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DOCUMENT

Power SCOE Requirements Specification

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Table of contents:

1 INTRODUCTION

This documents contains all the requirements necessary for the design, the development, and the manufacturing of the Power SCOE that will be used during all the Integration and Test activities performed on Euclid Satellites starting from the AVM and finally on the FM Spacecraft up to the launch. This specification covers the functional and the performance requirements for the SCOE and specifies the interfaces with the S/C and with the overall EGSE. The Power SCOE will constitute part of the Euclid Electrical Ground Support Equipment and will be composed of the following main functional blocks:

1. Solar Array Simulation
2. Battery Simulation
3. Battery Charge/discharge
4. Main Bus Voltage Monitoring
5. Launch Power Supply (making part of the COTE).

Each one of the mentioned functional blocks can also be considered as a specific SCOE but the ones listed in bullets 1, 4 and 5 that will be part of the same equipment.

1.1 Document structure

The Power SCOE Specification document is organised as briefly depicted here below.

Lists of the documentation to be applied or kept into account during the design and implementation phases of the Power SCOE are reported in Section 2, followed by a brief summary description of the foreseen mission and of the Power SCOE configuration used during different Integration and Test phases (Section 3).

General descriptions of the possible major tasks of these EGSE items can be found in Section 4.

Inside Section 5 the detailed functional and operational requirements are contained including the type of data/information the Power SCOE shall be in charge to manage.

Interface requirements are listed in Section 6 where all the interface are considered both towards the Spacecraft and towards other EGSE components (e.g. CCS). External interfaces like power from the facility and grounding concepts are also mentioned.

Operational requirements are depicted in Section 7 while some guidelines for Power SCOE Hardware and Software configurations to be provided by the Contractor are contained in Section 8.

Performance requirements to be satisfied by the Power SCOE in order to make it suitable to support all Integration and Test activities are described in Section 9.

Finally Verification Requirements are contained in sections 10 and 11 of this Power SCOE Specification document.

2 DOCUMENTS AND STANDARDS

In the following sub-paragraphs several documents, classified in two major categories (Applicable and Reference documents) are listed. More in details:

- Applicable documents (or single paragraphs or sub-paragraphs) which will be mentioned in this document must be considered as a part of it.
- Reference documents have been taken into account to prepare this document, but it is not mandatory to comply with them; they help to clarify and detail specific requirements.

2.1 APPLICABLE DOCUMENTS

The here below listed documents, in the latest issue, form part of this specification to the extent specified herein. In the event of conflict between the contents of this document and the contents of applicable documents listed below, the conflict shall be brought to the attention of the Prime Contractor for clarification.

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AD [2]	Deleted	
AD [3]	Deleted	
AD [4]	Deleted	
AD [5]	Deleted	
AD [6]	Deleted	
AD [7]	Deleted	
AD [8]	Deleted	
AD [9]	Deleted	
AD [10]	Deleted	
AD [11]	Soyuz CSG User's Manual	Dated March 2012
AD [12]	Deleted	
AD [13]	Deleted	
AD [14]	Deleted	
AD [15]	Deleted	
AD [16]	Deleted	

2.2 REFERENCE DOCUMENTS

The here below listed documents have to be considered in their latest issue:

RD [1] Deleted

RD [2] Deleted

RD [3] Space Engineering Software *ECSS-E-40B*

RD [4] Deleted

2.3 Applicable Standards

- ECSS-E-ST-10-02C, Verification, Issue 2, 06 March 2009
- ECSS-E-ST-10-03C Testing dated 1 June 2012
- ECSS-E-ST-20 C, Electrical and electronic, Issue 2, 31 July 2008
- ECSS-E-ST-20-07C, Electromagnetic compatibility, Issue 1 Rev.1, 7 February 2012
- ECSS-Q-ST-30-02C, Failure modes, effects (and criticality) analysis (FMEA/FMECA), 6 March 2009
- ECSS-E-ST-50-03C, Space data links - Telemetry transfer frame protocol, Is.2, 31 July 2008,
- ECSS-E-ST-50-04C8, Space data links - Telecommand protocols synchronisation and channel coding, Is.2, 31 July 200
- ECSS-E-ST-50-12C, SpaceWire – Links, nodes, routers and networks, Is.2, 31 July 2008
- ECSS-E-ST-50-13C, Interface and communication protocol for MIL-STD-1553B data bus on-board spacecraft, Is.1, 15 Nov 2008
- ECSS-E-70-41A, Ground systems and operations - Telemetry and telecommand Packet Utilization, 30 January 2003
- CSG-RS-10A-CN, CSG Safety Regulations – Volume 1
- CSG-RS-21A-CN, CSG Safety Regulations – Volume 2 Part 1
- CSG-RS-22A-CN, CSG Safety Regulations – Volume 2 Part 2

2.4 Acronyms

APID	Application Process Identifier
AVM	Avionic Model
BCE	Battery Conditioning Equipment
BS	Battery Simulator
CCS	Central Checkout System
CCU	Cryostat Control Unit
COTE	Check Out Terminal Equipment
CDMU	Control and Data Management Unit
EGSE	Electrical Ground Support
HK	HouseKeeping
I&T	Integration and Test
ISC	Integrated System Checks
IST	Integrated System Tests
LAN	Local Area Network
LPS	Launch Power Supply
PCDU	Power Control and Distribution
PFM	ProtoFlight Model
PLM	PayLoad Module
RTU	Remote Terminal Unit
SAS	Solar Array Simulator
SCOE	Special Check-Out Equipment
S/C	Spacecraft
S/L	Satellite
SVM	SerVice Module
TC	Telecommand
TM	Telemetry

3 GENERAL DESCRIPTIONS

3.1 Mission Description

[VA:I/O

Euclid is an optical/near-infrared survey mission designed to understand the origin of the accelerating expansion of the Universe. It will use cosmological probes to investigate the nature of dark energy, dark matter, and gravity by tracking their observational signatures on the geometry of the Universe and on the cosmic history of structure formation. Euclid has been approved by ESA and delegated bodies for a planned launch in 2020 in the frame of the Cosmic Vision 2015-2025 plan. The target orbit is a large-amplitude libration orbit around the night-side Lagrange point of the Sun-Earth system (L2). The launch service shall be provided by the Soyuz 2-1b Fregat from Kourou with direct insertion into the target orbit.

3.2 Power SCOE general description

[VA:I/O

Power SCOE will be used either during Euclid AVM, FM Service Modules test activities and also at Spacecraft level verification, including environmental testing, up to the launch campaign when LPS, making part of the overall COTE, will be used to provide power to the Spacecraft during the final count-down.

Refer to figures 3.2-1 and 3.2-2 for possible EGSE configurations in which the Power SCOE is foreseen to be used.

The Power SCOE shall be able to provide the required electrical power simulating the batteries and the Solar Array.

The control of the Power SCOE shall be possible for the operator either if the SCOE is locally commanded or when it is remotely controlled by the CCS via the SCOE/DFE LAN.

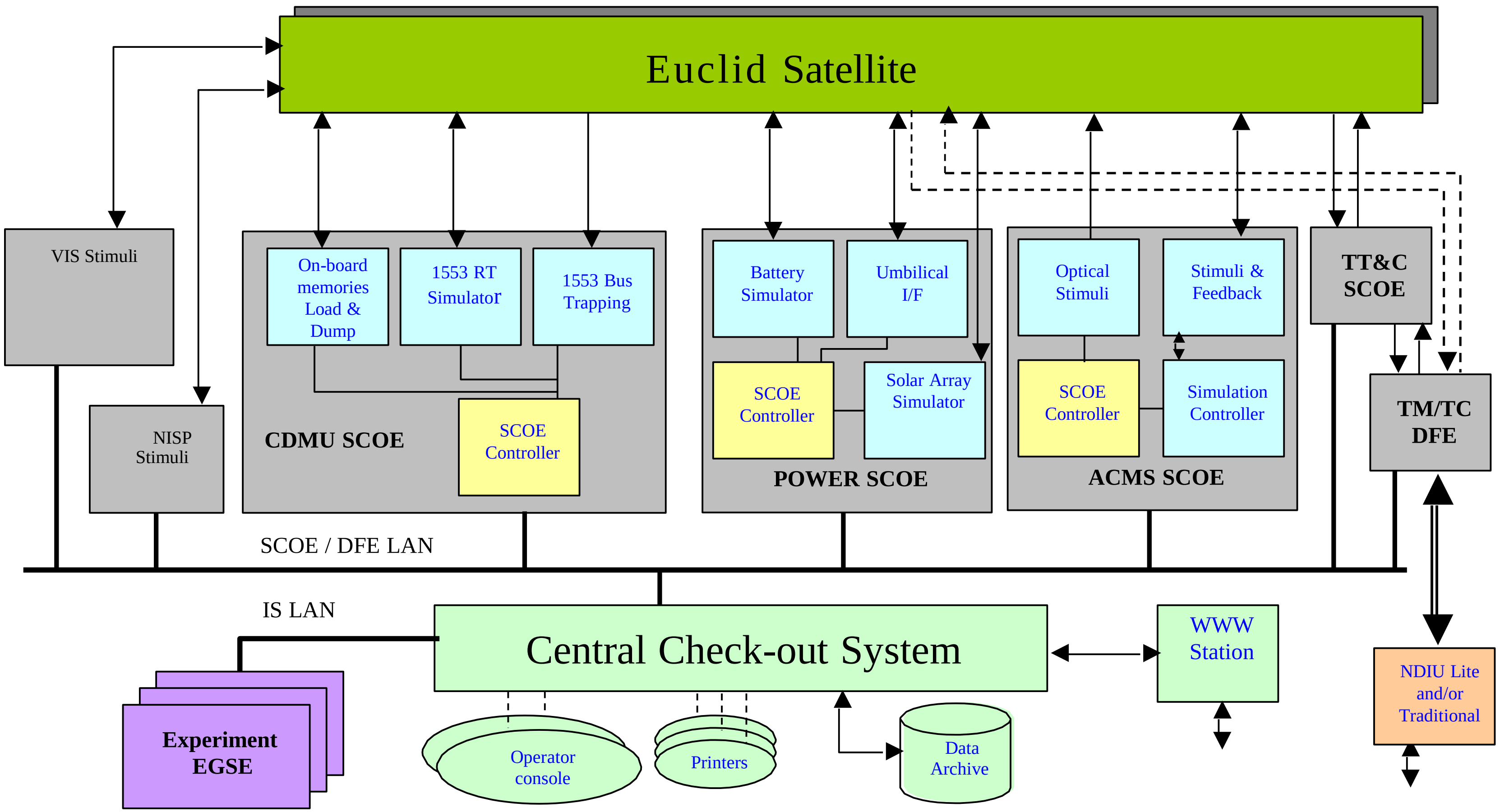

Euclid Satellite
VIS Stimuli
NISP Stimuli
On-board memories Load & Dump
1553 RT Simulator
1553 Bus Trapping
SCOE Controller
CDMU SCOE
Battery Simulator
Umbilical I/F
SCOE Controller
Solar Array Simulator
POWER SCOE
Optical Stimuli
Stimuli & Feedback
SCOE Controller
Simulation Controller
ACMS SCOE
TT&C SCOE
TM/TC DFE
SCOE / DFE LAN
IS LAN
Central Check-out System
WWW Station
NDIU Lite and/or Traditional
Experiment EGSE
Operator console
Printers
Data Archive

Figure 3.2-1 Euclid AVM/FM and EGSE functional architecture

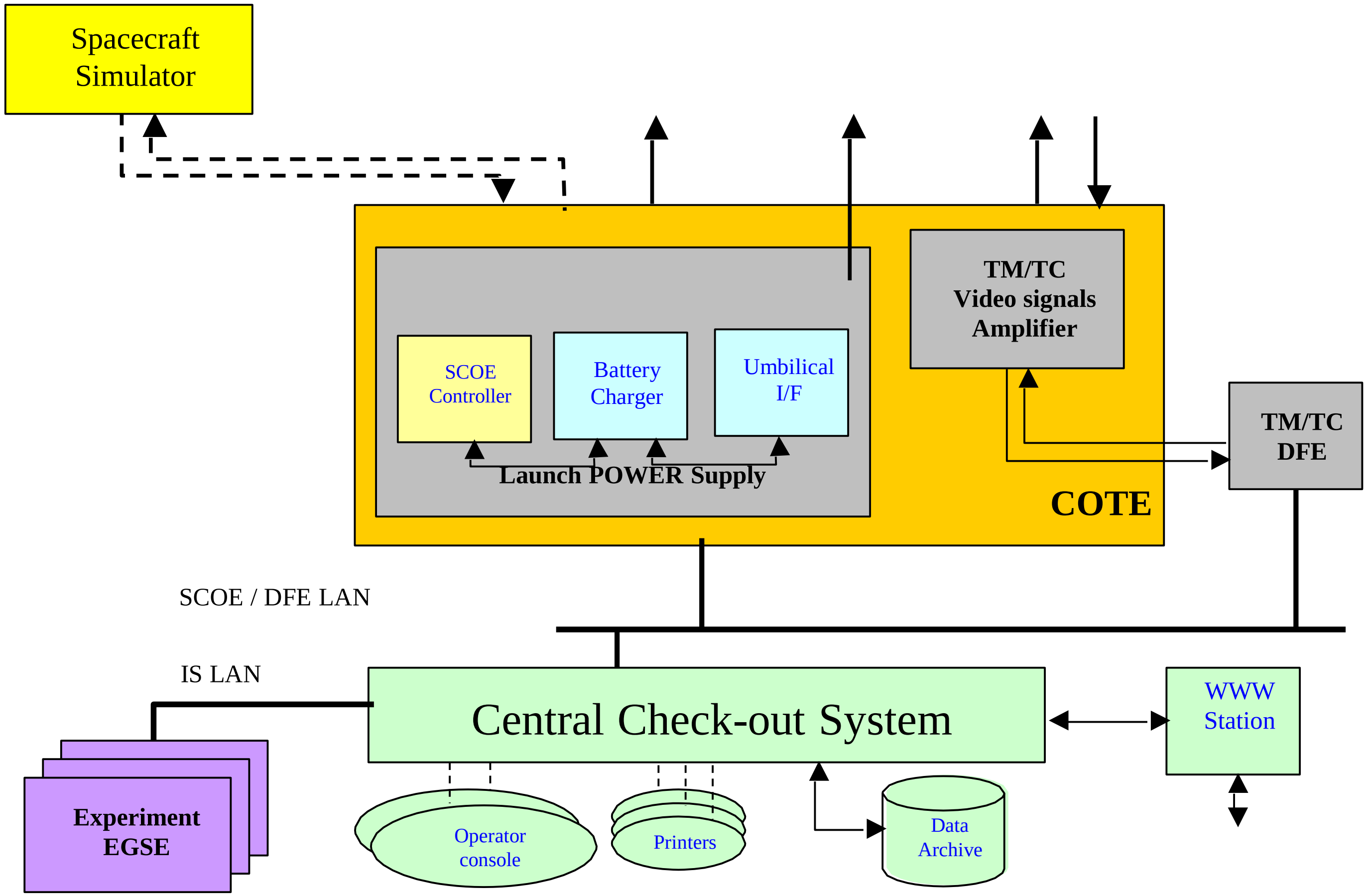


Figure 3.2-2 Euclid EGSE Launch configuration functional architecture

4 GENERAL REQUIREMENTS

4.1 Power SCOE main tasks

[VA:EQ/T

The Power SCOE shall be built around the following main functional blocks:
1. SCOE Controller
2. Solar Array Simulator
3. Battery Simulator
4. Launch Power Supply
5. Battery Conditioning Equipment

4.1.1 Power SCOE - Controller main functions

[VA:EQ/T
The Power SCOE Controller shall be able at least to:
- Perform command and control of the SCOE functions
- Communicate with the CCS for data transfer and mode control (except for BCE)
- Perform a self-test at power-on and on CCS request
- Provide archiving capability (BCE only)
- Provide logging capability.

4.1.2 Power SCOE – Solar Array Simulator (SAS) main functions

[VA:EQ/T

The Solar Array Simulator shall be able at least to:
- Simulate the 30 solar array sections by individual independent current sources
- Have individually adjustable source current and open loop voltage per section
- Simulate section output capacity
- Have over-voltage and over-current protection to avoid any damage to the Spacecraft
- Sense and display of the section currents and voltages
- Simulation of Sunlit to Eclipse and Eclipse to Sunlit transitions
- Simulation of the Solar Array temperature sensors

4.1.3 Power SCOE – Battery Simulator (BS) main functions

[VA:EQ/T

The Battery Simulator (BS) shall be able at least to:
- Simulate the flight Li-Ion battery in nominal mode (sun presence)
- Simulate the flight Li-Ion battery in discharge mode (eclipse)
- Simulate the flight Li-Ion battery in charge mode (sun presence after eclipse)
- Simulate the flight LI-Ion battery in Taper charge
- Simulate the source impedance
- Simulate the Li-Ion battery temperature
- Provide Over-voltage / over-current protections
- Provide sense and display capability for battery currents and voltages.

- Provide Battery PCDU protection switch

4.1.4 Power SCOE – Launch Power Supply (LPS) main functions

[VA:EQ/T

The Launch Power Supply shall be able at least to:

- Provide power to the S/C via Umbilical connector
- Provide charge capability for the battery
- Manage the interface between the SCOE and the S/C Umbilical connectors
- Provide signals Test points
- Monitor and display signals coming from the S/C
- Sense and display battery voltages of the on-board battery
- Sense and display Main Bus voltage
- Provide Over-voltage / Over-current protections.
- Simulate and monitor separation switches
- Manage the flashing light (indicating S/C is ON)

4.1.5 Power SCOE - Battery Conditioning Equipment (BCE) main functions

[VA:EQ/T

The Battery Conditioning Equipment shall be used in standalone configuration, i.e. it will be not connected to the CCS on the SCOE LAN as the other EGSE items; it shall be able at least to:

- Provide controller capability to manage the standalone configuration
- Charge the current source for the whole battery
- Taper charge source
- Discharge current sink for the whole battery
- Provide over-voltage / over-current protections
- Provide under-voltage protection
- Provide over temperature protection
- Allow the user to define different computer controlled charge / discharge current profiles
- Monitor and archive whole battery voltage, current and temperature
- Simulate sections output capacity.

5 POWER SCOE HIGH LEVEL FUNCTIONAL REQUIREMENTS

[VA:EQ/E

Regardless the operating mode, the Power SCOE shall be able to provide the required power to the Satellite during test activities from AVM integration up to the final tests performed during Launch campaign. It shall be able to simulate the real behaviour of the batteries and Solar Array panels. The Battery Conditioning Equipment shall be used, in standalone configuration, whenever is required to perform a battery conditioning cycle.

5.1 Power SCOE - Umbilical Interface Module High Level Functional Requirements

Moved to Section 5.4.10 and Section 5.4.11.

5.2 Power SCOE - Battery Simulator (BS) High Level Functional Requirements

5.2.1 Battery Simulator (BS) – Main task

[VA:EQ/ I/O

The Battery Simulator (BS) main task shall be the simulation of the Li-Ion battery behaviour installed on the Spacecraft.

5.2.2 Battery Simulator (BS) – Operational modes

[VA:EQ/T

The Battery Simulator (BS) shall be able to work in several different operational mode:

- Nominal mode (Sun presence)
- Charge mode
- Discharge mode
- Taper charge mode

5.2.3 Battery Simulator (BS) – Battery charge/discharge

[VA:EQ/T

The Battery Simulator (BS) shall be able to simulate the battery charge and discharge cycles over the voltage range 14 to 28 Volts.
In order to speed up the charging/discharging process, the Battery Simulator operator shall be able to select a current value (in the allowed range) and the SCOE shall automatically calculate the required charge/discharge time interval.
It shall be possible to pause the simulator at any time and suspend the discharge characteristic simulation. It shall then be possible to continue the simulation.
It shall be possible to pause the simulator at any time and suspend the charge characteristic simulation.
It shall then be possible to continue the simulation.

5.2.4 Battery Simulator (BS) – Battery discharge current

[VA:EQ/T

The Battery Simulator shall support a Battery discharge current value equivalent to 0 – 280W over the entire battery voltage range.

5.2.5 Battery Simulator (BS) – Battery charge current

[VA:EQ/T

The Battery Simulator shall provide a sink for battery charge currents of up to 10 A maximum over the entire battery voltage range.

5.2.6 Battery Simulator (BS) – Crossing between source and sink mode

[VA:EQ/T

The Battery Simulator (BS) shall allow an uninterrupted transition from charge to discharge (source and sink) mode and vice versa without interruption and without the need of user intervention. It shall be possible to alternate between any allowed charge and discharge rate and the battery simulator shall maintain the simulated state of charge. The simulation shall be suspended in the HOLD mode.

The Battery Simulator shall filter out current ripple emitted from the spacecraft in the frequency range 10Hz to 200kHz at an amplitude of 3 Amps peak to peak.

5.2.7 Battery Simulator (BS) –Initial battery Charge status

[VA:EQ/T

The Battery Simulator (BS) shall allow the operator to select a Voltage value that, when reached, is used by the SCOE itself as a trigger to start the battery charge process.

5.2.8 Battery Simulator (BS) – Peak Output power

[VA:EQ/T

The Battery Simulator (BS) shall provide for the simulated battery an output power of: 465 Watts for 30 minutes in the voltage range from 14V to 27 V.

Moreover the use of a (mechanical) relay is required at the power feeding outputs in order to galvanically isolate the Power SCOE from the Satellite.

5.2.9 Battery Simulator (BS) – Battery thermistors simulation

[VA:EQ/T

The Battery Simulator (BS) shall simulate 4 thermistors of Fenwall 526-31BS12-153 (15 KO at 25 °C) type for the Li-Ion battery.

[VA:EQ/T

Temperature sensors will be simulated by 3 fixed values that the user can manually select from SCOE.

5.2.10 Battery Simulator (BS) – Output voltage adjusting

[VA:EQ/T

The Battery Simulator (BS) shall provide the capability to adjust the battery output voltage between 0 V and 30 V at the user interface.

5.2.11 Battery Simulator (BS) – I-V characteristic adjusting

[VA:EQ/T

The Battery Simulator (BS) shall provide the capability to adjust the static I-V characteristics over the entire battery voltage range.

5.2.12 Battery Simulator (BS) – Maximum voltage

[VA:EQ/T

The Battery Simulator (BS) shall control the battery output so that the maximum voltage shall never exceed 26 V at the user interface.

5.2.13 Battery Simulator (BS) – Regulation capability

[VA:EQ/T

The Battery Simulator (BS) shall provide regulation capability using voltage sensing lines at the spacecraft interface to achieve better than 0.5% setting accuracy at the spacecraft interface.

5.2.14 Battery Simulator (BS) – Output Impedance

[VA:EQ/T

The battery simulator impedance at the spacecraft interface shall be 50mΩ±10% with an inductance of between 1 and 3 µH.

5.2.15 Battery Simulator (BS) – Output Voltage sensing

[VA:EQ/T

The Battery Simulator shall have the capability to sense the output voltage at the user interface and shall regulate the SCOE output accordingly (see para 6.1.2).

5.2.16 Battery Simulator (BS) – Battery temperature sensing

[VA:EQ/T

The Battery Simulator shall have the capability to sense the battery temperature lines.

5.2.17 Battery Simulator (BS) – Over-voltage protection

[VA:EQ/T

The Battery Simulator (BS) shall provide an over-voltage protection mechanism at the user interface, with adjustable level, for the outputs lines.
Default value triggering the over-voltage protection shall be 28 volts; protection intervention time shall be <50 micro seconds (without exceeding the over-voltage protection threshold).

Isolation of the fault shall not result in the spacecraft interface being shorted to ground (it is preferred that the BS be isolated via an output switch).

5.2.18 Battery Simulator (BS) – Over-current protection

[VA:EQ/T

The Battery Simulator (BS) shall provide an over-current protection mechanism at the user interface for the outputs lines.
Default value triggering the over-current protection shall be 2% of the maximum current; protection intervention time shall be <50 micro seconds (without exceeding the over-voltage protection threshold)**.**

Isolation of the fault shall not result in the spacecraft interface being shorted to ground (it is preferred that the BS be isolated via an output switch).

5.2.19 Battery Simulator (BS) – Safety Loop

[VA:EQ/T

The Battery Simulator (BS) shall provide a Safety Loop to manage the situation in which a failure on one of the power supply is detected (over-voltage, over-current): the safety loop interface shall switch off the power outlets of all power supplies in error condition.

[VA:EQ/T
The safety loop response time shall be < 1 ms, the safety loop threshold shall be adjustable between 28V and 33V.

[VA:EQ/T
Moreover Battery Simulator (BS), Umbilical I/F module and Solar Array Simulator (SAS) shall be linked one to the other.

5.2.20 Battery Simulator (BS) – Battery Protection switch

[VA:EQ/T

The battery Isolation relay will be introduced in between the Battery and the PCDU at the spacecraft external interface with the following requirements (the following requirements shall be applicable at each contact of the Battery protection switch):

- The maximum peak current shall be 120 Amps for approximately 1s while connected
- DC voltage drop (at Spacecraft connector interface) less than 0.7 Volts at 30 Amps
- Switch configuration shall be single failure tolerant to both ON and OFF switching actions (double, back to back, independent changeover configuration)
- Remote monitoring of the relay assembly input and output power terminal shall be provided so that voltage equalization within 1 volt may be achieved
- Battery side impedance < 60mΩ and 1µH
- PCDU side impedance 4000µF, 20mΩ and 50µH
- Battery voltage range 15V minimum to 26V maximum

- Switch mounting distance from body of spacecraft at lease 3m
- Possibility to extend link to 30m via an extension lead during spacecraft environmental testing
- Provide status indication
- Provide rough current measurement indication (GO/NOGO).

The Switch will be connected to the S/C to the connectors SK01BJ09 and SK01J10. Figure 5.2.20-1 provides an overview of the expected connections (the switch will be connected to the connector SK01BJ09 or SK01BJ10 or to both connectors).

Pins function and connector type is provided in Annex-2.

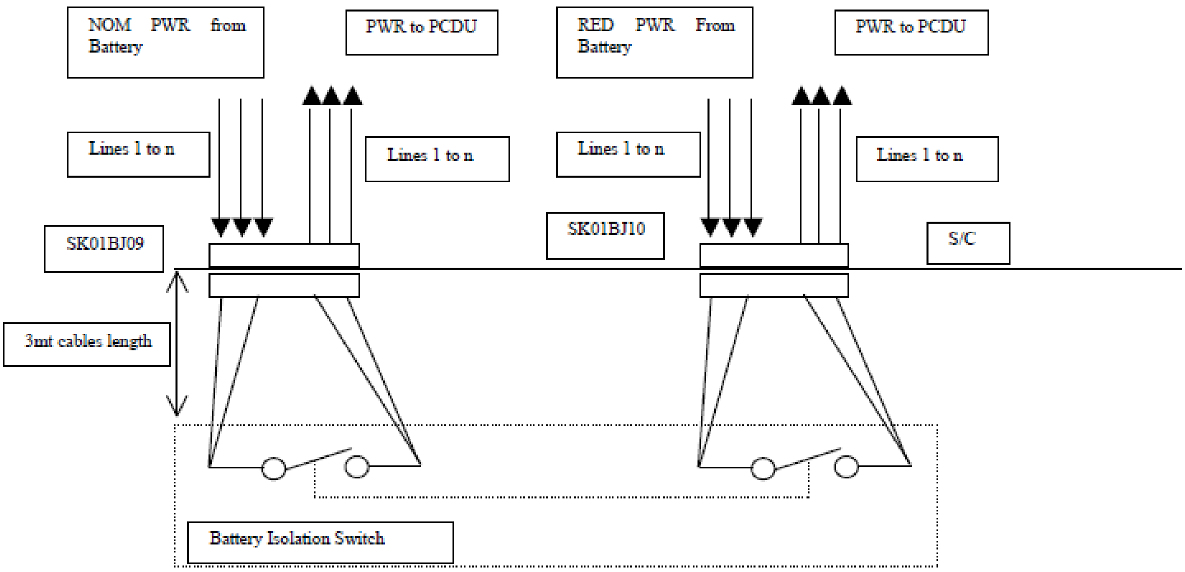


Figure 5.2.20-1 “Battery Isolation Switch connections”

5.3 Power SCOE - Solar Array Simulator (SAS) High Level Functional Requirements

5.3.1 Solar Array Simulator (SAS) – Main task

[VA:EQ/T

The Solar Array Simulator (SAS) main task shall be the electrically representative simulation, by individual current sources, of the each one of the 30 sections of the Solar Array panels.

Solar Array Sections shall be simulated in accordance to real sections characteristics as defined here-after.

5.3.2 Solar Array Simulator (SAS) – I-V characteristic adjusting

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide the capability to adjust the static I-V curve characteristics. Moreover the open circuit voltage shall be adjustable in the range from 0.0 to 60 V while the short circuit current shall be adjustable in the range from 0.0 to 3.0 A measured at Spacecraft connector level.

5.3.3 Solar Array Simulator (SAS) - Output power

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide the output power as defined in predefined default I-V characteristics applicable to all 30 sections. These characteristics shall be programmable by the user.

In particular at Spacecraft interface connector the following values shall be guaranteed:

- Current shall be in the range from 0 to 3.0 A for each section

The use of a (mechanical) relay is required at the power feeding outputs in order to galvanically isolate the Power SCOE from the Satellite.

At I/F connector with S/C the voltage will be in the range 29 to 33 V (for information only).

5.3.4 Output current measurement

[VA:EQ/T

The Solar Array Simulator (SAS) shall be able to provide a current measurement accuracy better than 1% at user interface level.

5.3.5 Solar Array Simulator (SAS) - Output impedance

[VA:EQ/T

The SAS shall simulate the output impedance of each Solar Array sections at user interface (i.e. at the end of the SCOE cables)as follows:

- The effective inductance shall individually adjustable between 4μH and 8μH (including cable). The SCOE shall be delivered with all inductances set at 5μH;
- The effective capacitance shall individually adjustable between 2μF and 10μF (including cable). The SCOE shall be delivered with all capacitances set at 5μF;

The length of the SAS SCOE cables (30 meters) shall to be taken into account during SCOE design in order to fulfil above mentioned impedance requirements.

5.3.6 Solar Array Simulator (SAS) – Shunt regulator

[VA:EQ/T

The Solar Array Simulator (SAS) shall be able to cope with dynamic shunt current regulators on any segments or a combination of them.

5.3.7 Deleted

Deleted

5.3.8 Solar Array Simulator (SAS) – Current sensing and monitoring

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide the capability sense each output current line with a measurement accuracy less than 1%.

5.3.9 Solar Array Simulator (SAS) – Sunlight/eclipse transitions

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide the capability to simulate, at the same time for all sections:

1. The transition from sunlight to eclipse
2. The transition from eclipse to sunlight.

5.3.9.1 Solar Array Simulator (SAS) – Transitions time

[VA:EQ/T

The Solar Array Simulator (SAS) shall allow the user to adjust the transition time specifying it with 1second steps between 1 and 256 seconds.

5.3.9.2 Solar Array Simulator (SAS) – Transitions management

[VA:EQ/T

The Solar Array Simulator (SAS) shall allow the user to hold or stop a transition in whenever needed: the reached current level shall be maintained until a new request from the user.

5.3.10 Solar Array Simulator (SAS) - Thermistors simulation

[VA:EQ/T

The Solar Array Simulator (SAS) shall be able to simulate Thermistors for the Solar Array sections. In particular:

- Number 6 of ROSEMOUNT 118F / 2KO / – 100 ÷ + 150 ºC.

The Temperature sensors will be simulated by 3 fixed values that the user can manually select from SCOE.

5.3.11 Solar Array Simulator (SAS) – Over-voltage protection

[VA:EQ/T

The Solar Array Simulator (SAS & LPS) shall receive the Prime and redundant spacecraft bus voltage sensors provided through the Umbilical interface and provide a main bus over-voltage protection mechanism at the user interface, with adjustable level between 28 V to 31 V, for the voltage output lines. Default value triggering the over-voltage protection shall be 29 volts protection intervention time shall be 50 µseconds.

5.3.12 Solar Array Simulator (SAS) – Over-current protection

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide an over-current protection mechanism at the SAS module before the impedance matching circuit, with adjustable level from 0 to 3.5 A, for the current outputs lines. Default value triggering the over-current protection shall be 3.5 Amps; protection intervention time shall be 50 micro seconds.

5.3.13 Solar Array Simulator (SAS) – Safety Loop

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide a Safety Loop to manage the situation in which a failure on one of the power supply is detected (over-voltage, over-current): the safety loop interface shall switch off the power outlets of all power supplies in error condition.

The safety loop response time shall be < 1 ms, the safety loop threshold shall be adjustable between 28V and 33V.

Moreover Battery Simulator (BS), Umbilical I/F module and Solar Array Simulator (SAS) shall be linked one to the other.

5.3.14 Solar Array Simulator (SAS) – High Priority Commands

[VA:EQ/T

The SAS shall provide to both local and remote operator the capability to send 4 on board High Priority commands addressed to the PCDU to turn ON and OFF two on-board Battery Discharge Regulators.

5.4 Power SCOE – Launch Power Supply (LPS) High Level Functional Requirements

5.4.1 Launch Power Supply (LPS) – Main Task

[VA:EQ/T

The main task of the Launch Power Supply (LPS) shall be to provide, via Umbilical link, to the Spacecraft during all integration and testing activities including launch campaign:

1. Nominal and redundant Main Bus power lines (6 SAS sections)
2. Two Battery support power lines (via on-board PCDU battery charger).

The use of a (mechanical) relay is required at the power feeding outputs in order to galvanically isolate the Power SCOE from the Satellite.

5.4.2 Launch Power Supply (LPS) – Power Requirements

[VA:EQ/T

The Launch Power Supply (LPS) shall be able to provide:

- Nominal and Redundant Main Bus support current loops each providing 0 to 3 Amps to the Spacecraft PCDU via the umbilical connector.
- Protection to ensure that the S/C to SAS I/F voltage does not exceed 30.8 Volts.
- Current limit setting accuracy shall be better than 1% (FSD).
- Each current loop impedance at the PCDU shall be R<2.5Ω, C<0.5μF and L<75μH.
- Each current loop shall be compatible with S3R bus regulation in the S/C PCDU.

The use of a (mechanical) relay is required at the power feeding outputs in order to galvanically isolate the Power SCOE from the Satellite.

5.4.3 Launch Power Supply (LPS) – Umbilical connection

[VA:EQ/T

The Launch Power Supply (LPS) shall provide and shall be able to manage the interface between the SCOE and the S/C Umbilical connectors such that:

1. No single failure within the SCOE shall result an overload of the PCDU interface (current >3.0A, Voltage >31V).
2. Over-voltage OR over-current protection shall be effective within 50μs (without exceeding item 1 above).
3. No single failure shall result in the loss of both prime and redundant support systems.
4. The SCOE shall provide back EMF protection during separation simulation to prevent arks at the end of the SCOE cable.
5. Charge array disable link

5.4.4 Launch Power Supply (LPS) – Umbilical parameters acquisition

[VA:EQ/T

The Launch Power Supply (LPS) shall receive the spacecraft's precision Main Bus voltage sense lines (see paragraph 6.1.1) and accurately buffer them for distribution to the following functions:

- Remote main bus voltage control for distribution to bus voltage monitor (via prime umbilical connector)
- Prime bus voltage monitor
- Prime battery voltage monitor

5.4.5 Launch Power Supply (LPS) –Sensing capability

[VA:EQ/T

The Launch Power Supply (LPS) shall provide the capability to sense and display the on-board Battery voltage and temperature plus the Main Bus output voltages.

5.4.6 Moved to section 5.3.14

5.4.7 Launch Power Supply (LPS) – Over-voltage protection

[VA:EQ/T

The Launch Power Supply (LPS) shall provide an over-voltage protection mechanism at the user interface, with adjustable level, for the voltage output lines.
Default value triggering the over-voltage protection shall be adjustable in the range from 18 V to 22 V.

5.4.8 Launch Power Supply (LPS) – Over-current protection

[VA:EQ/T

The Launch Power Supply (LPS) shall provide an over-current protection mechanism at the user interface, with adjustable level, for the current outputs lines.
Default value triggering the over-current protection shall be 3 A.

5.4.9 Launch Power Supply (LPS) - Safety loop

[VA:EQ/T

The Launch Power Supply (LPS) shall a Safety Loop to manage the situation in which a failure on one of the power supply is detected (over-voltage, over-current): the safety loop interface shall switch off the power outlets of all power supplies in error condition.
The safety loop response time shall be < 1 ms, the safety loop threshold shall be adjustable between 28V and 33V and finally the on LPS only, the safety loop could be disabled by the operator via a dedicated command.

5.4.10 Launch Power Supply (LPS) – Monitor and Display Capabilities

[VA:EQ/T

The Launch Power Supply (LPS) shall be able to acquire, with an accuracy better than 1%, at least the here below listed signals coming from the Spacecraft, to monitor their value and to display them to the operator

- Battery voltage
- Battery voltage sensors lines (1 for Voltage control and one for Battery protection).

5.4.11 Launch Power Supply (LPS) – Separation Switches Simulation and Monitoring

[VA:EQ/T

The Launch Power Supply (LPS) shall provide the capability to simulate separation switches behaviour. Relevant switch status shall also be monitored and displayed.

5.4.12 Flashing Light

[VA:EQ/T

The LPS shall be able to detect that the Satellite is powered ON and shall command the flashing light (this information will be taken from the Umbilical lines).

5.4.13 SAS/LPS – Charge array disable link simulation and monitoring

[VA:EQ/T

The SAS/LPS shall provide a capability to simulate nominal and redundant switches to short-circuit Solar Array sections during battery SAFE/ARM connectors mating activities as shown in Figure 5.4.13 - 1. Relevant switch status shall also be monitored and displayed

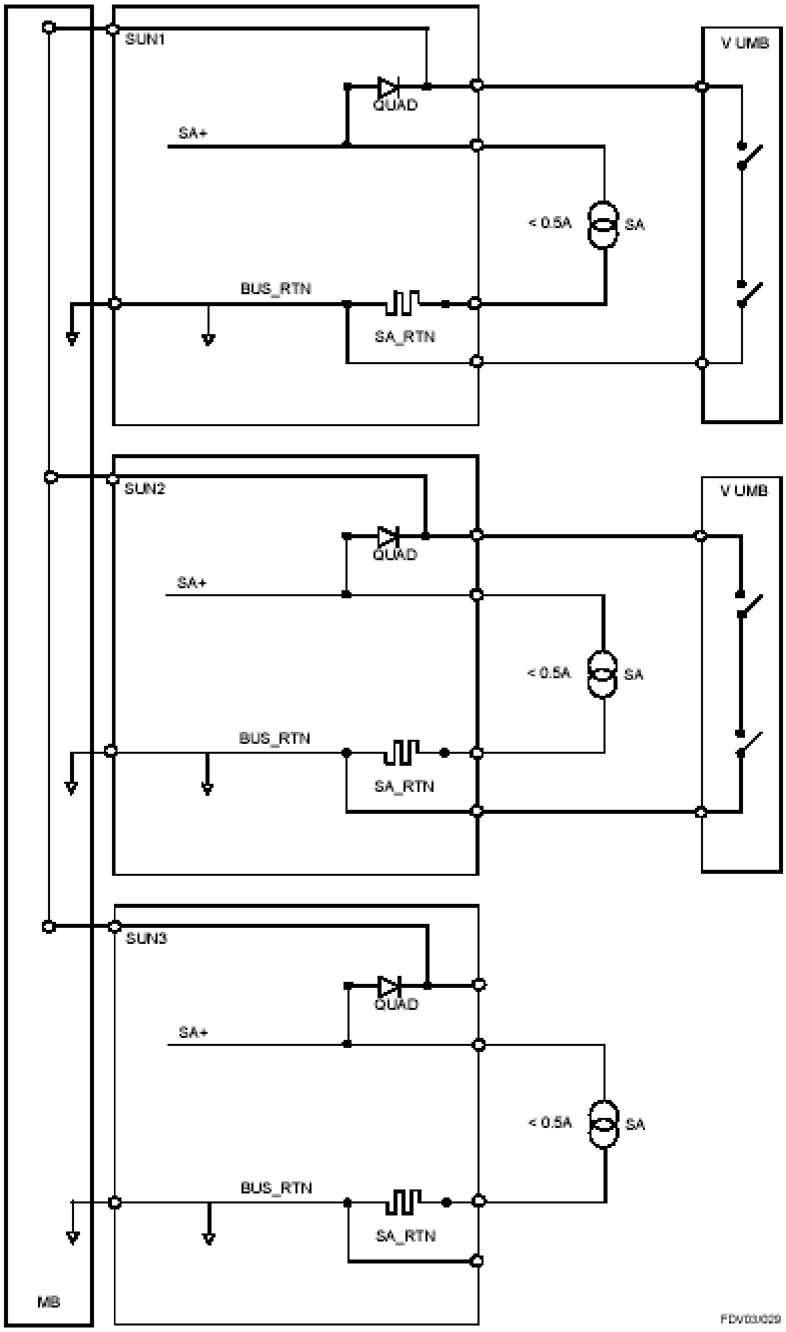


Figure 5.4.13 - 1. Charge array disable link

5.5 Power SCOE - Battery Conditioning Equipment (BCE) High Level Functional Requirements

5.5.1 Battery Conditioning Equipment (BCE) – Main task

VA:[I/O

The Battery Conditioning (BCE) main task shall allow the conditioning of the Euclid battery.

5.5.2 Battery Conditioning Equipment (BCE) - Configuration

VA:[EQ/T

The Battery Conditioning Equipment (BCE) shall work in standalone configuration, i.e. without the remote control from of the CCS.

5.5.3 Battery Conditioning Equipment (BCE) - Battery charging

VA:[EQ/T

The Battery Conditioning (BCE) shall provide the capability to charge the Li-Ion battery – with a selectable constant current value – up to the Nominal End of Charge Voltage (V_{EOC}) of 25.2 V. Taper Charge shall be applied when a voltage of 25.5 V is reached.

(Taper charge definition: when the Battery reaches the maximum voltage level, the charge has to be maintained at a constant level by regulating Voltage).

5.5.3.1 Battery Conditioning Equipment (BCE) – Charge current

VA:[EQ/T

The Battery Conditioning Equipment (BCE) shall provide an adjustable charge current source: the value of the charge current shall not exceed 9.0 A for nominal charge mode while a constant voltage shall be maintained during Taper charge.

5.5.3.2 Battery Conditioning Equipment (BCE) – Charge cycle setting

VA:[EQ/T

The Battery Conditioning Equipment (BCE) shall allow the operator to select, beside the charge current value, also the voltage. Default value shall also be provided on the BCE.

5.5.4 Battery Conditioning Equipment (BCE) - Battery discharging

VA:[EQ/T

The Battery Conditioning (BCE) shall provide the capability to discharge the Li-Ion battery in Normal mode only, i.e. the whole battery only can be discharged.

In order to reach the minimum voltage (V_{EOD}) of 18 V (V_{EOD} min = 14.75 V) proper dedicated loads (electronic or resistive loads) will be used for the discharge capability.
The operator shall be notified with an Alarm message when V_{EOD} equals to 18 V and Battery discharge process needs to be aborted when V_{EOD} equals to 15 V; also in this case proper message shall be notified to the operator.

5.5.4.1 Battery Conditioning Equipment (BCE) – Discharge current

VA:[EQ/T

The battery conditioning equipment shall provide a discharge current sink.

5.5.4.2 Battery Conditioning Equipment (BCE) – Discharge cycle setting

VA:[EQ/T

The Battery Conditioning Equipment (BCE) shall allow the operator to select, beside the discharge current value, also the voltage limits for the whole battery. Default values shall also be provided on the BCE.

5.5.5 Battery Conditioning Equipment (BCE) - Battery capacity determination accuracy

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide the capability to measure the battery capacity with accuracy better than 2%.

5.5.6 Battery Conditioning Equipment (BCE) - Output sensing

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall sense the voltage and current at the user interface and shall regulate the SCOE output accordingly.

5.5.7 Battery Conditioning Equipment (BCE) – Battery monitoring

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide the capability to acquire, to monitor and to archive inside dedicated archive files at least the following parameters during both charge or discharge cycles:

- Battery overall voltage
- Battery overall current
- Temperature readout from thermistors
- Acquisition date and time
- Half string voltage.

The monitored values shall be acquired each second and with an accuracy of 0.01 V for voltages and 0.01 A for charge/discharge current.

5.5.8 Battery Conditioning Equipment (BCE) – Automated operation

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide the capability to perform charge and discharge cycles under the supervision of dedicated software installed inside the BCE controller. At least the following functions shall be provided to the local operator:

- Definition and storage of different charge and discharge profiles
- Definition of levels/limits that – if exceeded – cause the charge/discharge process to be interrupted
- Archiving voltage, current and temperature values as monitored during battery conditioning
- Calculation of battery capacity
- Archived data retrieval, post-processing and presentation.

5.5.8.1 Charge/discharge configuration set-up

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide - for example - the possibility to define that:

1. The charge shall be performed according to the selected constant current until the following limits are reached:
   Battery Voltage : from 25.2 V to 25.5 V

2. The discharge shall be performed at the selected constant current until the following limits are exceeded:
   Battery Under Voltage : from 20 V to 16 V.

5.5.9 Battery Conditioning Equipment (BCE) – Over-voltage protection

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide an over-voltage protection mechanism at the user interface, with adjustable level, for the voltage output lines.
Default value triggering the over-voltage protection shall be 26 V; protection intervention time shall be 50 seconds.

5.5.10 Battery Conditioning Equipment (BCE) – Over-current protection

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide an over-current protection mechanism at the user interface for the current outputs lines.
Default value triggering the over-current protection shall be +2% of the maximum current; protection intervention time shall be 50 µseconds.

5.5.11 Battery Conditioning Equipment (BCE) – Over-temperature protection

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide an over-temperature protection mechanism based on the battery temperature monitored via the thermistors.
The outputs of the Battery Conditioning Equipment (BCE) shall be switched off at an adjustable upper temperature limit of around +35°C.

5.5.12 Battery Conditioning Equipment (BCE) – Safety Loop

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide a Safety Loop to manage the situation in which a failure on one of the power supply is detected (over-voltage, over-current): the safety loop interface shall switch off the power outlets of all power supplies in error condition.

5.5.13 Battery Conditioning Equipment (BCE) – Under-voltage Protection

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide an under-voltage protection mechanism at the user interface, with adjustable level, for the voltage output lines. Default values triggering the under-voltage protection shall be 15 V; protection intervention time shall be 50 µsec.

6 POWER SCOE INTERFACES REQUIREMENTS

6.1 Power SCOE electrical and functional Interfaces

6.1.1 Deleted

6.1.2 Battery Simulator (BS) Interfaces

[VA:EQ/T

The Battery Simulation Equipment (BS) shall interface the Satellite via the harness at battery level and shall provide at least the following interfaces (two separate cables):

1. Battery power simulation interface
2. Thermistor interfaces for battery

Refer to Annex-2.

6.1.3 Solar Array Simulator (SAS) Interfaces

[VA:EQ/T

The Solar Array Simulator (SAS) shall provide at least the following interfaces:

- Power outlets for solar array panel simulation to the flight interface (Solar Array connection)
- Temperature sensors simulation interface.

Refer to Annex-2.

6.1.4 Battery Conditioning Equipment (BCE) Interfaces

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall interface directly to the Battery connectors and shall provide at least the following interfaces:

1. Power input/output interface to Battery power connector
2. Interface to battery test connector to monitor overall battery
3. Thermistors interfaces to Battery monitor connector

Refer to Annex-2.

6.1.5 Launch Power Supply (LPS) Interfaces

[VA:EQ/T

The Launch Power Supply (LPS) shall provide at least the following interfaces:

1. Power lines (6 sections 3 A max R 1 /loop)
2. Interface to Battery Voltage Monitor lines
3. Umbilical interface for Main Bus Voltage acquisition (Bus monitor lines) and separation switches status
4. Battery temperature
5. Umbilical interface for analogue data acquisition
   The spacecraft provides two main bus voltage monitor signals (2 positive and 2 negative) each connected to the main bus via a 100k 0.05% resistor.
   The spacecraft provides two battery voltage monitor signals (2 positive and 2 negative) each connected to the battery via a 100k 0.05% resistor

Refer to Annex-2.

6.1.6 Deleted

6.2 Power SCOE – Cable length

6.2.1 Cable between Power SCOE and Spacecraft

[VA:EQ/T

The cables connecting the Power SCOE panels to the on-board units shall be 30 meters long except the BCE cables that shall be 5 meters long.
Cables shall be manufactured as “straight” lines avoiding as much as possible “octopus” configurations. In the schematics reported in next paragraphs showing all SCOE cables connections, “octopus” cables are to be intended only due to drawing limitations and not as a mandatory requirement.

6.2.2 Cables between SAS/LPS SCOE and TM/TC DFE

[VA:EQ/T

The cables connecting the SAS/LPS SCOE panels to the TM/TC DFE in order to provide the Telemetry and Telecommands direct link (Bypass) shall be 30 meters long. They will be built using DEMA9P connectors type at TM/TC DFE interface, while at Spacecraft side connectors (Umbilical 1 &2) type is defined in Annex-2.

The relevant pins functions at TM/TC DFE side are reported here below.

TM Primary NRZ-L				
PIN #	**Name**	**Direction**	**Level**	**Description**
1	IF_GND1	--	--	Interface Ground (1)
2	--	--	--	Not Connected
3	--	--	--	Not Connected
4	TMSCP_CLK_T	From S/C	RS-422	Primary TM Clock true signal
5	TMSCP_DAT_T	From S/C	RS-422	Primary TM Data true signal
6	--	--	--	Not Connected
7	LOCK	--	--	Keying pin
8	TMSCP_CLK_C	From S/C	RS-422	Primary TM Clock comp. signal
9	TMSCP_DAT_C	From S/C	RS-422	Primary TM Data comp. signal

TM Redundant NRZ-L				
PIN #	**Name**	**Direction**	**Level**	**Description**
1	IF_GND1	--	--	Interface Ground (1)
2	--	--	--	Not Connected
3	LOCK	--	--	Keying pin
4	TMSCR_CLK_T	From S/C	RS-422	Redundant TM Clock true signal
5	TMSCR_DAT_T	From S/C	RS-422	Redundant TM Data true signal
6	--	--	--	Not Connected
7	--	--	--	Not Connected
8	TMSCR_CLK_C	From S/C	RS-422	Redundant TM Clock comp. signal
9	TMSCP_DAT_C	From S/C	RS-422	Redundant TM Data comp. signal

TC Primary NRZ-L				
PIN #	**Name**	**Direction**	**Level**	**Description**
1	IF_GND2	--	--	Interface Ground (2)
2	TCSCP_CLK_T	To S/C	RS-422	Primary TC Clock true signal
3	TCSCP_DAT_T	To S/C	RS-422	Primary TC Data true signal
4	TCSCP_ENA_T	To S/C	RS-422	Primary TC Bypass Enable true signal
5	LOCK	--	--	Keying pin
6	TCSCP_CLK_C	To S/C	RS-422	Primary TC Clock comp. signal
7	TCSCP_DAT_C	To S/C	RS-422	Primary TC Data comp. signal
8	TCSCP_ENA_C	To S/C	RS-422	Primary TC Bypass Enable comp. signal
9	--	--	--	Not Connected

TC Redundant NRZ-L				
PIN #	**Name**	**Direction**	**Level**	**Description**
1	IF_GND2	--	--	Interface Ground (2)
2	TCSCR_CLK_T	To S/C	RS-422	Redundant TC Clock true signal
3	TCSCR_DAT_T	To S/C	RS-422	Redundant TC Data true signal
4	TCSCR_ENA_T	To S/C	RS-422	Redundant TC Bypass Enable true signal
5	--	--	--	Not Connected
6	TCSCR_CLK_C	To S/C	RS-422	Redundant TC Clock comp. signal
7	TCSCR_DAT_C	To S/C	RS-422	Redundant TC Data comp. signal
8	TCSCR_ENA_C	To S/C	RS-422	Redundant TC Bypass Enable comp. signal
9	LOCK	--	--	Keying pin

6.2.3 Launch Power Supply (LPS) cables

6.2.3.1 SAS/LPS Cables For AIV Activities

[VA:EQ/T

The SAS/LPS will interface with the Spacecraft during AIV activities with 30 mt length cables.

6.2.3.2 LPS Cables On Launch Site

[VA:EQ/T

The LPS will power the Spacecraft already mounted on the launcher; it will be connected to the facility patch panel with 15 m cables.
In any case the LPS shall be carefully designed in order to fulfil performance requirements over long cables distance and taking into account the cabling characteristics of the Launch facility infrastructure, i.e.:

1. Cables type: Twisted shielded
2. Cable total TBD

6.2.4 Cables naming

[VA:EQ/E

All cables shall be identified with unambiguous names and properly labelled.
Moreover cables shall be labelled on both side indicating at least, besides the cable identification, SCOE or Satellite side, and relevant connector it has to be connected to.

6.3 Power SCOE – Connectors and pins function

[VA:I/O

The connectors mounted on POWER SCOE harness and interfacing the Spacecraft shall be capable of mating the Spacecraft connectors as specified in the next paragraphs.

Related Spacecraft Connectors, type and relevant pins function are detailed in Annex-2.

All Power SCOE connectors shall be identified with unambiguous names and properly labelled.

6.3.1 Deleted

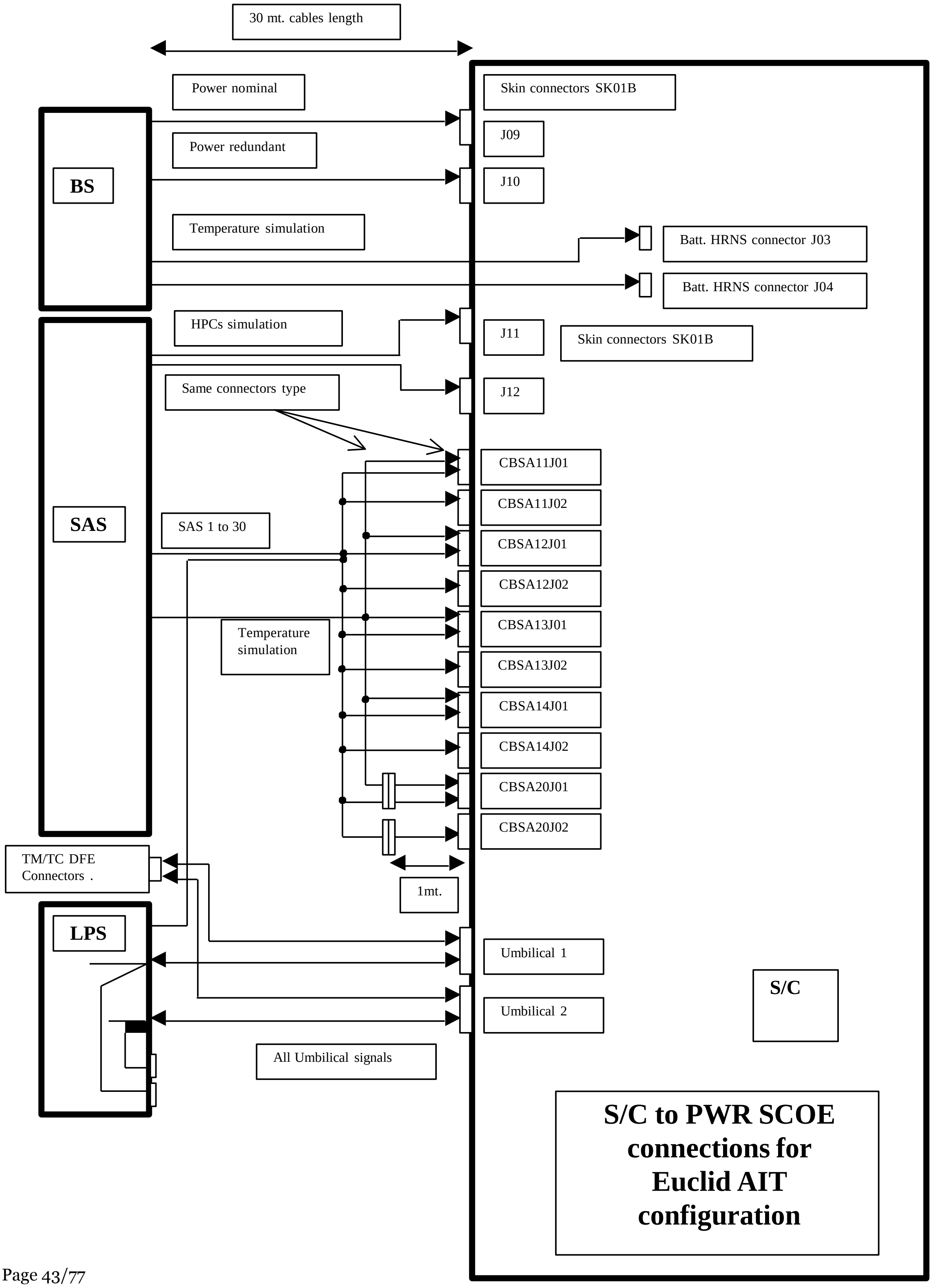
6.3.2 Deleted

6.3.3 Deleted

6.3.4 BS/LPS/SAS Connection Configuration

[VA:EQ/T

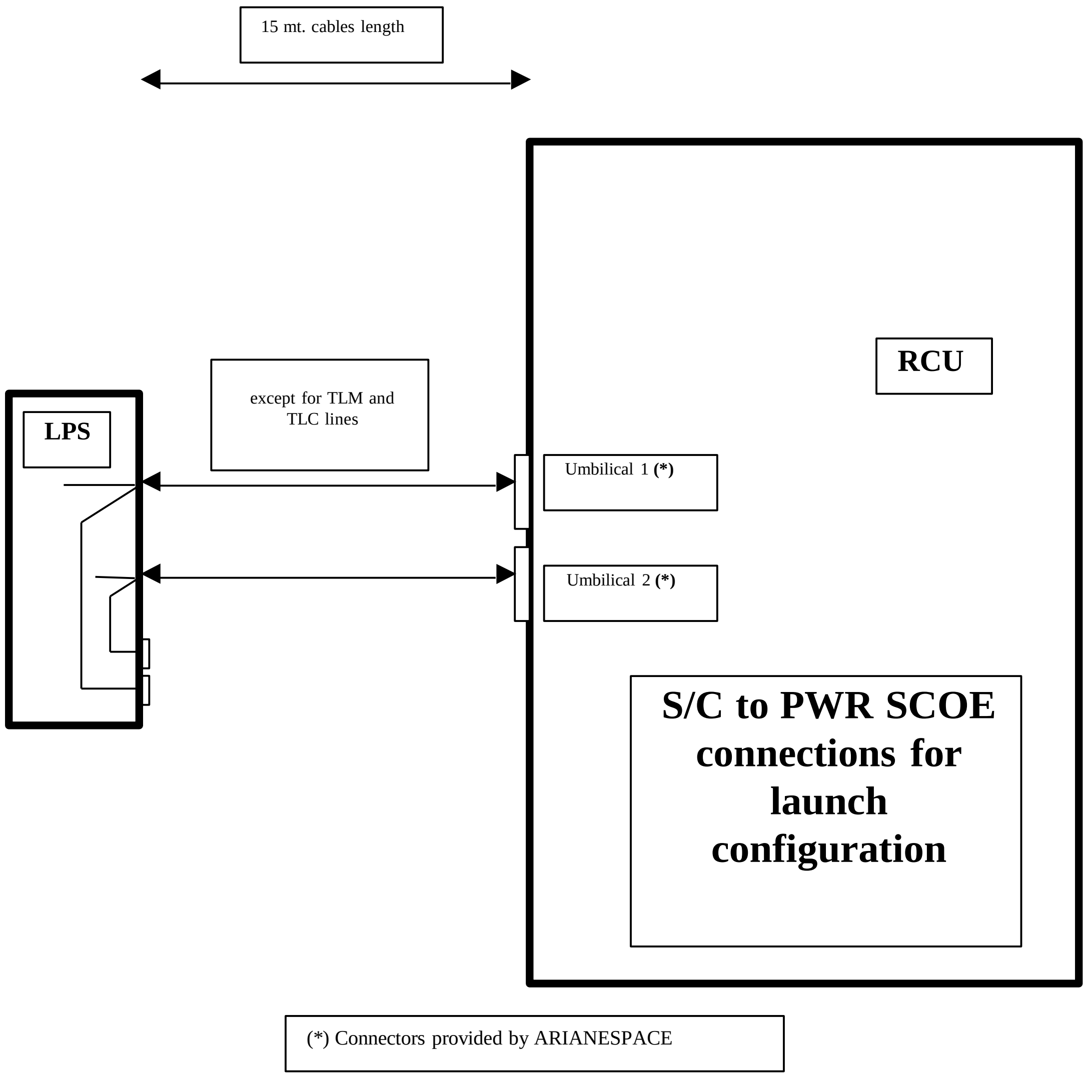
The harness of the BS/LSP/SAS to perform the AIT activities shall be realised as follows. Connectors type and pins function are provide in Annex-2.


30 mt. cables length
Power nominal
Skin connectors SK01B
J09
Power redundant
BS
J10
Temperature simulation
Batt. HRNS connector J03
Batt. HRNS connector J04
HPCs simulation
J11
Skin connectors SK01B
Same connectors type
J12
CBSA11J01
CBSA11J02
SAS
SAS 1 to 30
CBSA12J01
CBSA12J02
CBSA13J01
Temperature simulation
CBSA13J02
CBSA14J01
CBSA14J02
CBSA20J01
CBSA20J02
TM/TC DFE Connectors .
1mt.
LPS
Umbilical 1
S/C
Umbilical 2
All Umbilical signals
S/C to PWR SCOE connections for Euclid AIT configuration

6.3.5 *Deleted*

6.3.6 *LPS Connection Configuration*

The LPS harness for launch AIT activities shall be realised as following. Connectors type and pin function are provide in Annex-2.

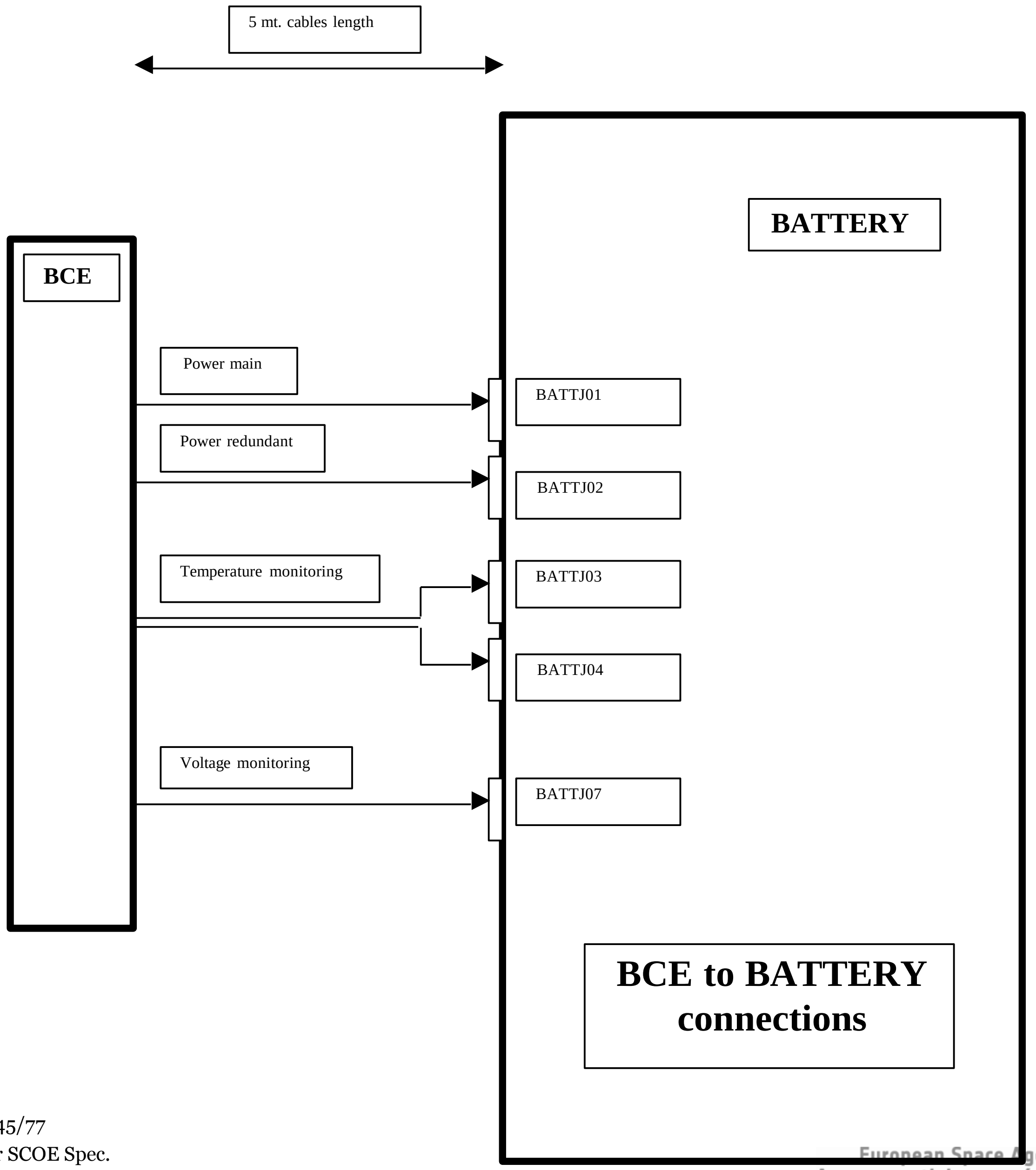


6.3.7 Battery Conditioning Equipment (BCE) Connection Configuration

[VA:EQ/T

The harness of the BCE to perform the all the AIT activities shall be realised as following. Connectors type and pins function are provide in Annex-2.

For what concerns BATTJ07 connector pins function refer to next paragraph 6.3.8.



6.3.8 BATTJ07 pins function

Pins function for BATTJ07 – Telemetry for Battery positive and negative voltage and mid string voltage is shown here below:

Equipment Interconnection		
	Connector Type	37-Way D Type Plug
	Connector Reference	J07 – Mid String Sense 340180201BDCMA37PNMBFO

Pin	Function	Signal Type	CURRENT		RESISTANCE		FREQ	VOLTAGE RANGE				CAPACITANCE			IF Code
								Source		Load					
			Source Max (A)	Load Max (A)	Source (Ω)	Load (Ω)	(Hz)	Min (V)	Max (V)	Min (V)	Max (V)	Source (pF)	Load (pF)	Total I/F* (pF)	
1	N/C	N/A													
2-13	Mid String Voltage	Telemetry	TBD[1]		10k			8.0	12.6						TM
14-15	N/C	N/A													
16	Battery Voltage +ve	Telemetry	TBD		10k			16.0	25.2						TM
17-20	N/C	N/A													
21-32	Mid String Voltage	Telemetry	TBD		10k			8.0	12.6						TM
33-35	N/C	N/A													
36	Battery Voltage –ve	Telemetry	TBD		10k			16.0	25.2						TM
37	N/C	N/A													

1. Dependent on monitoring system.

6.4 Power SCOE - Test Points

[VA:EQ/T

Test-points shall be foreseen for each critical signal in order to allow calibration, integration, operation and maintenance as well as surveying of signals at the interfaces level.

6.4.1 Power SCOE - Test Points characteristics

[VA:EQ/T

The test points shall be short circuit protected or secured by other means.

6.4.2 Power SCOE - Test Points connectors

[VA:EQ/T

All the Power SCOE test-points shall be provided using the same connector type (ex. 4 mm banana jacks or BCN connectors) in order to allow easy use of measurement probes and commercial laboratory equipment. In any case the connectors shall be of standard types.

6.4.3 Power SCOE - Test Points accessibility

[VA:EQ/T

Test-points shall be accessible without dismounting and disconnecting any equipment or parts of Power SCOE.

6.4.4 Power SCOE - Test Points availability

[VA:EQ/T

Test points shall be provided for every critical signal
to allow:

1. Easy isolation and identification of failed items without dismounting or disconnecting other equipment
2. Calibration
3. Integration
4. Maintenance.

6.4.5 Grounding concept

[VA:EQ/T

Refer to Annex-1.

6.5 Power and Signal ground separation

[VA:EQ/T

Signal and power returns of the Power SCOE shall be separated.
It shall be possible to ground the Power Supply return. There will be DC isolation between the Power Supply and the remaining part of the Power SCOE.

6.6 External powering

[VA:EQ/T

An independent Power Distribution Unit (Insulation Transformer) shall be used in order to power the Power SCOE.

6.7 Power SCOE to CCS Interfaces

[VA:EQ/T

The Power SCOE shall be able to interface with the CCS node via a 100 Mb/s Ethernet Local Area Network using the standard TCP/IP protocol. Refer to Annex-3.

6.7.1 Communication Control for Power SCOE

[VA:EQ/T

The communication links between CCS and the POWER SCOE shall be managed following a Client/Server philosophy where the CCS acts as a Client and the SCOE is the Servers accepting connection and service requests.

6.7.2 Communication Link start up

[VA:EQ/T

The Power SCOE shall automatically accept a "connection request" coming from the CCS in order to try to establish the connection with it.

6.7.3 Exchanged messages format

[VA:EQ/T

The communication with the CCS shall be based on a Packet-oriented protocol where the packets format is the same defined for the ones exchanged with the Spacecraft. Refer to Annex-3.

Dedicated APID have already been defined for EGSE; they range from 2016 to 2046. Refer to Annex-3.

6.7.4 Exchanged messages contents

[VA:EQ/T

The main types of data travelling from the Power SCOE Controller to the CCS, beside the handshaking messages used to establish and control the communication link, shall be:

1. Periodic packets containing vital data acquired by the SCOE
2. Non periodic packets containing the answer to a CCS issued command (ex. Status request, ...)
3. Asynchronous packets containing special events or errors/warning notifications
4. Other

While the Power SCOE will mainly receive from the CCS – always with packet formats – specific commands to get particular parameters values or to change the operational mode and Telecommand requests.

Note for Battery Conditioning Equipment (BCE) only: BCE will not receive any remote commands from the CCS and will not deliver to CCS any packet.

7 POWER SCOE OPERATIONAL REQUIREMENTS

7.1 Power SCOE – Testing capability

[VA:I/O

The Power SCOE shall provide the capability to perform tests through test software installed in the SCOE controller: this test software shall receive commands and inputs either from local keyboard or from the CCS.

7.2 Power SCOE – Main capabilities

[VA:EQ/T

The Power SCOE shall provide at least the following main capabilities available during either off-line or on-line mode:

1. Preparation of configuration data for the test
2. Preparation and editing of commands files
3. Deleted
4. Execution of command files
5. Logging of test activities (operator actions) and test results
6. Error detection and relevant messages management
7. On-line help for operation, failure investigation/removal
8. Display of self-test results and status parameters
9. Messages exchange with CCS including also data transfer and mode control
10. Off-line test result evaluation of data retrieved from logbook files
11. Other.

7.2.1 Battery Conditioning Equipment (BCE) – Main capabilities

[VA:EQ/T

In addition to the capabilities listed in previous requirement (with the exception of the Message exchange with the
CCS- bullet 8), the Battery Conditioning Equipment shall be able also to:

1. Execute charge/discharge cycles as programmed by the operator
2. Archive Test result during charge/discharge cycles
3. Retrieve and post–process data archived
4. Other.

7.3 Power SCOE – Power on

[VA:EQ/T

After the Power-on the Power SCOE shall be in a well-known and predefined operating mode such that no hazard is caused to the Spacecraft.

7.3.1 Power SCOE – Status after Power on

[VA:EQ/T

After the Power SCOE power On, the On-line software shall be correctly running, but its status shall be Off-line, the self-test shall be completed and the SCOE shall be in Remote operating mode.

Note for Battery Conditioning Equipment (BCE) only: after the self-test completion the BCE shall be Local mode.

7.4 Power SCOE Operative modes

[VA:EQ/T

The Power SCOE shall allow the run-time activity to operate in three different operative modes, i.e. Local Mode, Remote Mode and Manual Mode.

Note for Battery Conditioning Equipment (BCE) only: Remote mode is not required for BCE.

7.4.1 Power SCOE - Local Mode

[VA:EQ/T

In Local mode, the SCOE controller shall assure the whole functionality of the Power SCOE, i.e. the SCOE shall be fully programmable and managed by the local Software and controlled by means of the commands entered using the local keyboard only.

7.4.2 Power SCOE - Remote Mode

[VA:EQ/T

In Remote mode the whole functionality of the Power SCOE shall be assured by the SCOE controller, as in Local mode, but it shall be controlled by means of remote commands coming from the CCS.

Note for Battery Conditioning Equipment (BCE) only: this requirement is not applicable for BCE.

7.4.3 Power SCOE - Manual Mode

[VA:EQ/T

In Manual Mode the SCOE user shall be able to change all adjustable levels manually acting on the front panel knobs/switches: the actual adjusted level shall be displayed (screen, LCD, pointer reading etc.). Moreover the operator shall be allowed to program all circuits/power supplies manually to default values (previously agreed with the Sub-Contractor) acting on the front panel with a single knob/switch.

7.4.4 Power SCOE – Emergency shut -down button

[VA:EQ/T

Regardless the currently selected operational mode the operator shall be able to operate on an easily accessible Emergency power off switch (latching) located on the front panel.

7.4.5 Power SCOE – Operative Modes switching

[VA:EQ/T

It shall be possible to externally intervene on the equipment in order to change the operative mode of the Power SCOE. The operational mode transition shall be independent from the Local/Remote configuration. The transitions from Local to Remote control (and viceversa) shall not affect the current configuration and setting of the SCOE.

7.4.6 Operative Modes – Switching commands

[VA:EQ/T

While the transition between Local and Remote Mode shall be possible using dedicated keyboard commands available both to local user and remotely from the CCS, the transition to/from Manual Mode shall be possible acting on a knob/key located on the SCOE front panel.

7.4.7 Power SCOE Remote Control

[VA:EQ/T

The Power SCOE shall be able to be remotely controlled and monitored by the CCS, to execute commands like:

1. Operational mode (Local – Remote) transition
2. Start, stop the running Software
3. Assignment of values to SCOE internal variables
4. Commutation between main and redundant interfaces
5. Acquisition/transfer of data from/to the CCS
6. Deleted
7. Other.

The same commands and primary functions shall also be available to the Power SCOE user directly acting on local keyboard, i.e. when the SCOE is not remotely controlled by the CCS (Local mode).

Note for Battery Conditioning Equipment (BCE) only: this requirement is applicable for BCE only for what concerns the availability of keyboard commands.

7.4.8 Power SCOE Commands

[VA:EQ/T

Deleted.

7.5 Power SCOE - Off-line and On-line mode definition

[VA:EQ/T

The Power SCOE On-line software shall support two distinct operational modes, i.e. Off-line mode and On-line mode.

7.5.1 Off-line mode – Interfaces status

[VA:EQ/T

When in Off-line mode, all power and signal interfaces to the Spacecraft shall be galvanically separated, i.e. neither power nor other signals shall be provided at the Spacecraft interface.

7.5.2 On-line mode – Interfaces status

[VA:EQ/T

When operating in On-line mode, all the Power SCOE interfaces to the Spacecraft shall be connected.

7.5.3 On-line mode – Interfaces setting

[VA:EQ/T

The interface setting shall be in accordance with the configuration locally set if in Local mode and with the configuration set by the CCS if working under in Remote control.

7.6 Power SCOE - Self-test

[VA:EQ/T

The POWER SCOE shall provide a full self-test capability in order to support failure investigation down to individual drawer or module level.

In case of Self-Test failure (ex. one instrument is not available for whichever reason), a warning message shall be sent to the user and, depending on the type of detected failure, it shall be possible to keep on using the Power SCOE in a “reduced performance” configuration.

7.6.1 Interface behaviour during Self-test

[VA:EQ/T

During the self-test execution special attention shall be paid to the interfaces connecting the Power SCOE with the Spacecraft, i.e. the self-test shall prove that all these interfaces are in a well-defined status and guarantee that no hazard is caused (no signal shall be sent) to the Spacecraft.

7.6.2 Self-test activation

[VA:EQ/T

The Power SCOE shall provide the capability to initiate at any time the self-test either from local keyboard or remotely by the CCS.
In any case the self-test shall be automatically performed at power-up of the Power SCOE.

Note for Battery Conditioning Equipment (BCE) only: this requirement is not applicable for BCE for what concerns the activation of self-test remotely from the CCS.

7.6.3 Self-test logging

[VA:EQ/T

The self-test activation shall be logged together with the results of its execution so that these information will be available for later investigation.
The self-test results plus diagnostic messages in the case of unsuccessful execution shall be both locally displayed and reported to the CCS.

Note for Battery Conditioning Equipment (BCE) only: this requirement is not applicable for BCE for what concerns the diagnostic messages transfer to the CCS.

7.7 Power SCOE - Archiving capability for Battery Conditioning Equipment

[VA:EQ/T

The Battery Conditioning Equipment (BCE) is the only item belonging to Power SCOE where it is required the capability to archive in separate and distinct archive files (whose format shall be compatible with the CSV files) the following type of data:

1. Auxiliary information (Date, time, operator remarks, …)
2. Type of cycle (charge, discharge, …)
3. Cycle definition set-up
4. Battery parameters set-up
5. Battery monitored parameters (raw and calibrated)

6. Others.

7.7.1 Battery Conditioning Equipment (BCE) -Archive files naming

[VA:EQ/T

The Battery Conditioning Equipment (BCE) archive files shall be identified by names containing the creation date and time and stored in proper sub-directories also organised by date.

7.7.2 Battery Conditioning Equipment (BCE) -Archive files management

[P:HP-ASPI-1-SP-0045#3.3.1.1-GRQT-0050
[VA:EQ/T

Each data file shall be closed when its size reaches a defined limit (ex. 1GB); a new file shall be automatically opened in order to ensure no data loss during the whole test activities.
On the contrary, whenever only few data are to be stored, files can be closed in order to contain all the data relevant to a complete charge/discharge cycle.

7.7.3 Battery Conditioning Equipment (BCE) -Archive files storage on local disk

[VA:EQ/E

The Battery Conditioning Equipment (BCE) shall be equipped with sufficient disk space to allow the storage of archive files for at least 20 . complete charge/discharge cycles.

7.7.4 Battery Conditioning Equipment (BCE) -Local disk unavailability for archiving

[VA:EQ/T

In case no more disk space is available for archive files storage, the operator shall be notified in advance with dedicated warning and error messages in order to avoid loss of data.

7.8 Power SCOE Logbook capability

[P:HP-ASPI-1-SP-0045#3.3.1.2-GRQT-0060
[VA:EQ/T

The Power SCOE shall generate and maintain local logbook files containing, organised in chronological order and time stamped, at least the following information:

1. General test data (ex. Start / end time and date of test)
2. Configuration information (HW and SW)
3. Error, diagnostic and warning messages
4. System events , error messages, simulation messages
5. Deleted
6. Command execution results
7. Power SCOE status changes
8. All messages exchanged with the CCS
9. Deleted
10. Other.

Note for Battery Conditioning Equipment (BCE) only: bullet 5 of this requirement is not applicable for BCE for what concern the reception of remote commands from the CCS and bullet 8 is not applicable at all.

7.8.1 Logging task activation

[VA:EQ/T

The log function shall start automatically when the Power SCOE reaches any automatic operating mode, i.e. when the relevant On-line software is started and running.

7.8.2 Logbook files organisation and naming convention

[VA:EQ/T

The logbook files shall be identified by names containing the creation date and time and stored in proper sub-directories also organised by date.

7.8.3 Logbook files management

[P:HP-ASPI-1-SP-0045#3.3.1.2-GRQT-0090
[VA:EQ/T

Log files shall be crated and closed in such a way to avoid too big files. In case big amount of data should be logged, the files have to be closed when their size reach reaches 1MB.
On the contrary, whenever only few data are to be logged, files can be closed on daily basis.

7.8.4 Logbook files storage on local disk

[VA:EQ/E

The Power SCOE shall be equipped with sufficient disk space to allow the storage of logbook files for at least one month of test activities.

7.8.5 Local disk unavailability for logging

[VA:EQ/T

In case no more disk space is available for logbook files storage, the operator shall be notified in advance with dedicated warning and error messages in order to avoid loss of data.

7.8.6 Logbook files directories

[VA:EQ/T

Logbook files shall be stored in proper distinct and dedicated directories.

Logbook files format shall be chosen in such a way to allow the users to easily read from them the required data: the normal Operating System capabilities can be used for this purpose.

7.9 Power SCOE Errors and Failures management

7.9.1 Error Detection Mechanism

[VA:EQ/E

The Power SCOE system shall be able to provide a strong and complete error detection mechanism aimed to monitor the behaviour of its internal software and composing hardware and to promptly notify to the user the relevant error messages. The main categories of "system errors" refer to:

1. Hardware malfunctioning
2. Operating system
3. Commercial software
4. Subcontractor provided software
5. Interface errors towards CCS
6. Communication problems with CCS
7. Resources unavailability
8. Other

The diagnostics mechanism shall be exhaustive, i.e. no error condition shall remain undetected and/or not notified by the system to the user.

Note for Battery Conditioning Equipment (BCE) only: bullet 5 and bullet 6 of this requirement are not applicable for BCE.

7.9.2 Failures detection

[VA:EQ/T

The Power SCOE shall not propagate failures to the on board units. Failures in the SCOE must not damage or even stress on-board equipment's.

7.9.3 Self-diagnostic capability

[VA:EQ/T

The Power SCOE shall provide a self-diagnostic Software, which allows the easily identification of SCOE H/W failures.

7.9.4 Errors reporting and management

[VA:EQ/T

In case of any failure the Power SCOE shall be capable to report the error and to take adequate actions to ensure that no damages are provoked/propagated to the on board units.

7.10 On-line Activities

[VA:I/O

The On-line software will be automatically started after the Power SCOE power-On; it shall be designed and used in order to perform the test activities on the Service Module and on Spacecraft.

7.10.1 Test Session start up – Auxiliary information input

[VA:EQ/T

At the Test Session start-up the user shall be asked to input several auxiliary information useful to define the test configuration and SCOE initial set-up.

7.10.2 Test Session start up time

[VA:EQ/T

The On-Line software shall be ready to be used by the operator for Test activities in less than 5 minutes after the start-up.

7.10.3 Simulation ON/OFF

[VA:EQ/T

The POWER simulation of the SCOE shall be started and stopped upon user commands sent either locally or remotely from CCS.

Note for Battery Conditioning Equipment (BCE) only: this requirement is not applicable for BCE for what concerns the reception of remote commands from the CCS.

7.10.4 On-line mode – Test execution

[VA:EQ/T

The Power SCOE shall provide at least the following functions available during a Test execution session:

1. Simulate Thermistors and Switches as defined in the simulation/configuration files
2. Communicate with the CCS for data transfer and mode control
3. Execute Test and pre-programmed sequences of commands
4. Parameters acquisition, monitoring, display and archiving
5.
6. Other.

7.10.5 On-Line software – Further capabilities

[VA:EQ/T

The On-Line software shall provide to the user at least the capabilities summarised here below:

1. Acquire and monitor of Power SCOE peculiar data and parameters
2. Display of SCOE status and test data in dedicated presentation windows (see below)
3. Send commands directly entered at local keyboard
4.
5.
6. Other

7.10.6 On-Line software – Acquisition and Monitoring

[VA:EQ/T

When the On-line software is running the Power SCOE shall perform, as an always-running background task, a cyclic acquisition of all the parameters relevant to the particular running function.
The list of parameters to be cyclically acquired and monitored shall be contained inside a configuration file/table.

The acquisition cycle for SCOE parameters only shall be not lower than 10 seconds.
The monitored SCOE parameters shall be transmitted to the CCS in the correct packet format.

Note for Battery Conditioning Equipment (BCE): It is not required to transmit data to the CCS.

7.10.6.1 Logbook window

[VA:EQ/T

The On-Line software shall foresee at least a Logbook window: it shall contain, with the relevant time stamp, notification of all the events occurring during the current Test Session including both error messages and normal operational information (ex. Power SCOE status changes,
All messages displayed inside the Logbook window will be stored inside the Logbook file.

7.10.6.2 Monitor window

[VA:EQ/T

The On-Line software shall provide, besides the Logbook window, a dedicated Monitor window in which the ongoing test information, peculiar Power SCOE data and parameters cyclically acquired shall be listed and their measured/set values kept updated together with the relevant time stamps.
Each displayed value shall be clearly identified by its name (and description), its type (analogue, digital), and its status in case operational limits are defined.

7.10.7 On-Line software Termination

[VA:EQ/T

In order to terminate the On-line application currently running, a dedicated command shall be foreseen.
It will be in charge to stop, in the right order, all the running tasks and processes.

7.11 Off-line Activities

7.11.1 Battery Conditioning Equipment (BCE) - Stored data retrieval

[VA:EQ/T

The Battery Conditioning Equipment (BCE) shall provide to the user the possibility to retrieve data from the Archive files produced during On-line test activities.

7.11.2 Test results post-processing

[VA:EQ/T

The Power SCOE shall provide to the user the capability to easily retrieve from logbook messages, data/test results stored during a Test Session and analyse them with proper tools (Operating System standard function can be used for this purpose).

7.12 File exchange

[VA:EQ/T

The Power SCOE shall be able to provide to the user the mean to exchange data files with external users (via FTP or NFS)

8 POWER SCOE HARDWARE AND SOFTWARE CONFIGURATION

8.1 Power SCOE Architecture

[VA:EQ/A

The Power SCOE shall be built to the maximum possible extents using "off-the-shelf" equipment; wherever is possible custom-made hardware and software development shall be minimised.

8.2 Power SCOE software organisation

[VA:EQ/T

The Power SCOE shall provide the capability to store, in separated disks (or partitions), the various kind of Software.
In particular the Software developed and provide by the Subcontractor, the user developed Software (command/configuration files), the Logbook and the Archive files (BCE only) shall be stored in dedicated disks or partitions distinct from the one/ones where System and Base Software will be installed.

8.3 Power SCOE housing

[P:HP-ASPI-1-SP-0045#3.5.2.3-GRQT-0900
[VA:EQ/T

All (to the maximum possible extent) the boxes/equipment making part of the Power SCOE shall be housed inside standard 19" racks.

8.3.1 Solar Array Simulator & Launch Power Supply (SAS/LPS) housing

[VA:EQ/E

The Solar Array Simulator and the Launch Power Supply functionality's will be provided by the same SCOE housed inside 3 racks. More in details one SAS/LPS SCOE will be housed in standard 19" normal racks, while for the other 2 SCOE's 2 anti-seismic racks (for parts common to LPS) plus one normal rack (for the other SAS equipment's) shall be used.
In any case this means that all the boxes/equipment making part of the Launch Power Supply (LPS) shall be housed inside suitable anti-seismic 19" racks (provided by the facility) able to survive to the ambient environment (unmanned Bunker subject to shock vibrations and acoustic noise) during Launch phase. Refer to AD [11].

8.4 Power SCOE Controller characteristics

[VA:EQ/T

The Power SCOE will be equipped with a Controller for MMI and Test Preparation/Execution, equipped at least with:

1. Stand alone boot capability
2. Colour Screen with high resolution
3. American keyboard
4. Mouse
5. CD reader
6. Local printer to produce a hard copy of the locally displayed data and for local files outputs.

8.4.1 Launch Power Supply - Controller location

[VA:EQ/E

The Launch Power Supply (LPS) shall be designed in such a way that its controller can be located in a manned room 20 Km far from the racks.
Moreover the LPS shall be designed to have a hot redundancy for the LAN between its controller and the rack.

8.5 Interchangeability

[P:HP-ASPI-1-SP-0045#3.5.2.3-GRQT-0310
[VA:EQ/E

All hardware components design shall be done in such away to be easily replaced without the need of special adaptation work (special tool and procedure) required.

9 POWER SCOE PERFORMANCES

9.1 Continuous Operations

[P:HP-ASPI-1-SP-0045#3.3.5.1-GRQT-0300
[VA:EQ/T

The Power SCOE shall be able to run a test session continuously over 20 days, 24 hours a day without stopping or losing any data and without the need of restarting, rebooting or resetting the system or its components during that time.

9.2 Performances at user interface

[VA:EQ/T

The Power SCOE shall be able to satisfy all requirements concerning output voltage, current or impedance at the user interface level, i.e. at the point where the SCOE cable connectors are attached to the flight-hardware respectively EGSE

9.3 Launch Power Supply (LPS) – Launch site configuration

[VA:EQ/T

The Launch Power Supply (LPS), when used during the pre-launch Test activities, shall be able to provide the required signal with correct electrical characteristic at the Satellite side.

Moreover the Controller located in different area from the Launch Tower, shall be able to command and control the LPS Rack located in the Ariane 5 Launch Table.

9.4 Disks Space

[VA:EQ/E

The Power SCOE shall be equipped with enough space in order to guarantee that Simulation/Configuration files, Logbook and Archive files **(Archive files for BCE Only),** can be stored and maintained at the same time in well identified and distinct disks/partitions/directories.

9.5 Life time

[VA:EQ/A

The Power SCOE will be designed in such way to guarantee it shall be fully operative for 1 years after the Acceptance Review of the Spacecraft.

9.6 Operational condition

[VA:EQ/A

Deleted

9.7 Periodic maintenance

[VA:EQ/E

The Power SCOE shall be designed in such away that periodic maintenance of the hardware component shall be reduced to minimum possible frequency.

9.8 EMC compatibility

[VA:EQ/E

The Power SCOE shall be designed to support system level EMC tests. This implies that the SCOE shall be able to withstand system susceptibility tests without malfunction.

9.9 European Safety Standards

[VA:EQ/E

The Power SCOE shall be designed taking into account the applicable European safety standards, in addition to any specific Spacecraft related safety requirements; in particular the Power SCOE shall conform to the C€ regulations plus other rules, for example relevant to the Launch site.

10 POWER SCOE SPECIAL REQUIREMENTS

10.1 Deleted

10.2 Product Assurance Requirements

Not applicable in this context.

11 POWER SCOE VERIFICATION REQUIREMENTS

11.1 Verification responsibility

[VA:N/A

The Power SCOE Contractors shall be responsible for the inspection, verification, integration and system testing of each delivered equipment, of firmware and software packages up to and including the final system tests.

11.2 Verification purpose

[VA:N/A

The POWER SCOE Contractors shall have to demonstrate with proper documentation and with a dedicated acceptance tests campaign that:

- ☒ The developed Power SCOE design conforms to the requirements
- ☒ The developed POWER SCOE item hardware and software comply with the design in terms of manufacturing and performances
- ☒ The developed Power SCOE is free of workmanship errors and is fully functional.

Adequate test equipment and simulators shall be made available to support the equipment verification process. This test equipment is not deliverable and may therefore be recruited from the supplier's laboratory inventory.
Of particular importance are the simulation of the communication interface with the CCS and the simulation of the interfaces with the on-board systems.
The acceptance tests shall verify, under nominal operational conditions only, that the electrical and mechanical performances of the equipment meet the requirements of the specifications.
In particular, electrical tests shall include application of expected voltages, impedance's, frequencies, pulses and waveforms at the electrical interface of the equipment, including all primary and redundant circuits.
All the Power SCOE electrical interfaces with the on-board equipment shall be tested during acceptance test campaign, before the first connection to the real Spacecraft in order to verify that there are no hazardous voltages/currents or short-circuits that could damage the on-board equipment.

11.3 Power SCOE Acceptance

[VA:N/A

The Acceptance tests of each EGSE item shall be run to verify all hardware and software requirements stated inside the relevant Specification documents. Preliminary acceptance tests shall be run at Contractors premises and shall foresee a hierarchical test approach, i.e. from module to fully integrated SCOE level in all possible configuration and operational mode. Further Acceptance tests are foreseen at Customer premises with the POWER SCOE included in the overall EGSE configuration

11.3.1 Power SCOE Acceptance – Performance tests

[VA:N/A

The Power SCOE Contractors shall demonstrate that the provided product fully conforms to the Performance requirements planning and executing a complete performance test under worst-case load conditions.

11.4 Final Power SCOE Acceptance documentation approval and witnessing

[VA:N/A

The Customer shall review the verification documentation and give approval to the test procedures in advance respect to the tests run.
The Contractor shall witness the Final System Acceptance tests.
Test results shall be provided within The Test Reports that shall include also the test description and the configuration status of the item under test.

11.5 Verification methods

[VA:N/A

For qualification of a generic item against a requirement, dealing with either Hardware or Software or the union of the two, the following methods are allowed:

- ☒ Test (T)
- ☒ Analysis (A)
- ☒ Assessment (E) including both Review of Design and Inspection
- ☒ Similarity (S)

The convention used inside this document to indicate the Verification Method is here below explained.

The Verification Method statement syntax foresee to have:

[VQ:<Code level>/<Method Code>/Note for Qualification
[VA:<Code level>/<Method Code>/Note for Acceptance

where:

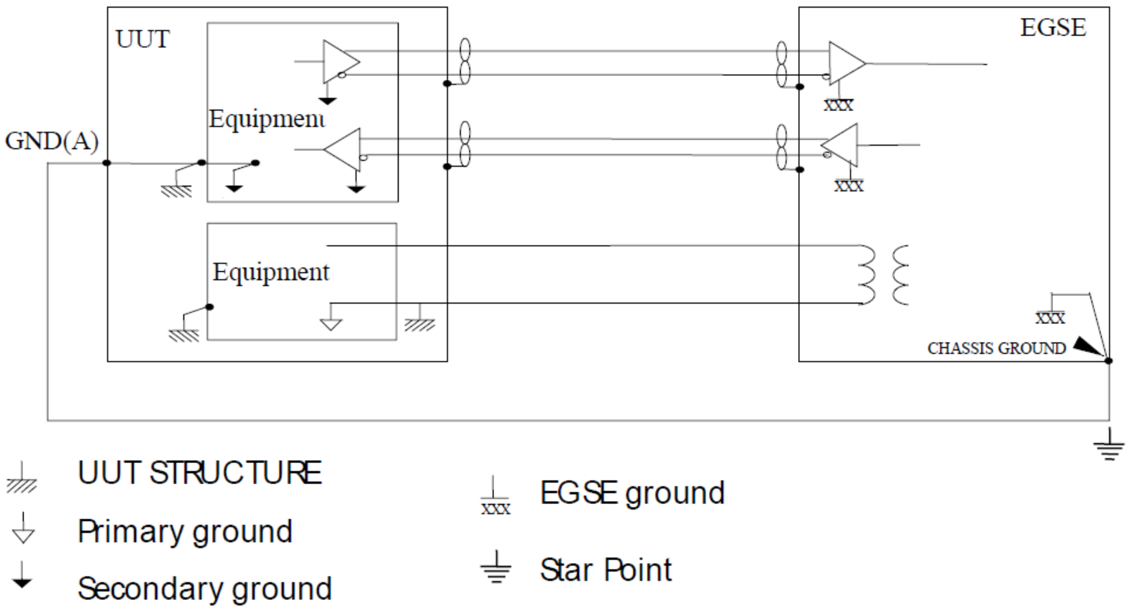
Level Code:	SY	System	
	PF	Platform	
	IT	Instrument	
	SS	Subsystem	
	EQ	Equipment	
Method Code:	T	Test	
	A	Analysis	
	E	Assessment	Review of Design
			Inspection
	S	Similarity	
Note:	I/O	Information Only	
	N/R	Not Required	
	N/A	Not Applicable	

ANNEX-1 - GROUNDING

- The insulation between any output terminal and the AC power line shall be higher than 10 MΩ
- A ground terminal shall be foreseen on the equipment for grounding connections.
- For equipment racks used in clean room areas, a grounding bridge shall be provided to allow ground connection either to the main safety ground or facility ground.

The EGSE grounding concept shall be the following:

- All signal lines are floating ones with respect to S/C I/F
- With respect galvanic insulation, the electronic components of the EGSE side must be referenced to EGSE ground
- With respect galvanic insulation, the electronic components of the S/C side (within the EGSE) must be referenced to the S/C ground (primary or secondary ground)
- The umbilical signals which are referenced to the S/C primary ground (respectively to the secondary ground) shall be processed in EGSE by electronic unit referenced to the S/C primary ground (respectively to the S/C secondary ground) and shall be isolated from EGSE ground



ANNEX-2 - SPACECRAFT INTERFACES

Spacecraft connectors interfacing the Power SCOE and pins function.

TBD

ANNEX-3 - CCS INTERFACES

The Power SCOE shall be able to interface with the CCS node via a 100 Mb/s Ethernet Local Area Network using the standard TCP/IP protocol.
The communication with the CCS shall be based on a Packet-oriented protocol where the packets format is the same defined for the ones exchanged with the Spacecraft.