the DPU, the power to each sensor will be interrupted. Data transfers to the SSMM and the OBC will be interrupted and will result in incomplete data distributions for each sensor.

Recovery of SWA will require a complete turn on sequence for the DPU and sensors.

The SWA sensors should always be powered down using the correct controlled power down sequence. This will ensure that all high voltages generated within the instrument have reduced to a low level before the HV control circuits are powered down.

An uncontrolled power shutdown should only be performed in emergency situations.

DPU	The DPU routes and switches primary power to each SWA sensor. In the event of the loss of the primary power to the DPU, the power to each sensor will be interrupted. Data transfers to the SSMM and the OBC will be interrupted and will result in incomplete data sets for each sensor. Recovery will require a complete turn on sequence for the DPU and sensors.

EAS	EAS has only volatile storage for sequence, after power down all data, sequence and configuration information is lost. This data will need to be re-loaded at the next power up. HVs will need to be ramped up under DPU control.
PAS	PAS has only volatile storage for sequence, after power down all data, sequence and configuration information is lost. This data will need to be re-loaded at the next power up.
HIS	On power up the DPU will need to send a small number of commands to switch from standby to science modes. HV ramping is performed internally by HIS software control, without the need for externally commanding.

Table 3-2 SWA response to uncontrolled shut down

A further details can be found in IR10 and in the EID-B [IR12

3.4 Data Handling

The interface between the SWA and the S/C will consist only of TC/TM packets. Some S/C on-board control procedures will be expected in order to control the SWA sensor suite. Specific information will be provided by the SWA contribution to the service 20. This will be signalled by the cyclic HK TM Packet (3,25), which contains the supplied and received data (see Appendix 6 for details).

3.4.1 SWA Service 20 contribution

Table 3.3 describes the data that will be provided by SWA-DPU Application SW as a contribution to the Service 20.

Field Name	Field Size	Description
Solar Wind Velocity Vector (Order 1 Pas Moment)	3 x 16 bits = 6 bytes	X, Y and Z coordinates (3) values
Proton Density (Order 0 Pas Moment)	1 x 16 bits = 2 bytes	1 value
Proton Peak	16 bits = 2 bytes	Data from PAS to HIS (calculated by ASW).
Flag Bits	1 byte	Two bits for each of the 4 sensors, denoting the following:

		• 00 = Not operating, • 01 = normal operation • 10 = burst mode operation
Total	11 bytes	

Table 3.3 Data provided by SWA-DPU to the Service 20

There is no EAS or HIS data provided from the DPU to the Service 20.

4 INSTRUMENT OPERATIONS

4.1 Operating Principles

The summary of the instrument operating principle, including a description of a typical operations timeline over an orbit is to be inserted.

4.2 Instrument Operations Constraints

This section will define all the constraints applicable to the flight operations of the instrument.

4.2.1 Internal Constraints

This section will describe the constraints on instrument and unit operations due to the instrument and unit internal design in the version for FM.

4.2.2 Environmental Contraints

4.2.2.1 Thermal Constraints

The required temperatures for switch-on of equipment, operational and non-operational temperature limits are given in IR12

4.2.2.2 Illumination Constraints

This section will give the constraints on illumination of the instrument aperture and will include a description of the required configuration in case of an attitude anomaly in the version for FM.

4.2.2.3 Attitude and Orbit Constraints

This section will give Constraints regarding required or forbidden operations depending on the mission phase and/or the S/C attitude in the version for FM. This shall include required calibration or engineering activities during the different mission phases. The current plan is given in Operational Concept report [IR11].

4.2.3 Spacecraft Related Constraints

This section will identify conflicts between instrument operations and specific spacecraft subsystem operations in the version for FM.

4.2.4 Ground Operations Constraints

This section will identify constraints imposed on the ground segment due to instrument design, e.g. required turn-around times for data re-prioritisation, needs for non-standard TM/TC resources for particular activities etc. The current plan is given in Operational Concept Report [IR11].

4.2.5 Operational Constraints With Other Instruments

Details of required simultaneous operations with another payload and triggered events is given in IR13.

4.3 Instrument Operating Modes

The current description of the engineering and operating modes is given in the Scientific Operations, Algorithms and Processes Requirements Document [IR17].

4.4 Autonomy

Autonomy functions as planned currently are given in the EID-B [IR12].

4.5 FDIR

The Failure Detection Identification and Recovery (FDIR) strategy is described in the following sections.

4.5.1 Instrument FMEA and FTA

TBC

4.5.2 Spacecraft Provided Monitoring

Although there is no specific SW monitoring of SWA by the spacecraft, ground will be informed about the actual status of the sensors. This critical information is supplied as status parameters in the cyclic HK TM packets. Due to some SWA internal recovery action, a single sensor can be put into a safing mode (i.e. turned off). The reactivation of the sensor is controlled by the ground following a reset of the failure condition (e.g. HIS has a dedicated TC in order to reset the data used to manage the HeartBeat monitoring).

4.5.3 SWA Internal Monitoring

Only the HIS Sensor it will be reported a detailed description of the requested surveillance and related recovery action.

The DPU ASW will be able:

- to monitor a limited set of DPU and sensors parameters and
- to take autonomous actions in case of limit violation (internal configuration tables will define the enabled surveillance and related recovery action).

The objectives of increasing autonomy are to allow the ASW to take decisions on the activities to be performed when unplanned events are detected with the aim to reduce or suppress their impacts. If this will not be possible, the ASW will put the SWA Instruments in a safe configuration where all the nominal operation are suspended and that can be exited only on Ground intervention (i.e.: command reception).

The applicable failure detection, isolation and recovery strategies implemented by the ASW result from the combination of direct actions performed by the ASW and the services provided by the PUS Library services (Application Service Software layer).

The following generic surveillances have been identified at SWA-DPU Application Software Level:

- SW failure condition as task overrun, exception, etc: These will be handled, reporting the condition to the Spacecraft and, if needed, will require an ASW reboot (NO S/C OBC intervention required)

- PCS (Primary Current) management: The primary currents are monitored and controlled in order to maintain the SWA Sensors (EAS1, EAS2, PAS and HIS) current in a valid operative range. The out of limit condition can be handled as follows (TBC):

    - First recovery level: Reset the sensor by means of a simple Power Cycling:
        - Power OFF
        - WAIT
        - Power ON
    - Second recovery level: Immediately power off the sensor:
        - Power OFF
        - Wait for ground intervention

- Spacecraft Link Monitor/Spacecraft not alive: No TCs or Service 20 or Time Code messages are received for a TBD second period. This will be interpreted as a major problem at Spacecraft Level thus all the SWA Sensors will be switched off and wait for a SWA power down by spacecraft

- Sensors SpW Links Monitor Sensor not Alive: No HK or Scientific telemetry packets received by DPU. This condition can be handled as follows:
    - First Recovery Level: Reset the affected sensor by means of a power off -> power on cycle
    - Second Recovery Level: The sensor is powered off until ground intervention

- Sensors Health Status handling: TBD Sensors Housekeeping data will be analysed in order to detect some failure condition. Two different scenarios can be possible:
    - The monitoring and related recovery action will be under the OBC control
    - The monitoring and related recovery actions are under DPU control

The current information about the Sensors HK data monitoring items and the related recovery actions is given in the SWA FDIR [IR18].

- Sensors HW Failure not recoverable by the Basic Software Level: E.g: the sensor doesn't react on the SpW, the services used to send/acquire data return an Error. This condition will be handled by powering off the affected sensor.

4.5.3.1 Specific HIS Sensor Surveillances:

HIS Housekeeping TM data:

No HIS Housekeeping Data monitoring is requested to the ASW.

HIS HeartBeat:

The ASW will be able to check if HIS generates any telemetry packet (housekeeping, science, events)

It will be considered a single failure if HIS does not produce telemetry packet for "MISSING_TM_TIMEOUT" (configurable parameter) seconds

When ASW checks this aliveness failure for N_INTERVAL (number of consecutive "MISSING_TM_TIMEOUT" intervals) intervals, the ASW will execute the following actions:

1. Send HIS a Safe-Mode request
2. Wait TBD (configurable) seconds
3. Turn OFF HIS (via EXOS low level services)
4. Wait TBD seconds
5. Turn ON HIS (via EXOS low level services)

Note: step 3 to 5 are known as "HIS power cycling".

The HIS failure condition will be checked for TBD (configurable) power cycles and the ASW will TURN OFF the HIS Sensor if it is waiting for a dedicated TC aimed at clearing the condition.

Power Draw:

The ASW will monitor the current draw of HIS from the power supply (this data belongs to the DPU HW Housekeeping Data). The HIS Power Draw value will be checked against two different validity thresholds values:

- Yellow Alarm
- Red Alarm

Both these value are configurable values inside the PUS Monitoring Service. The HIS power draw value lower than a "Yellow Alarm" value is the nominal condition. If the HIS power draw value is such that:

"Yellow Alarm" < Actual Power Draw value < "Red Alarm"

A controlled HIS Power Off is executed as follows:

- Send HIS a Safe-Mode request
- Wait TBD (configurable) seconds
- Turn off HIS (via EXOS low level services)

If the HIS power draw value is such that:

Actual Power Draw value >= "Red Alarm"

An immediate HIS Power Off is executed as follows:

- Turn OFF HIS (via EXOS low level services)

Communication Loss:

When the ASW routes a TC to HIS, it has to wait for the HIS appropriate service responses (TARS/TARF/TECS/TECF). If HIS does not send the responses in TBD (configurable) seconds, this will be treated as a single aliveness check and handled as HIS Heartbeat fail (see above section).

Note: two different configurable timeout values are possible for this surveillance:

- ACCEPTANCE_TIMEOUT: max time for the TARS/TARF reception
- COMPLETION_TIMEOUT: max time for the TECS/TECF reception

Event (5,3) Error/Anomaly Report - Medium Severity TM Packet reception

When the ASW receives event subservice 3 from HIS, the following actions will be performed:

- Route the received TM packet to the Spacecraft
- Wait 10 (TBC) seconds
- Power off HIS (via EXOS low level services)

Event (5,4) Error/Anomaly Report - High Severity TM Packet reception

When the SWA-DPU receives event subservice 4 from HIS, the following actions will be performed:

- Route the received TM packet to the Spacecraft after changing the subservice to 3 (the spacecraft interprets the event as ground action instead of in-flight action)
- Power off HIS (via EXOS low level services)

4.5.3.2 Specific EAS/PAS Sensor Surveillances:

EAS/PAS Housekeeping TM data (TBC):

At the moment MSSL has not specified the EAS/PAS Housekeeping Data monitorings and their validity ranges (if any).

EAS/PAS HeartBeat (TBC):

The ASW will be able to check if EAS/PAS generates any telemetry packet (housekeeping, science). It will be considered a single failure if EAS/PAS does not produce telemetry packet for "MISSING_TM_TIMEOUT" (configurable parameter) seconds. When ASW checks this aliveness failure for N_INTERVAL (number of consecutive "MISSING_TM_TIMEOUT" intervals) intervals, the ASW will execute the following actions:

- Turn off EAS/PAS (via EXOS low level services)
- Reset the EAS/PAS Manager SW status parameter to the default one
- Send an EVENT (5,3) TM packet to inform GROUND that EAS/PAS has been turned off

EAS/PAS Power Draw (TBC):

The ASW will monitor the current draw of EAS/PAS from the power supply (this data belongs to the DPU HW Housekeeping Data). The EAS/PAS Power Draw value will be checked against a single validity threshold value:

- Red Alarm.

This is a value configurable inside the PUS Monitoring Service. The EAS/PAS power draw value lower than a "Red Alarm" value is the nominal condition. If the EAS/PAS power draw value is such that:

Actual EAS/PAS Power Draw value >= "Red Alarm"

the ASW will execute the following actions:

- Turn off EAS/PAS (via EXOS low level services)
- Reset the EAS/PAS Manager SW status parameter to the default one
- Send an EVENT (5,3) TM packet to inform GROUND that EAS/PAS has been turned off

4.6 Operations Plan and Instrument Configuration per Mission Phase

The current level of planning is given in the Operations Concept report [IR11].

4.6.1 LAUNCH CONFIGURATION

TBC

4.6.2 LAUNCH AND EARLY ORBIT PHASE (LEOP)

TBC

4.6.3 NEAR-EARTH COMMISSIONING PHASE (NECP)

TBC

4.6.4 CRUISE PHASE (CP)

TBC

4.6.5 NOMINAL MISSION PHASE (NMP) / EXTENDED MISSION PHASE (EMP)

4.6.5.1 Calibrations and Engineering Activities

TBC

4.6.5.2 Routine Science Operations

TBC

4.7 Instrument Performance Evolution

TBC

5 INSTRUMENT FLIGHT OPERATIONS PROCEDURES

This section will define all procedures required for operation of the instrument in-flight in the version for FM.

5.1 Nominal Flight Control Procedures (FCP)

TBC

5.2 Contingency Recovery Procedures (CRP)

TBC

5.3 Commissioning Phase Procedures (COM)

TBC

6 APPENDIX A INSTRUMENT TM/TC ICD

6.1 SW DPU Telemetries

PUS MNGR HSK				
Parameter Tag	***Length (bytes)***	***Description***	***Allowable Values***	***SID Data Length***
TBD	2	SID		
TBD	1	lastAccTcl Service Type		
TBD	1	lastAccTcl Service Sub Type		
TBD	2	lastAccTcl PSC		
TBD	1	lastRejTc Service Type		
TBD	1	lastRejTc Service SubType		
TBD	2	lastRejTc PSC		
TBD	1	lastExecTc Service Type		
TBD	1	lastExecTc Service SubType		
TBD	2	lastExecTc PSC		
TBD	1	lastExecFailTc Service Type		
TBD	1	lastExecFailTc Service SubType		
TBD	2	lastExecFailTc PSC		
TBD	2	totReceivedTc;		
TBD	2	totAccTc;		
TBD	2	totRejTc;		
TBD	2	totNotExecTc;		
TBD	2	lastTcErr;		
TBD	2	lastTcErr;		
TBD	1	issuedTmPkt		
TBD	1	lostTmPkt		

Details on EAS/PAS Sensor Specific HK TM Packets content are missing due to the unavailability of the related specific documents.

6.2 SWA DPU Telecommands

6.2.1 DPU Manager TCs

6.2.1.1 Enter the DIAGNOSTIC mode

6.2.1.1.1 Description

This command configures the DPU Manager in “Diagnostic” Mode by activating the related MACRO.The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*

1	VN	TY	DF	**PID = 95 DEC**	PKT
2	SF	PSC			
3	PL				
4	SHF	PVN = 1	ACK	**ST = 200**	
5	**SS = 128**			SI	
6	PEC				

6.2.1.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
DiagEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
DiagEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

6.2.1.2 Enter the StandBy Mode

6.2.1.2.1 Description

This command configures the DPU Manager in “Stand-by” Mode by activating the related MACRO.

6.2.1.2.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 129**								SI							

6	PEC

6.2.1.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
StdByEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
StdByEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

6.2.1.3 Enter the OPERATIONAL MODE

6.2.1.3.1 Description

This command configures the DPU Manager in “Operational” Mode by activating the related MACRO. The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.3.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 130**								SI							
6	PEC															

6.2.1.3.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
OpsEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
OpsEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

6.2.1.4 DUMP BOOT Report

6.2.1.4.1 Description

This command allows Ground to dump the boot report.

6.2.1.4.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 131**								SI							
6	PEC															

6.2.1.4.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
None		

TECF Error Code	**Hex Value**	**Meaning**
DpuBootErr		Problem retrieving/formatting the boot report

6.2.1.5 Dump/Reset the error log

6.2.1.5.1 Description

This command allows Ground to dump or reset the error log. The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.5.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 132**								SI							
	action															
6	PEC															

Where:

action	The parameter indicating if a report or reset have to be performed

6.2.1.5.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
DpuErrLog		Problem retrieving/formatting/resetting the error log

6.2.1.6 MODIFY Configuration Parameters

6.2.1.6.1 Description

This command allows Ground to modify the values of all or part of the pre-stored configuration parameters used in the DPU ASW.

6.2.1.6.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1			ACK				**ST = 200**							
5	**SS = 133**								SI							
6	**Num_Params**															
7	**Param1_Desc.Par_Id**															
8	**Param1_Desc.Size**															
	Param1_first word															
	… …															
	Param1_last word															
	… …															
	… …															
	… …															
	… …															
	… …															
	… …															
	… …															
	ParamN_Desc.Par_Id															
	ParamN_Desc.Size															
	ParamN_first word															
	… …															
	ParamN_last word															
N (Max 228 TBC)	PEC															

Where:

Num_Params	Number of configuration items to be modified in the range [1..MAX_PARAM] and coherently with the TC data size.
Param1_Desc.Par_Id	The parameter identifier

.. ParamN_Desc.Par_Id	
Param1_Desc.Size .. ParamN_Desc.Size	The parameter length (in 16 bits words) (see sect.1.1.1.2 for detail)
ParamX_First_Word ParamX_Last_Word	The block of values characterizing the identified parameter (see sect. 1.1.1.2 for detail)

6.2.1.6.3 Error Codes

TARF Error Codes	Hex Value	Meaning
ParNumOutOfRange		The specified Number of parameters is not valid
ParTcLenErr		The single Parameter Length is not valid
BuffOverErr		Not all the TC contained parameters can fit into the temporary buffer
ParIdError		The single Parameter ID is not valid
LenghtErr		the actual TC Length is not consistent with the sum of the parameters sizes

TECF Error Codes	Hex Value	Meaning
DpuParameterErr		the TC execution is not ok

6.2.1.7 Report Configuration Parameters

6.2.1.7.1 Description

This command allows Ground to dump the current values of all the parameters configuring the ASW DPU.

6.2.1.7.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			

<table>
<tr><td>2</td><td colspan="2">SF</td><td colspan="5">PSC</td></tr>
<tr><td>3</td><td colspan="7">PL</td></tr>
<tr><td>4</td><td>SFH</td><td colspan="2">PVN = 1</td><td>ACK</td><td>ST = 200</td><td colspan="2"></td></tr>
<tr><td>5</td><td colspan="5">SS = 134</td><td>SI</td><td></td></tr>
<tr><td>6</td><td colspan="7">Num_Params</td></tr>
<tr><td>7</td><td colspan="7">Param_ID 1</td></tr>
<tr><td></td><td colspan="7">Param_ID 2</td></tr>
<tr><td></td><td colspan="7">…….</td></tr>
<tr><td></td><td colspan="7">…….</td></tr>
<tr><td></td><td colspan="7">…….</td></tr>
<tr><td></td><td colspan="7">…….</td></tr>
<tr><td></td><td colspan="7">Param_ID N</td></tr>
<tr><td>7 + Num_Params</td><td colspan="7">PEC</td></tr>
</table>

Where:

Num_Params	Number of configuration items to be modified.
Param_ID	The parameter identifier in the range [1.. MAX_PARAM]

In particular the parameter identifier can be one of the following :

Param_ID
TBW

6.2.1.7.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
ParIdError		The single Parameter ID is not valid
LenghtErr		the actual TC Length is not consistent with the sum of the parameters sizes
ParNumOutOfRange		The specified Number of parameters is not valid

TECF Error Code	**Hex Value**	**Meaning**
DpuParameterErr		the TC execution is not ok

6.2.1.8 Accept Configuration Parameter change

6.2.1.8.1 Description

This command make available to the ASW the new uploaded parameters value.

6.2.1.8.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 135**								SI							
6	PEC															

6.2.1.8.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
BuffEmptyErr		No previous “Updated Configuration Parameters” TC has been received

TECF Error Codes	**Hex Value**	**Meaning**
DpuParameterErr		the TC execution is not ok

6.2.1.9 CLEAR CONFIGURATION Parameters Change

6.2.1.9.1 Description

This command clear the buffer used to temporary contain the just uploaded new parameters values.

6.2.1.9.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 137**								SI							
6	PEC															

6.2.1.9.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
BuffEmptyErr		No previous “Updated Moments Configuration Parameters” TC has been received

TECF Error Codes	**Hex Value**	**Meaning**
None		

6.2.1.10 Restore the Configuration parameters default values

6.2.1.10.1 Description

This command is used to restore the default parameter values (stored in PROM).

6.2.1.10.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 136**								SI							
6	**Num_Params**															

7	**Param_ID 1**
	Param_ID 2
	…….
	…….
	…….
	…….
	Param_ID N
7 + Num_Params	PEC

Where:

Num_Params	Number of configuration items to be modified.
Param_ID	The parameter identifier in the range [1.. MAX_PARAM] to be restored to default value

6.2.1.10.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
ParIdError		The single Parameter ID is not valid

TECF Error Code	**Hex Value**	**Meaning**
DpuParameterErr		the TC execution is not ok

6.2.1.11 Modify Macro

6.2.1.11.1 Description

This command allows Ground to modify the values of all or part of a macro step (DPU Macro). The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.11.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															

4	SFH	PVN = 1	ACK	**ST = 200**
5	**SS = 138**			SI
6	**Macro_Id**			
7	**Num_Steps**			
8	**Step1.Position**			
9	**Step1.actionId**			**Step1.ackReq**
10	**Step1.timeOffset**			
11	**Step1.majOff**			
12	**Step1.minOff**			
13	**Step1.absTime**			
14	**Step1.addInfo[0]**			
15	**Step1.addInfo[1]**			
16	**Step1.addInfo[2]**			
17	**Step1.addInfo[3]**			
	… …			
	… …			
	… …			
	StepN.Position			
	StepN.actionId			**StepN.ackReq**
	StepN.timeOffset			
	StepN.majOff			
	StepN.minOff			
	StepN.absTime			
	StepN.addInfo[0]			
	StepN.addInfo[1]			
	StepN.addInfo[2]			
	StepN.addInfo[3]			
	… …			
	… …			
	… …			
	StepLast.Position			
	StepLast.actionId			**StepLast.ackReq**

	StepLast.timeOffset
	StepLast.majOff
	StepLast.minOff
	StepLast.absTime
	StepLast.addInfo[0]
	StepLast.addInfo[1]
	StepLast.addInfo[2]
	StepLast.addInfo[3]
N (Max 228 TBC)	PEC

Where:

Macro_Id	The identifier of the macro to update
Num_Steps	The number of macro step to modify
Step.Position	The position of the step to modify inside the macro
Step.actionId	The unique identifier of the action to be performed
Step.ackReq	The flag indicating if the actionId require an acknowledge
Step.timeOffset	The time offset to start the current step (expressed in time slice)
Step.majOff	The absolute major time offset: it will be considered between 0 .. 299
Step.minOff	The absolute minor time offset: it will be considered between 0 .. 7
Step.absTime	The flag to indicate when majOff,minOff have to be used
Step.addInfo[0..3]	The additional info associated to the actionId

6.2.1.11.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
StepNumOutOfRange		The specified step number is not valid
MacroIdErr		The macro identifier is not valid

StepPosErr		The step position is not valid

TECF Error Codes	Hex Value	Meaning
DpuMacroErr		the TC execution is not ok

To change more steps in a Macro may require ground to send several “Modify Macro” TC. The TCs received before an “Accept MACRO Sequence change” TC have to refer to same “Macro_Id” otherwise the packet will be rejected.

6.2.1.12 Report MACRO Sequence

6.2.1.12.1 Description

This command allows Ground to dump the content of a macro. The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.12.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 139**								SI							
6	**Macro_Id**															
7	PEC															

Where:

Macro_Id	The identifier of the macro to update

6.2.1.12.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

MacroIdErr		The macro identifier is not valid

TECF Error Code	Hex Value	Meaning
DpuMacroErr		the TC execution is not ok

6.2.1.13 Accept MACRO Sequence change

6.2.1.13.1 Description

This command make the new macro available to the ASW, only if the checksum match with the expected one. The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.13.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SFH</td><td colspan="2">PVN = 1</td><td>ACK</td><td colspan="4">ST = 200</td><td colspan="8"></td></tr>
<tr><td>5</td><td colspan="8">SS = 140</td><td colspan="4">SI</td><td colspan="4"></td></tr>
<tr><td>6</td><td colspan="16">Macro_Id</td></tr>
<tr><td>7</td><td colspan="16">Checksum</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

Macro_Id	The identifier of the macro to update
Checksum	The checksum of the just modified macro sequence

6.2.1.13.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
MacroEmptyErr		No previous “Modify MACRO” TC has been

		received
MacroIdErr		The macro identifier is not valid
MacroChKErr		The checksum is not correct

TECF Error Codes	**Hex Value**	**Meaning**
DpuMacroErr		the TC execution is not ok

6.2.1.14 Restore MACRO Default

6.2.1.14.1 Description

This command is used to restore the default macro value (stored in PROM). The current DPU Manager mode must be equal to "Stand-By" mode.

6.2.1.14.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 141**								SI							
6	**Macro_Id**															
7	PEC															

Where:

Num_Params	Number of configuration items to be modified.
Macro_Id	The identifier of the macro to be restored to the default value

6.2.1.14.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

MacroIdErr		The macro identifier is not valid

TECF Error Code	**Hex Value**	**Meaning**
DpuMacroErr		the TC execution is not ok

6.2.1.15 Discard MACRO Change

6.2.1.15.1 Description

This command clear the buffer used to temporary contain the just uploaded new macro values. The current DPU Manager mode must be equal to “Stand-By” mode.

6.2.1.15.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SFH</td><td colspan="2">PVN = 1</td><td>ACK</td><td colspan="4">ST = 200</td><td colspan="8"></td></tr>
<tr><td>5</td><td colspan="8">SS = 142</td><td colspan="4">SI</td><td colspan="4"></td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.1.15.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
BuffEmptyErr		No previous “Updated Moments Configuration Parameters” TC has been received

TECF Error Codes	**Hex Value**	**Meaning**
None		

6.2.1.16 Enable Science data compression

6.2.1.16.1 Description

This command allows Ground to enable the science data compression algorithm on the scientific data product.

6.2.1.16.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 143**								SI							
6	PEC															

6.2.1.16.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
None		

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.1.17 Disable Science data compression

6.2.1.17.1 Description

This command allows Ground to disable the science data compression algorithm on the scientific data product.

6.2.1.17.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							

5	**SS = 144**	SI
6	PEC	

6.2.1.17.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
None		

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.1.18 Enable RPW Trigger handling

6.2.1.18.1 Description

This command allows Ground to enable the handling of the RPW Trigger Signal used to freeze the Rolling Buffers Content.

6.2.1.18.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 145**								SI							
6	PEC															

6.2.1.18.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
None		

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.1.19 Disable RPW Trigger handling

6.2.1.19.1 Description

This command allows Ground to disable the handling of the RPW Trigger Signal used to freeze the Rolling Buffers Content.

6.2.1.19.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 146**								SI							
6	PEC															

6.2.1.19.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
None		

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.1.20 Enable Book Keeping handling

6.2.1.20.1 Description

This command allows Ground to enable the handling of the Book Keeping algorithm.

6.2.1.20.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							

5	**SS = 147**	SI
6	PEC	

6.2.1.20.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.1.21 Disable Book Keeping handling

6.2.1.21.1 Description

This command allows Ground to disable the handling of the Book Keeping algorithm.

6.2.1.21.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 148**								SI							
6	PEC															

6.2.1.21.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.1.22 Apply Config Change in EEPROM

6.2.1.22.1 Description

This command is used to make the currently used parameter value (RAM stored) the new default EEPROM parameter value.

6.2.1.22.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SFH	PVN = 1		ACK	**ST = 200**											
5	**SS = 149**								SI							
6	**Num_Params**															
7	**Param_ID 1**															
	Param_ID 2															
	…….															
	…….															
	…….															
	…….															
	Param_ID N															
7 + Num_Params	PEC															

Where:

Num_Params	Number of configuration items to be modified.
Param_ID	The parameter identifier in the range [1.. MAX_PARAM] to be make permanent in EEPROM

6.2.1.22.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
ParIdError		The single Parameter ID is not valid

TECF Error Code	**Hex Value**	**Meaning**
DpuParameterErr		the TC execution is not ok

6.2.1.23 Resume from Safe

6.2.1.23.1 Description

This command allows Ground to exit the ASW DPU from the safe mode returning in standby state. The current DPU Manager mode must be equal to “Safe” mode.

6.2.1.23.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 150**								SI							
6	PEC															

6.2.1.23.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.1.24 Reset SWA

6.2.1.24.1 Description

This command allows Ground to reboot ASW DPU.

6.2.1.24.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*

1	VN	TY	DF	**PID = 95 DEC**	PKT
2	SF	PSC			
3	PL				
4	SHF	PVN = 1	ACK	**ST = 200**	
5	**SS = 151**			SI	
6	PEC				

6.2.1.24.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.1.25 Configuration Parameters Report

6.2.1.25.1 Description

This TM is the report generated following a “Report Configuration Parameter” Tc.

6.2.1.25.2 TM Format

On reception of a valid “Report Configuration Parameters” command, the following TM packet is produced:

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			T	DFH	PID							PCAT			
2	GF		SC													
3	PL															
4	SFH	PVN		PECF	2#0#	DM	NS	EF	ST							
5	SS								DI				2#0000#			
6	OBRT															
7																

8	
9	SID **(TBC)**
10	Num_Params
11	Parameter1 Identifier
12	Parameter1 Length
13	Parameter1 Data(1)

	Parameter1 Data(Parameter1 Length)
	Param Data
	ParameterN Identifier
	ParameterN Length
	ParameterN Data(1)
	…………………..
N	ParameterN Data(Parameter1 Length)

Where:

Field Name	Field description
APID	
ST	200
SS	250
Num_Params :	Number of configuration items reported.
ParameterX_ID	TBW
ParameterX_Length	Length of the ParameterX_Data
ParameterX_Data(…)	array of words containing the values of the ParameterX

Following the reception of a valid “Report Configuration Parameters” command, the issue of several “Configuration Parameters Report” TM could be required according to the macro size.

6.2.1.26 Boot Report

6.2.1.26.1 Description

This TM is the report generated following a “Dump Boot Report” Tc.

6.2.1.26.2 TM Format

On reception of a valid “Dump Boot Report” command, the following TM packet is produced:

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			T	DFH	PID							PCAT			
2	GF		SC													
3	PL															
4	SFH	PVN		PECF	2#0#	DM	NS	EF	ST							
5	SS								DI				2#0000#			
6	OBRT															
7																
8																
9	SID **(TBC)**															
10	Boot data (TBD)															
11	…………………..															
12	…………………..															
13	…………………..															
	…………………..															
N	…………………..															

6.2.1.27 Error Log Report

6.2.1.27.1 Description

This TM is the report generated following a “Dump Error Log Report” Tc.

6.2.1.27.2 TM Format

On reception of a valid “Dump Error Log Report” command, the following TM packet is produced:

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			T	DFH	PID							PCAT			
2	GF		SC													
3	PL															
4	SFH	PVN		PECF	2#0#	DM	NS	EF	ST							
5	SS								DI				2#0000#			
6	OBRT															
7																
8																
9	SID **(TBC)**															
10	Error Log data (TBD)															
11	…………………..															
	…………………..															
N	…………………..															

6.2.1.28 Macro Report

6.2.1.28.1 Description

This TM is the report generated following a “Report MACRO Sequence” Tc.

6.2.1.28.2 TM Format

On reception of a valid “Report MACRO Sequence” command, the following TM packet is produced:

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			T	DFH	PID							PCAT			
2	GF		SC													

3	PL									
4	SFH	PVN	PECF	2#0#	DM	NS	EF	ST		
5	SS							DI	2#0000#	
6	OBRT									
7										
8										
9	SID **(TBC)**									
10	Macro data (TBD)									
11	…………………..									
12	…………………..									
13	…………………..									
	…………………..									
N	…………………..									

Following the reception of a valid “Report MACRO Sequence” command, several issues of the “Macro Report” TM could be required according to the macro size.

6.2.2 PUS Manager Tcs

6.2.2.1 Service 3: Housekeeping and Diagnostic Data Reporting TCs

6.2.2.1.1 Enable HK TM Pkt Issuing

6.2.2.1.1.1 Description

This command enables the issuing of the specified HK TM Packet. The command can be executed in all the DPU Manager modes.

6.2.2.1.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															

4	SHF	PVN = 1	ACK	**ST = 3**
5	**SS = 5**			SI
6	**Spare**			**tmSid**
7	PEC			

Where:

tmSid	This is the identifier of the HK TM Pkt to be enabled. The allowed values are:

6.2.2.1.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidSid	TBW	The specified tmSid is not valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.1.2 Disable HK TM Pkt Issuing

6.2.2.1.2.1 Description

This command disables the issuing of the specified HK TM Packet. The command can be executed in all the DPU Manager modes.

6.2.2.1.2.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 3**							

5	**SS = 6**	SI
6	**Spare**	**tmSid**
7	PEC	

Where:

tmSid	This is the identifier of the HK TM Pkt to be enabled. The allowed values are:

6.2.2.1.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidSid	TBW	The specified tmSid is not valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.1.3 Modify HK TM Pkt Issuing Rate

6.2.2.1.3.1 Description

This command modifies the specified HK TM Packet generation rate. The command can be executed in all the DPU Manager modes.

6.2.2.1.3.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 3**							
5	**SS = 129**								SI							

6	**Spare**	**tmSid**
7	**tmSidRate**	
8	PEC	

Where:

tmSid	This is the identifier of the HK TM Pkt to be enabled. The allowed values are:
tmSidRate	This field specifies the issuing rate in terms of time slices (125 msec) number. This value has to be a multiple of 8 (1 second)

6.2.2.1.3.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidSid	TBW	The specified tmSid is not valid
InvalidHkRate	TBW	The specified rate is 0 or it is not a multiple of 1 sec.

TECF Error Code	Hex Value	Meaning
None		

6.2.2.2 Service 5: Event Reporting TCs

6.2.2.2.1 Enable Event TM PKT Issuing

6.2.2.2.1.1 Description

This command enables the issuing of the specified EVENT TM Packet. The command can be executed in all the DPU Manager modes.

6.2.2.2.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			

2	SF	PSC		
3	PL			
4	SHF	PVN = 1	ACK	**ST = 5**
5	**SS = 5**			SI
6	**Spare**			**eventId**
7	PEC			

Where:

eventId	This is the identifier of the EVENT TM Pkt to be enabled. The allowed values are:

6.2.2.2.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidEventIdentifier	TBW	The specified Event Identifier is not valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.2.2 Disable Event TM PKT Issuing

6.2.2.2.2.1 Description

This command disables the issuing of the specified Event TM Packet. The command can be executed in all the DPU Manager modes.

6.2.2.2.2.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 5**							
5	**SS = 6**								SI							
6	**Spare**								**eventId**							
7	PEC															

Where:

eventId	This is the identifier of the EVENT TM Pkt to be enabled. The allowed values are:

6.2.2.2.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidEventIdentifier	TBW	The specified Event Identifier is not valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.3 Service 6: Memory Management TCs

6.2.2.3.1 Load Memory By Absolute Address

6.2.2.3.1.1 Description

This command allows a memory area to be modified physically with the content of the TC data field. The command can only be executed in the following DPU Manager mode:

- DIAGNOSTIC State

6.2.2.3.1.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 6</td></tr>
<tr><td>5</td><td colspan="8">SS = 2</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">MemoryId</td></tr>
<tr><td>7</td><td colspan="16" rowspan="2">StartAddress</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td colspan="16" rowspan="2">Length</td></tr>
<tr><td>10</td></tr>
</table>

11	**DataBlock1**
12	
13	
	DataBlockN
N	PEC

Where:

MemoryId	Unique identifier, indicating the addressed memory area. The allowed values are: DpuRam = 0, DpuEEprom = 1, DpuProm = 2, HismemId = from 0x8040 to 0x8080
StartAddress	Defines the start address of the memory area, to which this data block should be loaded
Length	The number of bytes to be loaded.
DataBlock	The content of the data block to be loaded, contiguously from the defined address (Start_Address). This block consists of a structured array of memory bytes.

6.2.2.3.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidMemoryId	TBW	The specified MemoryId value is not valid
InvalidStartAddress	TBW	The StartAddress for the specified Memory is not valid
InvalidLength	TBW	The specified Length value is not valid. The “Start address + (length-1)” exceeds the physical memory

TECF Error Code	Hex Value	Meaning

LoadingError	TBW	An error encountered while copying datablock into the addressed Memory

6.2.2.3.2 Dump Memory By Absolute Address

6.2.2.3.2.1 Description

This command allows to physically dump a memory area content. The command can be executed only in the following DPU Manager mode:

- DIAGNOSTIC State

A set of DUMP TM Pkt (6,6) will be generated until the completion of the download.

6.2.2.3.2.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 6</td></tr>
<tr><td>5</td><td colspan="8">SS = 5</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">MemoryId</td></tr>
<tr><td>7</td><td colspan="16" rowspan="2">StartAddress</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td colspan="16" rowspan="2">Length</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td><td colspan="16">PEC</td></tr>
</table>

Where:

<table>
<tr><td>MemoryId</td><td>Unique identifier, indicating the addressed memory area. The allowed values are:
DpuRam = 0,
DpuEEprom = 1,
DpuProm = 2,
HismemId = from 0x8040 to 0x8080</td></tr>
<tr><td>StartAddress</td><td>Defines the start address of the memory area, from which the data block</td></tr>
</table>

	has to be downloaded
Length	The number of bytes to be donwloaded.

6.2.2.3.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidMemoryId	TBW	The specified MemoryId value is not valid
InvalidStartAddress	TBW	The StartAddress for the specified Memory is not valid
InvalidLength	TBW	The specified Length value is not valid. The “Start address + (length-1)” exceeds the physical memory

TECF Error Code	Hex Value	Meaning
DownLoadingError	TBW	An error encountered while copying datablock from the addressed Memory

6.2.2.3.3 Check Memory By Absolute Address

6.2.2.3.3.1 Description

This command allows the calculation of the checksum value of a specified memory area. The command can be executed only in the following DPU Manager mode:

- DIAGNOSTIC State

A DUMP TM Pkt (6,10) will be generated reporting the calculated checksum.

6.2.2.3.3.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 6</td></tr>
<tr><td>5</td><td colspan="8">SS = 9</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">MemoryId</td></tr>
<tr><td>7</td><td colspan="16" rowspan="2">StartAddress</td></tr>
<tr><td>8</td></tr>
</table>

9	**Length**
10	
11	PEC

Where:

MemoryId	Unique identifier, indicating the addressed memory area. The allowed values are: DpuRam = 0, DpuEEprom = 1, DpuProm = 2, HismemId = from 0x8040 to 0x8080
StartAddress	Defines the start address of the memory area to be checksumed
Length	The number of bytes to be checksumed.

6.2.2.3.3.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidMemoryId	TBW	The specified MemoryId value is not valid
InvalidStartAddress	TBW	The StartAddress for the specified Memory is not valid
InvalidLength	TBW	The specified Length value is not valid. The “Start address + (length-1)” exceeds the physical memory

TECF Error Code	Hex Value	Meaning
ChecksummingError	TBW	An error encountered while checksumming the addressed Memory

6.2.2.3.4 Abort Memory DUMP

6.2.2.3.4.1 Description

This command allows to abort an ongoing Memory Dump activity. The command can be executed only in the following DPU Manager mode:

- DIAGNOSTIC State

6.2.2.3.4.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 6**							
5	**SS = 129**								SI							
6	PEC															

6.2.2.3.4.3 Error Codes

TARF Error Codes	Hex Value	Meaning
NoDumpOnGoing	TBW	NO Dump activity is ON GOING

TECF Error Code	Hex Value	Meaning
None		

6.2.2.4 Service 12: Onboard Parameter Monitoring TCs

6.2.2.4.1 Enable Monitoring of Parameters

6.2.2.4.1.1 Description

This command enables the monitoring of parameters globally or for the specified Monitoring entries. The command can be executed in all the DPU Manager modes.

6.2.2.4.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 12**							
5	**SS = 1**								SI							
6	**nrOfMonId**								**Mon Id 1**							
7	**Mon Id 2**								**Mon Id 3**							

8		
9		
10		**Mon Id N**
11	PEC	

Where:

nrOfMonId	Number of Monitoring ID to be enabled. N = 0: The monitoring at service level will be set to "ENABLED" with each individual entry remaining in its current state. N > 0: Each specified monitor will be set to "ENABLED"
Mon Id 1..N	Identification of the monitoring to enable in the Parameter Monitoring List. The allowed values are:

6.2.2.4.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidEnDisMonNumber		The specified "Monitoring Number" is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_ENDIS_MONITORING_ITEMS
InvalidLengthEnDisMon		The TC Length is not congruent with the specified "nrOfMonId" value
InvalidMonId		At least one of the specified Mon Id value is not Valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.4.2 Disable Monitoring of Parameters

6.2.2.4.2.1 Description

This command allows to disable the monitoring of parameters globally or for the specified Monitoring entries. The command can be executed in all the DPU Manager modes.

6.2.2.4.2.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 12**							
5	**SS = 2**								SI							
6	**nrOfMonId**								**Mon Id 1**							
7	**Mon Id 2**								**Mon Id 3**							
8																
9																
10									**Mon Id N**							
11	PEC															

Where:

nrOfMonId	Number of Monitoring ID to be enabled. N = 0: The monitoring at service level will be set to "ENABLED" with each individual entry remaining in its current state. N > 0: Each specified monitor will be set to "ENABLED"
Mon Id 1..N	Identification of the monitoring to enable in the Parameter Monitoring List. The allowed values are:

6.2.2.4.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidEnDisMonNumber		The specified “Monitoring Number” is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_ENDIS_MONITORING_ITEMS
InvalidLengthEnDisMon		The TC Length is not congruent with the specified “nrOfMonId” value
InvalidMonId		At least one of the specified Mon Id value is not Valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.4.3 Configure the Monitoring Item

6.2.2.4.3.1 Description

This command allows to change the configuration parameter values related to the specified Monitoring Items. The command can be executed in all the DPU Manager modes.

6.2.2.4.3.2 TC Format

Word	0–15					
1	VN	TY	DF	**PID = 95 DEC**	PKT	
2	SF	PSC				
3	PL					
4	SHF	PVN = 1	ACK	**ST = 12**		
5	**SS = 107**	SI				
6	**Spare**	**nrOfMonId**				
7	**monId 1**					
8	**monStatus 1**					
9–10	**parId 1**					
11–12	**validityParId 1**					
13–14	**lowThreshold 1**					
15–16	**highThreshold 1**					
17	**parType 1**					
18	**filter 1**					
19	**lowEventId 1**					
20	**highEventId 1**					
21	……………….					
….	……………….					

….	………………
….	**monId N**
….	**monStatus N**
…. ….	**parId N**
…. ….	**validityParId N**
…. ….	**lowThreshold N**
…. ….	**highThreshold N**
….	**parType N**
….	**filter N**
….	**lowEventId N**
….	**highEventId N**
TBD	**PEC**

Where:

nrOfMonId	Number of Monitoring ID to be configured.
Mon Id X	Identification of the monitoring to configure in the Parameter Monitoring List. The allowed values are: TBD
monStatus X	Enable/Disable Monitoring Status
parId X	Identifier of the parameter to be monitored. The allowed values are: TBD
validityParId X	identifier of the validity parameter. The allowed values are: TBD
lowThreshold X	valid low Threshold value for the specified parameter
highThreshold X	Valid High Threshold value for the specified parameter
parType X	identifies the type of parameter among the following: 0 = PAR_WORD, 1 = PAR_FLOAT

filter X	filter value to be used as failure confirmation
lowEventId X	Identifier of the Event to be generated if the parameter Value is lower than the lowThreshold value for more than "filter" times. The allowed values are: TBD
highEventId X	Identifier of the Event to be geerated if the parameter Value is greater than the highThreshold value for more than "filter" times. The allowed values are: TBD

6.2.2.4.3.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidConfMonNumber		The specified "Monitoring Number" is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_MODI_MONITORING_ITEMS)
InvalidMonId		At least one of the specified Mon Id value is not Valid
InvalidConfParType		At least one of the specified "parType" field value is not Valid
InvalidConfParId		At least one of the specified "parId" or "validityParId" field value is not valid
InvalidMonEvntId		At least one of the specified "lowEventId" or "highEventId" field value is not valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.4.4 Report the Monitoring Item

6.2.2.4.4.1 Description

This command allows to report the actual Monitoring Items configuration parameter values. The command can be executed in all the DPU Manager modes.

A set of DUMP TM Pkt (12,109) will be generated until the completion of the download.

6.2.2.4.4.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 12**							
5	**SS = 108**								SI							
6	PEC															

6.2.2.4.4.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.2.4.5 Enable ErrorEvent Handler

6.2.2.4.5.1 Description

This command enables the specified Event Identifiers handling. The command can be executed in all the DPU Manager modes.

6.2.2.4.5.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 12**							
5	**SS = 110**								SI							
6	**nrOfMonId**								**Mon Id 1**							
7	**Mon Id 2**								**Mon Id 3**							
8																
9																
10									**Mon Id N**							

11	PEC

Where:

nrOfMonId	Number of Monitoring ID to be enabled. N = 0: The monitoring at service level will be set to "ENABLED" with each individual entry remaining in its current state. N > 0: Each specified monitor will be set to "ENABLED"
Mon Id 1..N	Identification of the monitoring to enable in the Parameter Monitoring List. The allowed values are:

6.2.2.4.5.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
InvalidEnDisMonNumber		The specified “Monitoring Number” is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_ENDIS_MONITORING_ITEMS
InvalidLengthEnDisMon		The TC Length is not congruent with the specified “nrOfMonId” value
InvalidMonId		At least one of the specified Mon Id value is not Valid

TECF Error Code	**Hex Value**	**Meaning**
None		

6.2.2.4.6 Disable ErrorEvent Handler

6.2.2.4.6.1 Description

This command disables the specified Event Identifiers handling. The command can be executed in all the DPU Manager modes.

6.2.2.4.6.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			

2	SF	PSC		
3	PL			
4	SHF	PVN = 1	ACK	**ST = 12**
5	**SS = 111**			SI
6	**nrOfMonId**			**Mon Id 1**
7	**Mon Id 2**			**Mon Id 3**
8				
9				
10				**Mon Id N**
11	PEC			

Where:

nrOfMonId	Number of Monitoring ID to be enabled. N = 0: The monitoring at service level will be set to "ENABLED" with each individual entry remaining in its current state. N > 0: Each specified monitor will be set to "ENABLED"
Mon Id 1..N	Identification of the monitoring to enable in the Parameter Monitoring List. The allowed values are:

6.2.2.4.6.3 Error Codes

TARF Error Codes	Hex Value	Meaning
InvalidEnDisMonNumber		The specified "Monitoring Number" is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_ENDIS_MONITORING_ITEMS
InvalidLengthEnDisMon		The TC Length is not congruent with the specified "nrOfMonId" value
InvalidMonId		At least one of the specified Mon Id value is not Valid

TECF Error Code	Hex Value	Meaning

None		

6.2.2.4.7 Reset Error Handler Counters

6.2.2.4.7.1 Description

This command resets the ERROR Condition counters for the specified Event Identifiers The command can be executed in all the DPU Manager modes.

6.2.2.4.7.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 12**							
5	**SS = 112**								SI							
6	**nrOfMonId**								**Mon Id 1**							
7	**Mon Id 2**								**Mon Id 3**							
8																
9																
10									**Mon Id N**							
11	PEC															

Where:

nrOfMonId	Number of Monitoring ID to be enabled. N = 0: The monitoring at service level will be set to "ENABLED" with each individual entry remaining in its current state. N > 0: Each specified monitor will be set to "ENABLED"
Mon Id 1..N	Identification of the monitoring to enable in the Parameter Monitoring List. The allowed values are:

6.2.2.4.7.3 Error Codes

TARF Error Codes	Hex Value	Meaning

InvalidEnDisMonNumber		The specified "Monitoring Number" is greater than the maximum number of Monitoring Items that can be contained in a single TC (MAX_ENDIS_MONITORING_ITEMS
InvalidLengthEnDisMon		The TC Length is not congruent with the specified "nrOfMonId" value
InvalidMonId		At least one of the specified Mon Id value is not Valid

TECF Error Code	Hex Value	Meaning
None		

6.2.2.5 Service 17: Connection Test TCs

6.2.2.5.1 Perform Connection Test

6.2.2.5.1.1 Description

This command performs a connection test between Ground and SWA. The test result is provided via a specific DUMP TM (17,2). The command can be executed in all the DPU Manager modes.

6.2.2.5.1.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 17</td></tr>
<tr><td>5</td><td colspan="8">SS = 1</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.2.5.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning

None		

6.2.2.6 Service 21: Science Data Transfer TCs

6.2.2.6.1 ENABLE/START Science transfer from User to SSMM TM PKT Issuing

6.2.2.6.1.1 Description

This command enables the DPU ASW issuing of all the Scientific TM Packet. The command can be executed in all the DPU Manager states.

6.2.2.6.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 21**							
5	**SS = 1**								SI							
6	PEC															

6.2.2.6.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.2.6.2 ENABLE/STOP Science transfer from User to SSMM TM PKT Issuing

6.2.2.6.2.1 Description

This command disables the DPU ASW issuing of all the Scientific TM Packet. The command can be executed in all the DPU Manager state.

6.2.2.6.2.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			

2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 21**							
5	**SS = 2**								SI							
6	PEC															

6.2.2.6.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
None		

TECF Error Code	Hex Value	Meaning
None		

6.2.3 Sensor Manager TCs

6.2.3.1 Enter All Sensor in Burst Mode

6.2.3.1.1 Description

This command configures all the sensor in burst mode by issuing burst command towards EAS1/2, PAS and HIS at the start of the next second. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.3.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 200**							
5	**SS = 160**								SI							
6	**time**															
7	PEC															

Where:

time	The parameter indicating the time to spent in burst mode

6.2.3.1.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
DPUBmEntErr		Problem with configuring one or more sensor in burst mode (additional value added to discriminate the failure)

If the sensors' configuration steps are expected before entering Burst mode, the configuration must be commanded before executing this TC (via dedicated TC expected by the single sensor managers).

MSSL is to provide information on when to configure each sensor in burst mode. Is it acceptable for the next second boundary or a fourth second boundary to be considered? It is necessary to confirm the time in which the sensor accept a command (i.e Half sec boundary for PAS/EAS) and the time in which the command is executed?

6.2.3.2 Enter Both EAS in Science Mode

6.2.3.2.1 Description

This command configures both EAS1 and EAS2 in normal science mode by issuing "Start Science Command" towards EAS1 and EAS2 on the next fourth second boundary. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.3.2.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 200</td></tr>
</table>

5	**SS = 161**	SI
6	PEC	

6.2.3.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
DPUNmEntErr		Problem with configuring one or more sensor in normal mode (additional value added to discriminate the failure)

If the sensors' configuration steps are expected before entering Normal mode, such configuration must be commanded before executing this TC (via dedicated TC foreseen by the single sensor managers).

6.2.4 EAS Manager TCs

6.2.4.1 Enter EAS1/2 in Normal Science mode

6.2.4.1.1 Description

This command configures the EAS1/2 in "Normal" Mode by activating the related MACRO. The current EAS Manager state must be equal to "Init" state. The command can be executed only in the following DPU Manager mode:

- OPS State

Different configuration of EAS specific data have to be performed by ground before commanding the "Enter in Normal Science mode" TC.

The acceptance criteria of the TC is checked against the only EAS State that have to be equal to Init. No check is performed on the EAS Mode. The assumption is that eventually the condition to reset the EAS sensor before pass into Normal mode will be contained in the EAS1Norm/EAS2Norm macro.

6.2.4.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													

3	PL			
4	SHF	PVN = 1	ACK	**ST = 201/202**
5	**SS = 128**			SI
6	PEC			

6.2.4.1.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1NmEntErr Eas2NmEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1NmEntMacroErr Eas2NmEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

This TC will configure EAS to execute a normal science sequence including the start sequence command to EAS FPGA. The Start Science operation command should be separately issued by ground.

It is for MSSL to define the Macro content.

6.2.4.2 Enter EAS1/2 in BURST mode

6.2.4.2.1 Description

This command configures the EAS1/2 in “Burst” Mode by issuing dedicated message through mailbox 2. The current EAS Manager state must be equal to “Running” state. The command can be executed only in the following DPU Manager mode:

- OPS State

Different configuration of EAS specific data have to be performed by ground before commanding the "Enter in Burst mode" TC.

The acceptance criteria of the TC is checked against the only Eas State that have to be equal to Running. No check is performed on the Eas Mode. The assumption is that eventually condition to reset the EAS sensor before pass in Burst mode will be contained in the Eas1Burst/Eas2Burst macro.

6.2.4.2.2 TC Format

Word	*0–2*	*3*	*4*	*5–11*	*12–15*
1	VN	TY	DF	**PID = 95 DEC**	PKT
2	SF (0–1)	PSC (2–15)			
3	PL (0–15)				
4	SHF (0), PVN = 1 (1–3)	ACK (4–7)		**ST = 201/202** (8–15)	
5	**SS = 129** (0–7)			SI (8–15)	
6	**time** (0–15)				
7	PEC (0–15)				

Where:

time	The parameter indicating the time to spent in burst mode

6.2.4.2.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

It is necessary to understand how EAS FPGA ACK has to be processed following a mailbox command in terms of ACK format and response time.

6.2.4.3 Enter EAS1/2 in Engineering mode

6.2.4.3.1 Description

This command configures the EAS1/2 in "Engineering" Mode by activating the related MACRO. The current EAS Manager state must be equal to "Init" state. The command can be executed only in the following DPU Manager mode:

- OPS State

Different configuration of EAS specific data have to be performed by ground before commanding the "Enter in Engineering mode" TC.

The acceptance criteria of the TC is checked against the only Eas State that have to be equal to Init. No check is performed on the Eas Mode. The assumption is that eventually condition to reset the EAS sensor before pass in Engineering mode will be contained in the Eas1Eng/Eas2Eng macro.

6.2.4.3.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 130</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.3.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1EmEntErr Eas2EmEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1EmEntMacroErr		Problem with Macro execution to the TC (additional value added to

Eas2EmEntMacroErr		which step fails and the kind of error)

This TC will configure EAS to execute an engineering science sequence including the start sequence command to EAS FPGA. The Start Science operation command should be issued separately by ground.

MSSL to define the Macro content.

6.2.4.4 SWITCH EAS1/2 on

6.2.4.4.1 Description

This command powers the EAS1/2 On. The current EAS Manager state must be equal to “Off” state. The command can be executed only in the following DPU Manager mode:

- Diagnostic State
- OPS State

6.2.4.4.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 131</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.4.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SwitchOnErr Eas2SwitchOnErr		Problem switching on EAS

6.2.4.5 SWITCH EAS1/2 off

6.2.4.5.1 Description

This command powers the EAS1/2 Off. The current EAS Manager state must be different from “Off” state. The command can be executed only in the following DPU Manager mode:

- Diagnostic State
- OPS State

6.2.4.5.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 132</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.5.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1SwitchOffErr Eas2SwitchOffErr		Problem switching off EAS

6.2.4.6 Reset EAS1/2

6.2.4.6.1 Description

This command reset the EAS1/2 by activating the related MACRO. The current EAS Manager state must be different from “Off” state. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.4.6.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 133</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.6.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1RsEntErr Eas2RsEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1RsEntMacroErr Eas2RsEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

6.2.4.7 EAS1/2 HV Ramp UP

6.2.4.7.1 Description

This command is used to run the EAS1/2 HV ramp up by activating the related MACRO. The current EAS Manager state must be equal to "Running" state. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.4.7.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 134</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.7.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1RuEntErr Eas2RuEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1RuEntMacroErr Eas2RuEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

MSSL to define the Macro content.

6.2.4.8 EAS1/2 HV Ramp Down

6.2.4.8.1 Description

This command is used to run the EAS1/2 HV ramp down by activating the related MACRO. The current EAS Manager state must be equal to “Running” state. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.4.8.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 135**								SI							
6	PEC															

6.2.4.8.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1RdEntErr Eas2RdEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1RdEntMacroErr Eas2RdEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

MSSL to define the Macro content.

6.2.4.9 EAS1/2 POWER ON

6.2.4.9.1 Description

This command is used to Power the EAS1/2 On by activating the related MACRO. The current EAS Manager state must be equal to “Off” state. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.4.9.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 136</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.9.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1OnEntErr Eas2OnEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1OnEntMacroErr Eas2OnEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

MSSL to define the Macro content.

6.2.4.10 EAS1/2 POWER Off

6.2.4.10.1 Description

This command is used to Power the EAS1/2 Off by activating the related MACRO. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.4.10.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	PID = 95 DEC							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				ST = 201/202							
5	SS = 137								SI							
6	PEC															

6.2.4.10.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1OffEntErr Eas2OffEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1OffEntMacroErr Eas2OffEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

MSSL to define the Macro content.

6.2.4.11 EAS1/2 FAST POWER Off

6.2.4.11.1 Description

This command is used to Fast Power the EAS1/2 Off by activating the related MACRO. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.11.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 138</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.11.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1FOffEntErr Eas2FOffEntErr		Problem with starting Macro associated to the TC (additional value added to discriminate the failure)
Eas1FOffEntMacroErr Eas2FOffEntMacroErr		Problem with Macro execution to the TC (additional value added to which step fails and the kind of error)

MSSL to define the Macro content.

6.2.4.12 Clear Sequencer Shared RAm

6.2.4.12.1 Description

This command is used to clear the sequencer shared RAM by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.12.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 139**								SI							
6	PEC															

6.2.4.12.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.13 Set Hemisphere Voltage look up Table

6.2.4.13.1 Description

This command is used to upload EAS hemisphere voltage look up table by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.13.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 140</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">LUT[0]</td><td colspan="8">LUT[1]</td></tr>
<tr><td>…</td><td colspan="8">…</td><td colspan="8">…</td></tr>
<tr><td>101</td><td colspan="8">LUT[190]</td><td colspan="8">LUT[191]</td></tr>
<tr><td>102</td><td colspan="16">PEC</td></tr>
</table>

Where:

LUT [0 ..191]	The look up table values to upload for the hemisphere scan voltage profile.

6.2.4.13.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.14 Set the deflection scan ratio table

6.2.4.14.1 Description

This command is used to upload EAS deflector scan ratio table by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.14.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 141</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">LUT[0]</td><td colspan="8">LUT[1]</td></tr>
<tr><td>…</td><td colspan="8">…</td><td colspan="8">…</td></tr>
<tr><td>53</td><td colspan="8">LUT[94]</td><td colspan="8">LUT[95]</td></tr>
<tr><td>54</td><td colspan="16">PEC</td></tr>
</table>

Where:

LUT [0 .. 95]	The look up table values to upload for the EAS deflector scan ratio.

6.2.4.14.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.15 Set the Hemisphere Voltage Ratio

6.2.4.15.1 Description

This command is used to upload EAS hemisphere voltage ratio value by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.15.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 142</td><td colspan="8">SI</td></tr>
</table>

6	spare	VR[0]
7	VR[1]	VR[2]
8	PEC	

Where:

VR [0 .. 2]	The values to upload for the EAS hemisphere voltage ratio.

6.2.4.15.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.16 Set the Hemisphere High Voltage

6.2.4.16.1 Description

This command is used to upload EAS hemisphere high voltage value by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.16.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 143</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">spare</td><td colspan="8">HV[0]</td></tr>
<tr><td>7</td><td colspan="8">HV[1]</td><td colspan="8">HV[2]</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

HV [0 .. 2]	The values to upload for the EAS hemisphere voltage ratio.

6.2.4.16.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.17 Set the VGF Ratio Upload

6.2.4.17.1 Description

This command is used to upload EAS which of the three VGF setting to use by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.17.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 144</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">spare</td><td colspan="8">VGF[0]</td></tr>
<tr><td>7</td><td colspan="8">VGF[1]</td><td colspan="8">VGF[2]</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

VGF [0 .. 2]	The values to upload the VGF ratio.

6.2.4.17.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the

		failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.18 Set the Analizer Voltage Offsets

6.2.4.18.1 Description

This command is used to upload EAS the value of the four analyzer voltage offset by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.18.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 145**								SI							
6	AVO[0]								AVO[1]							
7	AVO[2]								AVO[3]							
8	AVO[4]								AVO[5]							
9	AVO[6]								AVO[7]							
10	PEC															

Where:

AVO [0 .. 7]	The values to upload the analyzer voltage offset.

6.2.4.18.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.19 Set the Burst Mode Angle bin

6.2.4.19.1 Description

This command is used to upload EAS the burst mode angle bin by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.19.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 146**								SI							
6	BMA[0]								BMA[1]							

7	BMA[2]	BMA[3]
8	BMA[4]	BMA[5]
9	BMA[6]	BMA[7]
10	PEC	

Where:

BMA [0 .. 7]	The values to upload the burst mode angle bin.

6.2.4.19.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.20 Write Mailbox control

6.2.4.20.1 Description

This command is used to write the mail box by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.20.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 147</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">MB_Id</td><td colspan="8">MBV[0]</td></tr>
<tr><td>7</td><td colspan="8">MBV[1]</td><td colspan="8">MBV[2]</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

MB_Id	The mailbox identifier (mailbox1 or mailbox2).
MBV[0..1]	The command to be sent via mailbox.

6.2.4.20.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request
Eas1NotValidMailbox Eas2NotValidMailbox		The mailbox identifier is wrong

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.21 Upload Sequence table

6.2.4.21.1 Description

This command is used to upload the sequence table by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.21.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 148</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">Seq_Id</td></tr>
<tr><td>7</td><td colspan="16">PEC</td></tr>
</table>

Where:

Seq_Id	The sequence identifier (TBD).

6.2.4.21.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request
Eas1NotValidSeq Eas2NotValidSeq		The sequence identifier is wrong

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to define how many sequences have to be stored on board.

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.22 Start Sequence table

6.2.4.22.1 Description

This command is used to start the sequence by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.22.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 149</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.22.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request

Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.23 Set Pre-amp control Data

6.2.4.23.1 Description

This command is used to program the channels of the pre-amplifiers by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.23.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 150</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">Ch_1 Info</td></tr>
<tr><td>7</td><td colspan="16">Ch_2 Info</td></tr>
<tr><td></td><td colspan="16">…</td></tr>
<tr><td>37</td><td colspan="16">Ch_32 Info</td></tr>
<tr><td>38</td><td colspan="16">PEC</td></tr>
</table>

Where:

Ch_i_info (i=1..32)	The information useful to program one of the pre-amplifier channell.

According to the EAS programming mode, MSSL have to decide if it is acceptable to have a single TC containing the information to configure all the 32 channels, or it is necessary to have a different TC format (i.e. able to program a single channel).

6.2.4.23.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.24 SPW link Test

6.2.4.24.1 Description

This command is used to allow a loop back testing of the SpW by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.24.2 TC Format

Word 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1	VN	TY	DF	**PID = 95 DEC**	PKT
2	SF	PSC			
3	PL				
4	SHF	PVN = 1	ACK	**ST = 201/202**	
5	**SS = 151**			SI	
6	Spare			SPW[0]	
7	SPW[1]			SPW[2]	
8	PEC				

Where:

SPW[0..2]	The test word to be sent to the sensor.

6.2.4.24.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.25 Write Master Control register

6.2.4.25.1 Description

This command is used to modify one or more control registers by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.25.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 152</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">Pre_Amp_1</td><td colspan="8">Pre_Amp_2</td></tr>
<tr><td>7</td><td colspan="8">FPGA_Self_Test</td><td colspan="8">En_Monitoring</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

Pre_Amp_1	The value indicating if reset the pre_amp1 (possible values are ENABLE,DISABLE, UNCHANGED).
Pre_Amp_2	The value indicating if reset the pre_amp2 (possible values are ENABLE,DISABLE, UNCHANGED).
FPGA_Self_Test	The value indicating if perform FPGA Self test (possible values are ENABLE,DISABLE, UNCHANGED).
En_Monitoring	The value indicating if enable the monitoring on the overcurrent (possible values are ENABLE,DISABLE, UNCHANGED).

According to the EAS programming mode, MSSL have to decide if it is acceptable to have only the expected control register or if it would be better to insert all the 24 control register plus a mask.

6.2.4.25.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request
Eas1NotAllowedValue		The value associated to one of the

Eas2NotAllowedValue		parameter is wrong .

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.26 Write Pre-Amp power Control register

6.2.4.26.1 Description

This command is used to configure the pre-amplifier behavior (on/off) when an over current is detected (when the monitoring is enabled) by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.26.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 153</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">Pre_Amp_1</td><td colspan="8">Pre_Amp_2</td></tr>
<tr><td>7</td><td colspan="16">PEC</td></tr>
</table>

Where:

Pre_Amp_1	The value indicating if enable/disable the pre_amp1 power control (possible values are ENABLE,DISABLE).

Pre_Amp_2	The value indicating if enable/disable the pre_amp2 power control (possible values are ENABLE,DISABLE).

6.2.4.26.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.27 Set Heater Control loop parameters

6.2.4.27.1 Description

This command is used to configure the heater control loop parameters by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.27.2 TC Format

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
</table>

5	**SS = 154**		SI
6	Spare	Ki	
7	spare	Kp	
8	PEC		

Where:

Ki	The value indicating the integral term of heater control loop.
kp	The value indicating the proportional term of heater control loop.

6.2.4.27.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if the criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.28 Write Heater Control Register

6.2.4.28.1 Description

This command is used to define the heater set point by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State

- DIAG State

6.2.4.28.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 155</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="4"></td><td colspan="12">Set_Point</td></tr>
<tr><td>8</td><td colspan="16">PEC</td></tr>
</table>

Where:

Set_Point	The value indicating the heater set point.

Since the heater HK channel is always set to 5, it is not expected as a parameter in the TC.

6.2.4.28.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exist (eventually a further TARF code will be expected).

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.29 Write Time Control Register

6.2.4.29.1 Description

This command is used to upload the system time by issuing the dedicated command towards the EAS Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- DIAG State

6.2.4.29.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 156</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="8">COARSE[0]</td><td colspan="8">COARSE[1]</td></tr>
<tr><td>7</td><td colspan="8">COARSE[2]</td><td colspan="8">COARSE[3]</td></tr>
<tr><td>9</td><td colspan="16">PEC</td></tr>
</table>

Where:

COARSE[0..3]	The value of the coarse time to be uploaded to the sensor.

Since the fine time to be uploaded to the sensor is always 0, it is not expected as a parameter in the TC.

6.2.4.29.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning

Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.30 Read Time Control Register

6.2.4.30.1 Description

This command is used to download the EAS time by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- DIAG State
- OPS State

6.2.4.30.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 157</td><td colspan="8">SI</td></tr>
<tr><td>9</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.30.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.31 HK data Request

6.2.4.31.1 Description

This command is used to request an HK data packet by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.31.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 158</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.4.31.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.32 Set Max HV for MCP

6.2.4.32.1 Description

This command is used to set the maximum value of the High Voltage by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.32.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 159**								SI							
6	spare						Max_Val									
7	PEC															

Where:

Max_Val	The value of max MCP HV to be uploaded to the sensor.

6.2.4.32.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exists (eventually a further TARF code will be expected).

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.33 Set New HV for MCP

6.2.4.33.1 Description

This command is used to set the new requested value of the High Voltage by issuing the dedicated command towards the Eas Sensor SpW Interface. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.33.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 201/202</td></tr>
<tr><td>5</td><td colspan="8">SS = 160</td><td colspan="8">SI</td></tr>
</table>

6	spare	New_Val
7	PEC	

Where:

New_Val	The value of new MCP HV to be uploaded to the sensor.

6.2.4.33.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate if criteria to validate the TC parameters exists (eventually a further TARF code will be expected).

MSSL to communicate if there are any constraints to consider before modifying the configuration data, i.e. on particular EAS mode (eventually a further TARF code will be expected).

6.2.4.34 Dump Parameter

6.2.4.34.1 Description

This command is used to request a parameter dump by issuing the dedicated command towards the Eas Sensor SpW Interface (i.e. a read request). The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.34.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1		ACK					**ST = 201/202**							
5	**SS = 161**								SI							
6	Param_Id															
7	PEC															

Where:

Param_Id	The identifier of the EAS parameter to be read back.

6.2.4.34.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

MSSL to communicate which EAS parameter could be read back and if any constraint on particular EAS mode exists (eventually a further TARF code will be expected).

6.2.4.35 Set Moment Elaboration

6.2.4.35.1 Description

This command is used to modify the moment elaboration mode. The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG State

6.2.4.35.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 201/202**							
5	**SS = 162**								SI							
6	Moment_Mode															
7	PEC															

Where:

Moment_Mode	The moment mode to be considered in the moment computation (allowed values are AddSample or ForthSample).

6.2.4.35.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU Mode is not coherent with the TC request
Eas1NotPlausibleTcError/ Eas2NotPlausibleTcError		The actual EAS state is not coherent with the TC request
Eas1MomentModeError Eas2MomentModeError		The Moment_Mode commanded is wrong.

TECF Error Code	**Hex Value**	**Meaning**
Eas1SpwErr Eas1SpwErr		Problem related to the command issuing to the sensor (additional value added to discriminate the failure such as command id and failure details)

6.2.4.36 Dump Parameter Report

6.2.4.36.1 Description

This TM is the report generated following a “Dump Parameter” Tc.

6.2.4.36.2 TM Format

On receipt of a valid “Dump Parameter” command, the following TM packet is produced:

<table>
<tr><td>Word</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>1</td><td colspan="3">VN</td><td>T</td><td>DFH</td><td colspan="7">PID</td><td colspan="4">PCAT</td></tr>
<tr><td>2</td><td colspan="2">GF</td><td colspan="14">SC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SFH</td><td colspan="2">PVN</td><td>PECF</td><td>2#0#</td><td>DM</td><td>NS</td><td>EF</td><td colspan="8">ST</td></tr>
<tr><td>5</td><td colspan="8">SS</td><td colspan="4">DI</td><td colspan="4">2#0000#</td></tr>
<tr><td>6</td><td colspan="16" rowspan="3">OBRT</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td colspan="16">SID (TBC)</td></tr>
<tr><td>10</td><td colspan="16">Par_Id</td></tr>
<tr><td>11</td><td colspan="16">Par_Lenght</td></tr>
<tr><td>12</td><td colspan="16">Parameter Data(1)</td></tr>
<tr><td>13</td><td colspan="16">---------</td></tr>
<tr><td></td><td colspan="16">---------</td></tr>
<tr><td></td><td colspan="16">---------</td></tr>
<tr><td>N</td><td colspan="16">Parameter1 Data(Par_Lenght)</td></tr>
</table>

Where:

Par_Id	The parameter identifier
Par_Lenght	The parameter length
Parameter Data [1.. Par_Lenght]	The data read from the sensor

6.2.5 PAS Manager TCs

No TCs have been reported due to missing PAS Unit specific documents.

6.2.6 HIS Manager TCs

6.2.6.1 Switch on HIS

6.2.6.1.1 Description

This command powers the HIS On. The command can be executed only in the following DPU Manager mode:

- Diagnostic State
- OPS State

6.2.6.1.2 TC Format

Word	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	VN			TY	DF	**PID = 95 DEC**							PKT			
2	SF		PSC													
3	PL															
4	SHF	PVN = 1			ACK				**ST = 204**							
5	**SS = 120**								SI							
6	PEC															

6.2.6.1.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
HisSwitchOnErr		Problem switching on HIS

6.2.6.2 Switch Off HIS

6.2.6.2.1 Description

This command powers the HIS Off. The command can be executed only in the following DPU Manager mode:

- Diagnostic State
- OPS State

6.2.6.2.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
<tr><td>2</td><td colspan="2">SF</td><td colspan="14">PSC</td></tr>
<tr><td>3</td><td colspan="16">PL</td></tr>
<tr><td>4</td><td>SHF</td><td colspan="3">PVN = 1</td><td colspan="4">ACK</td><td colspan="8">ST = 204</td></tr>
<tr><td>5</td><td colspan="8">SS = 121</td><td colspan="8">SI</td></tr>
<tr><td>6</td><td colspan="16">PEC</td></tr>
</table>

6.2.6.2.3 Error Codes

TARF Error Codes	**Hex Value**	**Meaning**
DpuNotPlausibleTcError		The actual DPU state is not coherent with the TC request

TECF Error Code	**Hex Value**	**Meaning**
HisSwitchOffErr		Problem switching off HIS

6.2.6.3 SWA_TC_DPU_MACRO_START

6.2.6.3.1 Description

This command will start the DPU HIS macro execution indicated in the Macro_Id parameter. The command can be executed only in the following DPU Manager mode:

- OPS State

6.2.6.3.2 TC Format

<table>
<tr><th>Word</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>1</td><td colspan="3">VN</td><td>TY</td><td>DF</td><td colspan="7">PID = 95 DEC</td><td colspan="4">PKT</td></tr>
</table>

2	SF	PSC		
3	PL			
4	SHF	PVN = 1	ACK	**ST = 204**
5	**SS = 122**			SI
6	**Macro_Id**			
7	PEC			

Where:

Macro_Id	The identifier of the macro to start

6.2.6.3.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU state is not coherent with the TC request
MacroIdErr		The macro identifier is not valid
NoMacroErr		No macro running

TECF Error Code	Hex Value	Meaning
HisMacroErr		Problem with starting/executing Macro associated to the TC (additional value added to discriminate the failure)

MSSL to define how many macro have to be stored on-board and the Macro content.

6.2.6.4 SWA_TC_DPU_MACRO_STOP

6.2.6.4.1 Description

This command will stop the DPU HIS macro execution (if any). The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG state

6.2.6.4.2 TC Format

Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VN			TY	DF	**PID = 95 DEC**							PKT			

2	SF	PSC		
3	PL			
4	SHF	PVN = 1	ACK	**ST = 204**
5	**SS = 123**			SI
6	PEC			

6.2.6.4.3 Error Codes

TARF Error Codes	Hex Value	Meaning
DpuNotPlausibleTcError		The actual DPU state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
None		

6.2.6.5 SWA_TC_DPU_SAFE_RESET

6.2.6.5.1 Description

This command will clear the monitoring parameter making possible to power-on HIS The command can be executed only in the following DPU Manager mode:

- OPS State
- DIAG state

6.2.6.5.2 TC Format

Word	0 1 2	3	4	5 6 7 8 9 10 11	12 13 14 15
1	VN	TY	DF	**PID = 95 DEC**	PKT
2	SF	PSC			
3	PL				
4	SHF	PVN = 1	ACK	**ST = 204**	
5	**SS = 124**			SI	
6	PEC				

6.2.6.5.3 Error Codes

TARF Error Codes	Hex Value	Meaning

DpuNotPlausibleTcError		The actual DPU state is not coherent with the TC request

TECF Error Code	Hex Value	Meaning
None		

6.2.6.6 HIS Internal TC

DPU ASW will act as pass-through to a set of his internal TC, listed here after:

SWA_TC_DPU_SAFE_RESET
SWA_TC_HIS_HK_INT
SWA_TC_HIS_MRAM_WR
SWA_TC_HIS_MEM_COPY
SWA_TC_HIS_MEM_PAT
SWA_TC_HIS_MEM_DWELL_EN
SWA_TC_HIS_MEM_DWELL_DIS
SWA_TC_HIS_MEM_POKE
SWA_TC_HIS_HV_PWR
SWA_TC_HIS_DAC_SET
SWA_TC_HIS_DAC_REL
SWA_TC_HIS_OPTO_PWR
SWA_TC_HIS_AC_LI NK
SWA_TC_HIS_EDAC
SWA_TC_HIS_ERROR
SWA_TC_HIS_MACRO_START
SWA_TC_HIS_MACRO_STOP
SWA_TC_HIS_MACRO_CALL
SWA_TC_HIS_NOP
SWA_TC_HIS_RESET
SWA_TC_HIS_MODE
SWA_TC_HIS_CLEAR
SWA_TC_HIS_SHUTDOWN

SWA_TC_HIS_PARAM_SET
SWA_TC_HIS_TABLE_RELOAD
SWA_TC_HIS_STIM_EN
SWA_TC_HIS_STIM_DIS
SWA_TC_HIS_RUN_ADDR
SWA_TC_HIS_EVR

No check will be performed by ASW DPU on this TC except the monitoring related to the communication loss (i.e.: ACK/NACK TM Not received).

MSSL is responsible for the format of this TC. It will be defined in the document "15164-CMDDEF-01.

7 APPENDIX B INSTRUMENT DATA SHEETS

The current Instrument Data Sheets are in the EID-B [IR12]

8 APPENDIX C MECHANICAL INTERFACE CONTROL DRAWINGS (FM version)

This section will be left empty until final version is issued at instrument FAR. The current MICDS can be found in NR03, NR04, NR05 and NR06

9 APPENDIX D THERMAL INTERFACE CONTROL DRAWINGS (FM version)

This section will be left empty until final version is issued at instrument FAR..

10 APPENDIX E ELECTRICAL INTERFACE CONTROL DRAWINGS (FM version)

The EICD is give in the Harness report [IR10]

11 APPENDIX F INSTRUMENT PICTURES

This section is left blank until FM photos will be available.