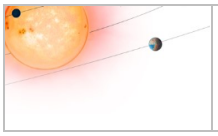

**PLATO**

**PLA**netary **T**ransits and **O**scillations of Stars

DLR

# F-FEE Emulator (SimuCam) Requirements Specification

Title

Subtitle Issue for SW-PDR Close-Out

Ref. **PLATO-DLR-PL-RS-0010**

Issue **1.~~4~~5 Draft**

Date ~~17.07.2019~~21.01.2020

CI Number 19511300

Model(s) GSE

| ~~---~~ | **Name** | **Signature ~~& Date~~** | **Date** |
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## CHANGE HISTORY

| Issue | Change | Approved | Date |
|---|---|---|---|
| 1 | Initial release | | |
| 1.1 | - Updated delivery schedule<br>- Updated F-FEE emulator use cases | | |
| 1.2 | - Updated development and test configurations in which the F-FEE emulator is foreseen<br>- Added new Transparent Mode | | |
| 1.3 | - Updated diagrams for use cases<br>- Modified requirement FF-SIM-2602 to implement transparent mode on the 4 available SpW channels<br>- Modified requirement FF-SIM-2539 to simulate only 1 F-FEE entity | | |
| 1.4 | - Updated schedule | | |
| 1.5 | - Added chapter on SpaceWire requirements | | |

## EXPORTED MODULES FROM IBM DOORS

| **Module** | | | | **Module ID** |
|---|---|---|---|---|
| **/PLATO/Payload/GSE/F-FEE Simulator User Requirement Specification** | | | | **00000340** |
| **Exported Version** | Current Version, Last change: ~~17.07.2019~~21.01.2020<br>doors://RMC-075001WTS.intra.dlr.de:36677/?version=2&prodID=0&urn=urn:telelogic::1-53ede90401644d27-M-00000340 | | | |
| **Exported View** | Export View | | | |
| **Pages in this document** | 7 - 80 | | | |
| **Changes** | Baseline | Created On | Created by | Description |
| | 2.0 | 05.02.2018 | ziem_cl | Before ITM and LESIA feedback. |
| | 2.1 | 07.02.2018 | ziem_cl | Added Requirement Titles |
| | 2.2 | 08.03.2018 | ziem_cl | Prepared for Draft Release. Updated Applicable and Reference Documents. |
| | 2.3 | 17.09.2018 | ziem_cl | |
| | 2.4 | 28.09.2018 | ziem_cl | Baseline for P/L PDR |
| | 2.5 | 05.10.2018 | ziem_cl | Final Baseline for P/L PDR |
| | 2.6 | 17.07.2019 | sand_do | Baseline for SW-PDR |

## TABLE OF CONTENTS

Field Code Changed

Field Code Changed

# 1 Introduction

## 1.1 Purpose of the document

The purpose of this document is to define the functional requirements of the F-FEE simulator. In the PLATO project both an F-FEE and an N-FEE simulator are needed. The requirements of the F-FEE and N-FEE simulators are very similar, so the developments are joined into a common device, called SIMUCAM. The SIMUCAM hardware used for F-FEE-simulator and N-FEE-simulator will be the same, only software and FPGA-design may differ. The requirements for the N-FEE Simulator are defined in [RD01].

## 1.2 Mission and Background

### 1.2.1 The PLATO Mission

PLATO is an M-class mission candidate of the European Space Agency's Science programme Cosmic Vision 2015-2025 foreseen to be launched by end 2024. "Planetary Transits and Oscillations of stars" aims to characterise exoplanetary systems by detecting planetary transits and conducting asteroseismology of their parent stars.

PLATO is the next generation planetary transit experiment; its objective is to characterise exoplanets and their host stars in the solar neighbourhood. While it builds on the heritage from CoRoT and Kepler, the major breakthrough to be achieved by PLATO will come from its strong focus on bright targets, typically with mV≤11. The PLATO targets will also include a large number of very bright and nearby stars, with mV≤8 (see also [RD03] and [RD04]).

The prime science goals of PLATO are:
- the detection and characterisation of exoplanetary systems of all kinds, including both the planets and their host stars, reaching down to small, terrestrial planets in the habitable zone;
- the identification of suitable targets for future, more detailed characterisation, including a spectroscopic search for biomarkers in nearby habitable exoplanets;
- a full characterisation of the planet host stars, via asteroseismic analysis: this will provide us with the masses, radii and ages of the host stars, from which masses, radii and ages of the detected planets will be determined.

These ambitious goals will be reached by ultra-high precision, long (few years), uninterrupted photometric monitoring in the visible of very large samples of bright stars, which can only be done from space. The resulting high quality light curves will be used on the one hand to detect planetary transits, as well as to measure their characteristics, and on the other hand to provide a seismic analysis of the host stars of the detected planets, from which precise measurements of their radii, masses, and ages will be derived. For the brightest targets, planets are also expected to be detectable through the modulation of stellar light reflected on the planet surface, and/or through the astrometric wobble induced on the star by the planet orbital motion.

The PLATO space-based data will be complemented by ground-based follow-up observations, in particular very precise radial velocity monitoring, which will be used to confirm the planetary nature of the detected events and to measure the planet masses.

The full set of parameters of the systems with detected exoplanets will thus be measured, including all characteristics of the host stars and their orbits, radii, masses, and ages of the planets. Measurements of the radii and masses will be used to derive the planet mean densities and therefore will give insight on their internal structure and composition. The orbital parameters, together with the precise knowledge of all characteristics of the host star, will enable us to estimate the temperature and radiation environment of the planets. Finally, the knowledge of the age of the exoplanetary systems will allow us to put them in an evolutionary perspective.

See **[RD03] and [RD04]** for further details on the PLATO mission.

### 1.2.2 Instrument Architecture

The instrumental concept proposed by the PLATO Payload Consortium is based on a multi-camera approach, involving a set of several normal instruments monitoring stars fainter than mV=8, plus a low number of fast instruments observing extremely bright stars with magnitudes brighter than mV=8.

The telescope is based on a fully dioptric design, working in an extended visible light range. It has been designed to be able to observe a very large field, with respect to a sufficient pupil diameter.

The 24 normal cameras are arranged in four sub-groups of 6 cameras. All 6 cameras of each sub-group have exactly the same Field of View (FOV), and the lines of sight of the four sub-groups are offset by +/-9,2° of their FOV of about 38°. This particular configuration allows surveying a very large field at each pointing, with various parts of the field monitored by 24, 12 or 6 normal cameras.

This strategy optimises both the number of targets observed at a given noise level and their brightness. It is assumed that the satellite will be rotated around the mean line of sight by 90° every 3 months, resulting in a continuous survey of exactly the same region of the sky.

Each camera is equipped with its own CCD focal plane array, comprised of 4 CCDs. The CCDs work in full frame mode for the normal cameras, and in frame transfer mode for the fast cameras.

Each FPA is associated to a Front End Electronics (FEE). The camera (after Instruments tests) is delivered for PLM AIT with its FEE box attached to the rest of the camera by a temporary structure which shall be removed during the integration of the camera on the optical bench. The camera is delivered with FEE and FPA connected together by their flexi-cables. For safety reasons, these links shall never be disconnected after the delivery of the camera to PLM.

There are several units, the AEUs, which provide secondary voltages for the FEEs. 2 N-AEU boxes provide voltages for the normal FEEs/cameras, one N-AEU for one batch of 12 normal cameras. One F-AEU provides the voltages for the two fast FEEs/cameras. Additionally the F-AEU contains a synchronization module which provides hardware synchronization signals to the FEEs (synchronizing the CCD read-out), power supplies (synchronizing the DC/DC converters) in the AEU and to the SVM (synchronizing the thermal temperature control of the TOUs).

### 1.2.3 On-Board Data Processing system (DPS) Architecture

The PLATO payload data processing system is made up of the DPUs and the ICU, with data routed through a SpaceWire network. The ICUs are connected to the SVM through SpaceWire links.

There are 12 normal DPUs. Each N-DPU is responsible for processing the data of 2 normal cameras. The processing cadence for N-DPUs is 25 sec.

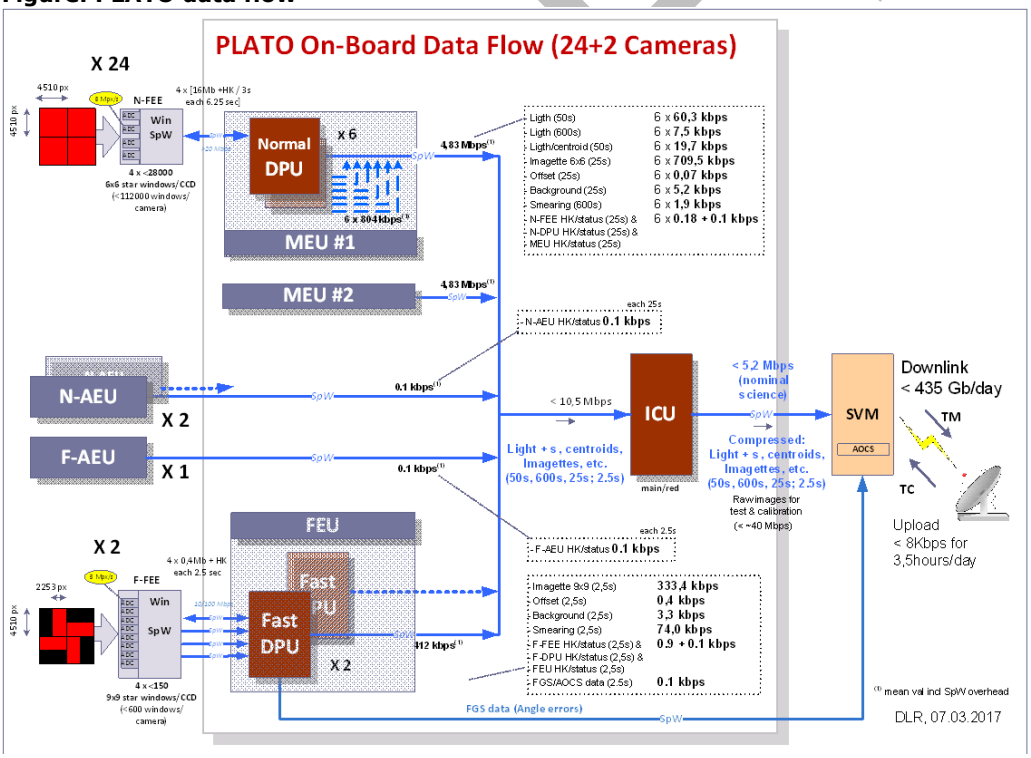
There are 2 fast DPUs gathered in one electronic box named **FEU (Fast Electronic Unit)**. Each F-DPU is responsible for processing the data of one fast camera. The processing cadence for F-DPUs is 2.5 sec.

The F-DPUs have a supplementary function: they are responsible for providing angle data measurements directly to the SVM AOCS.

There are 2 ICU sides which work in cold redundancy. The ICU is responsible for the management of the payload, the communication with the Service Module, the processing of scientific algorithms and the compressing of scientific telemetry before transmitting them to SVM.

The following figure gives an overview of the PLATO data processing system architecture and of the data flow rates. This chart focuses on the sharing of the main functions and the data flows. It is a simplified view of the hardware architecture. The SpaceWire routers are not shown and the F-DPU assembly boxes (FEU) are not drawn.

**Figure: PLATO data flow**



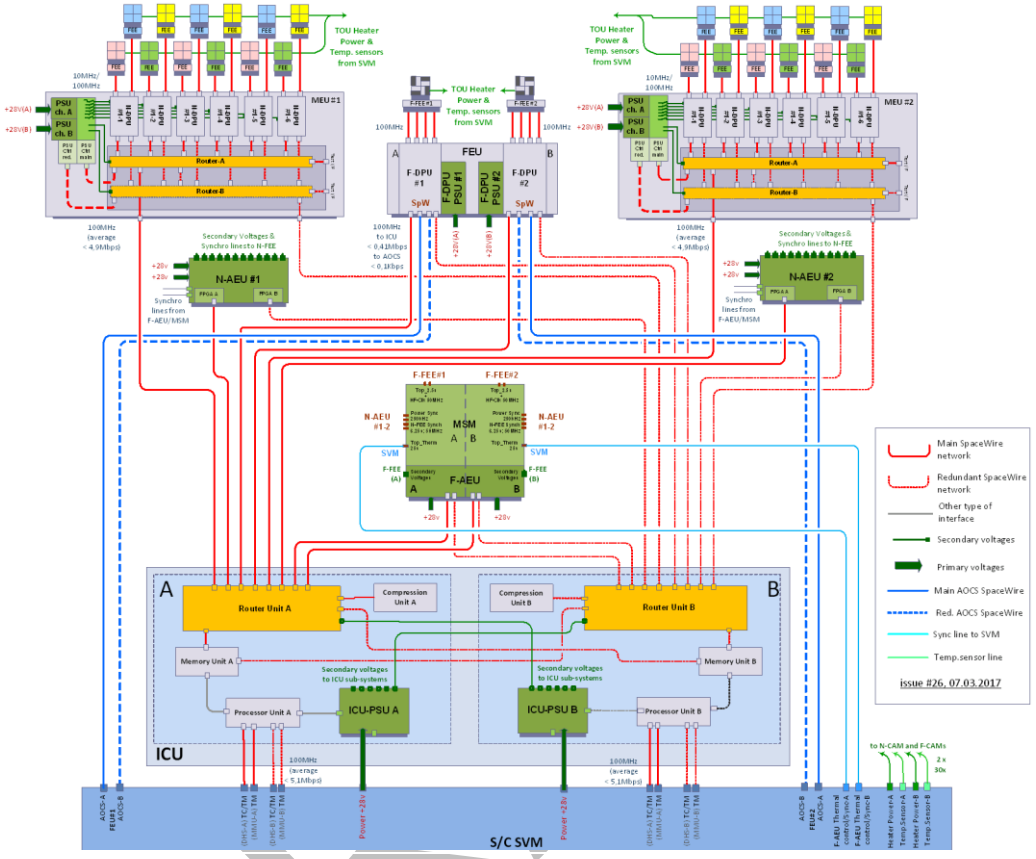

**Overview of the PLATO Data Processing System architecture**

For FMECA concerns and in order to optimise the resources (mass, volume, harness), the physical implementation of the architecture described above foresees to split the 12 N-DPUs in 2 groups of 6 N-DPUs. Each group of 6 N-DPUs is gathered in a box called Main Electronic Unit (MEU).

In the same way, the two ICU sides are gathered in a same box.

The figure below shows the PLATO SpaceWire network (physical view of the architecture):

**Figure: PLATO Payload Electrical Architecture**




## 1.3 Applicable Documents

This document shall be read in conjunction with the documents listed below, which complement the content to the extent specified herein.

| | Title | Reference |
|---|---|---|
| **AD01** | F-FEE User Requirements Document | PLATO-OHB-PL-RS-0009<br>Issue 4.0 |
| **AD02** | PLATO FEE-to-DPU Interface Requirement Document (IRD) | PLATO-DLR-PL-ICD-0011<br>Issue 1.3 |
| **AD03** | SimuCam pattern requirement | PLATO-LESIA-PL-TN-023<br>Issue 1.2 |
| **AD04** | PLATO CCD Definition | PLATO-MSSL-PL-TN-008<br>Issue 1.A |
| **AD05** | PLATO FFEE-to-FDPU Interface Control Document (ICD) | PLATO-DLR-PL-ICD-0007<br>Issue 3.0 |
| **AD06** | ~~EDEN Protocol~~PLATO EGSE Interface Control Document | ~~TL16405~~<br>PTO-TAS-SYS-ICD-0066<br>Issue ~~6~~2.0 |
| **AD07** | ECSS Software Engineering Standard | ECSS-E-ST-40C |
| **AD08** | Telemetry and telecommand packet utilization | ECSS-E-ST-70-41C |

| | | |
|---|---|---|
| **AD09** | SpaceWire - Links, nodes, routers and networks | ECSS-E-ST-50-12C |
| **AD10** | SpaceWire protocol identification | ECSS-E-ST-50-51C |
| **AD11** | SpaceWire - Remote memory access protocol | ECSS-E-ST-50-52C |
| **AD12** | SpaceWire - CCSDS packet transfer protocol | ECSS-E-ST-50-53C |
| **AD13** | PLATO SpaceWire Requirements Specification | PTO-EST-SYS-RS-0097 |
| ~~**AD13**~~**AD14** | Software product assurance | ECSS-Q-ST-80C |

## 1.4 Reference Documents

The following reference documents contain information that is relevant to the scope of this document.

| | Title | Reference |
|---|---|---|
| **RD01** | N-FEE Simulator User Requirement Document | PLATO-LESIA-PL-SP-004 Issue 1.0 |
| **RD02** | RDCU SIMUCAM User Requirement Document | PLATO-IWF-PL-RS-0013 Issue 0.1 |
| **RD03** | PLATO Mission Requirements Document | PLATO-ESTEC-MIS-RS-001 Issue 4.1 |
| **RD04** | PLATO Instrument Design report | PLATO-OHB-PL-DD-001 Issue 2 |
| **RD05** | FEE Windowing Technical Note | PLATO-DLR-PL-TN-018 Issue 1 |
| **RD06** | PLATO (on-board) Software System Specification (SSS) | PLATO-DLR-PL-RS-006 Issue 2.2 (Draft1) |
| **RD07** | FEU User Requirement Specification | PLATO-DLR-PL-RS-004 Issue 3.1 |
| **RD08** | PLATO TM/TC On-Board Software Interface Control Document (SICD) incl. AOCS ICU/FEU to SVM Interface | PLATO-DLR-PL-IC-001 Issue 2.0 |
| **RD09** | Image Generator User Requirements Specification | PLATO-DLR-PL-RS-0013 Issue 1.0 Draft |

## 1.5 Glossary & Acronyms

| | |
|---|---|
| AEU | Ancillary Electronics Unit |
| AIT | Assembly, Integration and Test |
| AIV | Assembly, Integration and Verification |
| ASW | Application Software |
| BB | Bread Board |
| C&C | Command and Control |
| CCD | Charge Coupled Device |
| DLR | German Aerospace Center |
| DPS | Data Processing System |
| DPU | Data Processing Unit |
| EDEN | EGSE Data Exchange Network |
| EGSE | Electrical Ground Support Equipment |
| EM | Engineering Model |
| ESA | European Space Agency |
| ESTEC | European Space Research & Technology Centre |

| | |
|---|---|
| F-DPU | Fast camera DPU |
| FEE | Front End Electronics |
| FEU | Fast Electronic Unit |
| Gb | Gigabit |
| GB | Gigabyte |
| GSE | Ground Support Equipment |
| HK | Housekeeping data |
| HKTM | Housekeeping telemetry |
| HW | Hardware |
| I/F | Interface |
| ICU | Instrument Control Unit |
| kbps | Kilobit per second |
| Mb | Megabit |
| Mbps | Megabit per second |
| Mpx | Mega-pixel |
| MEU | Main Electronics Unit |
| MOC | Mission Operation Centre |
| F-DPU | Normal camera DPU |
| P/L | Payload |
| PLATO | Planetary Transits and Oscillations |
| PLM | Payload Module |
| PLTM | Payload Telemetry |
| PSU | Power Supply Unit |
| Px | Pixel |
| RMAP | Remote Memory Access Protocol |
| SIS | Spacecraft Interface Simulator |
| SpW | SpaceWire |
| SVM | Service Module |
| SW | Software |
| TBC | To Be Confirmed |
| TBD | To Be Determined/Defined |
| TC | Telecommand |
| TM | Telemetry |
| TSC | Test Sequence Controller |

# 2 General Description

## 2.1 F-FEE Emulator and SIMUCAM

In order to reduce the number of simulators to be developed, it has been decided to have a common design for the F-FEE emulator and the N-FEE emulator: the same emulator hardware will be used for the N-chain activities and the F-chain activities. This common emulator is called 'SimuCam' and is developed by the Maua Institute of Technology (IMT) in Brazil, São Paulo. SimuCam is a system allowing the handling of up to 8 SpaceWire links simultaneously. It will therefore allow managing the simulation of up to 6 N-FEEs in one box or 1 F-FEEs in one box.

The present document covers the F-FEE emulator user requirements which are applicable to SimuCam. It does not cover the PLATO N-FEE emulator requirements or any other use-case of the SimuCam.

## 2.2 F-FEE Emulator Use-Cases and Users

The main use cases of the F-FEE emulator are listed below:

- Use case #1: F-DPU ASW development, verification and validation process (user = DLR)
- Use case #2: FGS algorithm real-time verification process (user = DLR)
- Use case #3: DPS AIT (user = DLR)
- Use case #4: FEU ASW validation at SVM level (user = S/C Prime + DLR + OHB)

## 2.3 F-FEE Emulator Requirements Overview

### 2.3.1 F-FEE Functional Simulation

SimuCam shall allow to simulate the F-FEE functional modes:

- On mode
- Standby mode
- Full image mode
- Windowing mode
- Full image pattern mode
- Window pattern mode

In the windowing and full image mode, the F-FEE emulator managed by the SimuCam transmits full images or window segment streams to the F-DPU via the SpaceWire links by fulfilling all the timing requirements of a real F-FEE and all the protocol requirements defined between the F-DPU and the F-FEE (see [AD02] and [AD05]).

### 2.3.2 Static Data Feeding Modes

The F-FEE emulator shall allow to feed data to the F-DPU (windows or full-frame images) with various types and sources of data:

- Patterns created dynamically (see [AD03])
- Full images stored in SSD
- Full images received from Ethernet
- Full images created by patching full images from SSD with imagettes received from Ethernet
- Imagettes stored in SSD
- Imagettes created from full images stored in SSD by mimicking the windowing functionality of the real FEE

The pattern feeding mode will be used mainly for low level test cases, basic coupling tests or for performance tests (load tests).

For validating the algorithms implemented in the F-DPU application software, a large amount of test data is needed. The test data could be full images or stacks of windows.

### 2.3.3 Real-Time Data Feeding Modes

The F-FEE emulator shall allow to feed data to the F-DPU (windows or full-frame images) ~~with various types and sources of data~~also dynamically with:

- Imagettes received from Ethernet
- Full images created from full images stored in SSD patched with imagettes received from Ethernet

For validating the FGS algorithms implemented in the F-DPU application software, it will be needed to produce the imagettes dynamically. The test data will be produced by the Image Generator as described in [RD09].

### 2.3.4 Other Requirements

The F-FEE emulator shall also offer the following functionalities:

- F-FEE command management via RMAP
- F-FEE HK generation
- Window position list management
- Error injection (SpaceWire, RMAP, data content, etc.)
- Synchronisation between N/F-FEE emulators
- Periodic status reporting
- Event reporting
- Log reporting
- SpW Timecode distribution

## 2.4 F-FEE Emulator Configurations and Scenarios

The F-FEE emulator will be used in development and test configurations together with other EGSEs, at various levels throughout the PLATO project lifetime: from DPS unit level, to DPS system level and SVM level. In order to harmonise the test environments, the communication protocol across all EGSE networks foreseen for the PLATO DPS is the EGSE Data Exchange Network (EDEN) protocol.

EDEN allows EGSE units to be controlled through telecommand and telemetry packets, like flight units. This implies that the EGSE telecommands and telemetry can be defined in a common AIT system database. EDEN is an encapsulation protocol that is based on the Protocol Data Unit (PDU). Please refer to AD06 for a more detailed information on the required header and packet structure.

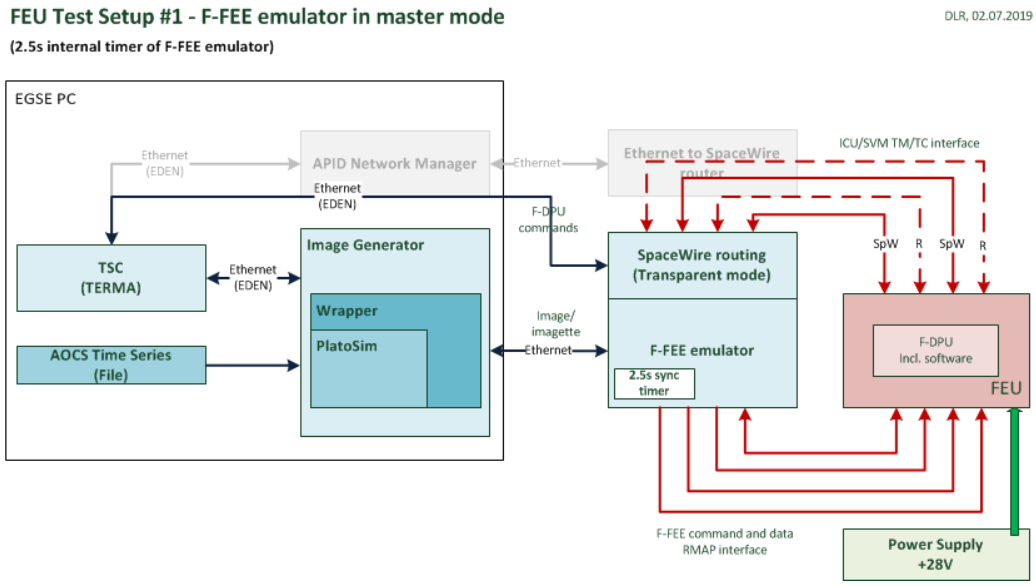
### 2.4.1 Configuration #1 - F-DPU ASW Development Bench Open-Loop

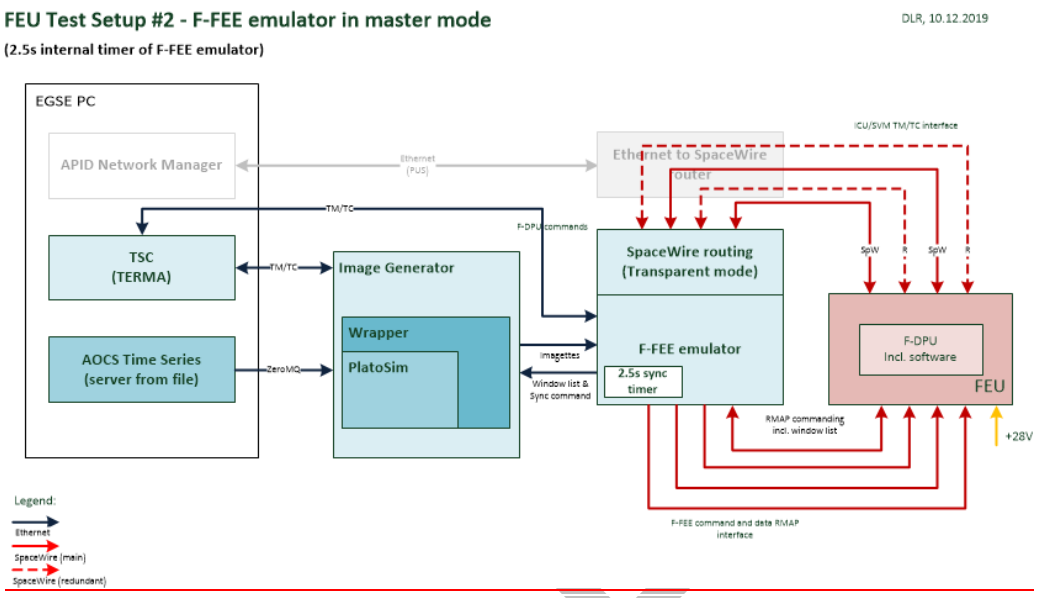
The first configuration in which the F-FEE emulator is required is used by the F-DPU software development team for development and testing of the F-DPU application software. It therefore covers use cases #1 and #2 and has the following features:

- Target: any stand-alone F-DPU board (development board, BB, EM, EQM, …)
- Functional scope:
  - Booting and testing the F-DPU application software with one F-DPU standalone board. This includes the FGS algorithm.
  - Emulation of 1 F-FEE (1 Fast Camera connected via 4 SpaceWire links to the F-DPU board).

The F-DPU board is by default a development board; however, depending on the test needs, an F-DPU breadboard or an F-DPU EM can be used instead of the development board. The figure below describes the development and test configuration.

**Figure: F-DPU BB/ EM Development and Test Set-up**





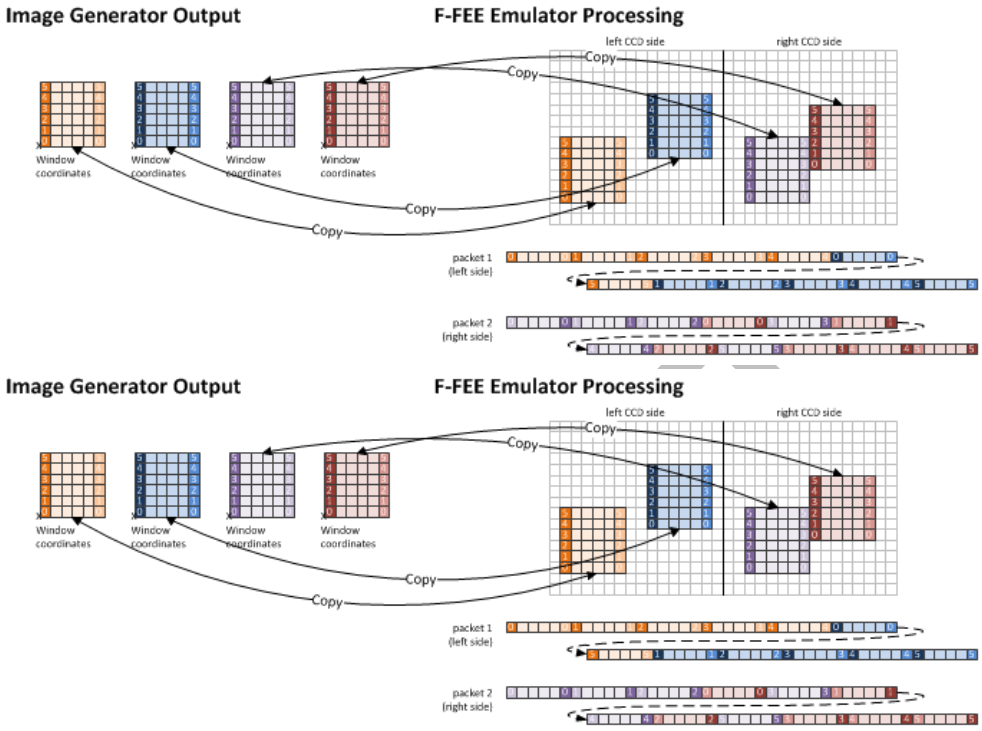

The F-FEE emulator is connected via 4 SpaceWire links to the F-DPU board/ EM. An EGSE PC ~~(annotated as "Laptop" in the figure)~~ is the central command, monitoring and control node of the configuration.

The F-FEE emulator shall implement a Transparent Mode, in which it takes PUS commands via the Ethernet interface (EDEN protocol [AD06]) and forwards these via one of the remaining SpaceWire channels to the F-DPU. On the same channel, the F-DPU shall be able to send telemetry, which the F-FEE emulator forwards via EDEN back to the command and control laptop.

In the activities for the first version of the software (V 0.4), the F-DPU team use the full image mode of the F-FEE emulator for initial F-DPU ASW development and testing. For development and tests of F-DPU ASW version 0.8 and higher, which is the software version including the FGS algorithms, the windowing mode is required. In this configuration, an additional EGSE component that is needed is the image generator [RD09], which is used in an open-loop set-up at F-DPU team level.

The image generator takes as input from the ~~C&C laptop~~F-FEE emulator the window list transmitted from the F-DPU, and from the EGSE PC an initial spacecraft attitude~~, a list of required windows~~ and a time-stamped static AOCS time series, which it uses to simulate and produce a series of star imagettes. This series of imagettes is transferred to the F-FEE emulator via the EDEN protocol [AD06], together with the window position, window size and star index. The F-FEE emulator has to copy the received imagettes into the correct position on the full image stored in memory, and then proceed with the emulation of the CCD readout as described in [AD02]. The packets are sent to the F-DPU via the 4 SpaceWire channel.

**Figure: Image generator and F-FEE emulator data transfer**




The synchronisation mechanism for this configuration remains ~~TBD.~~to be described in a separate document covering the EGSE configuration at DPS level (AD TBC).

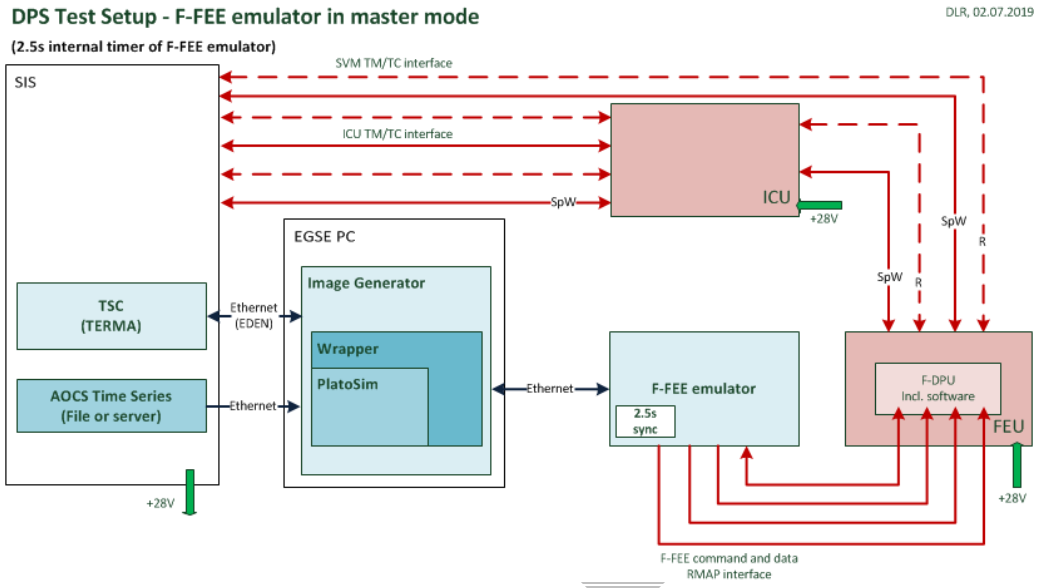
### 2.4.2 Configuration #2 - F-DPU SW Acceptance Bench Open-Loop at DPS Level

The second configuration is the test setup used at DPS level for the acceptance of the F-DPU software prior to system tests performed by the DPS team. It has the following features:

- Target: FEU EM with SW v0.4, FEU EQM with SW v0.8 (later SW v1.2), FEU PFM with SW v1.0.
- Functional scope:
  - Booting and testing the F-DPU application software with an F-DPU or a full FEU (x2 instances loaded by the GSE and running in the FEU), including implementation of standard PUS services and basic FGS interface tests.
  - Emulation of 1-2 F-FEEs (1-2 Fast Cameras).

The figure below describes the configuration.

**Figure: F-DPU Acceptance Test Set-up at DPS Level**




The FEU is connected via SpaceWire links to the Spacecraft Interface Simulator and to the ICU. Like in the F-DPU development and test set-up, the F-FEE emulator is used for verifying full image acquisition, window acquisition and FGS algorithm and interfaces in open-loop.

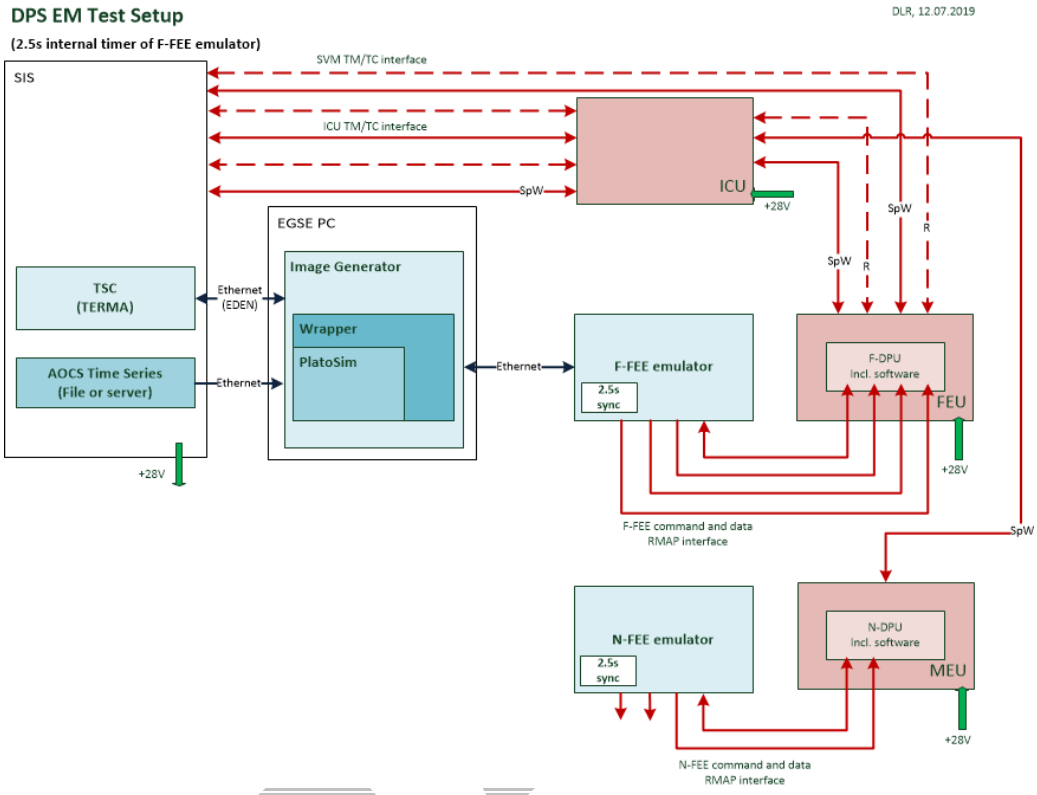
### 2.4.3 Configuration #3 - DPS AIT Test Bench Open Loop

The third configuration covers use case #3 and is used by the DPS team for DPS level AIT activities. With relation to the F-FEE emulator, its main features are:

- Target: FEU EM, FEU EQM, FEU PFM
- Functional scope:
  - Interface verification and validation (e.g. F-DPU-F-FEE, F-DPU – F-FEE, F-DPU – ICU, F-DPU – SVM).
  - Dataflow verification and validation.
  - Data processing including FGS verification.
  - Stress testing.
  - Long term stability testing.
  - Emulation of 1 F-FEEs (1 fast camera).

The figure below gives an example test set-up for the EM.

**Figure: DPS AIT Test Bench Set-up (Target FEU EM)**




### 2.4.4 Configuration #4 - FEU ASW at SVM Level Test Bench Closed-Loop

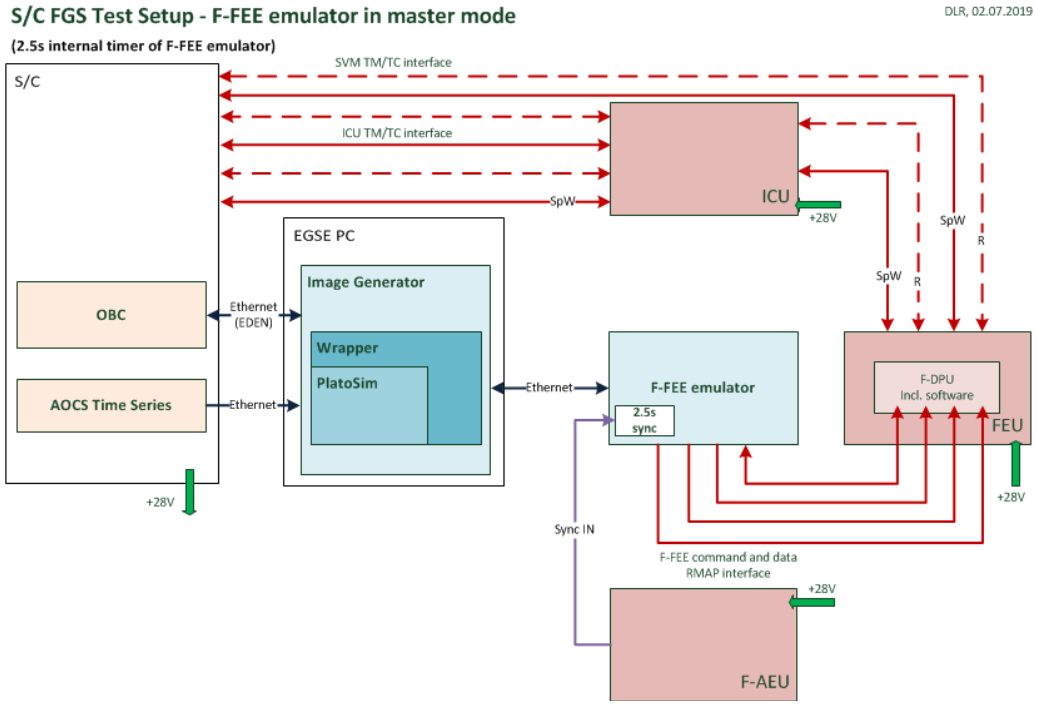
The fourth configuration #4 covers use case #4 for tests at satellite level, including the closed-loop verification of the FGS. In terms of F-chain testing its main features are:

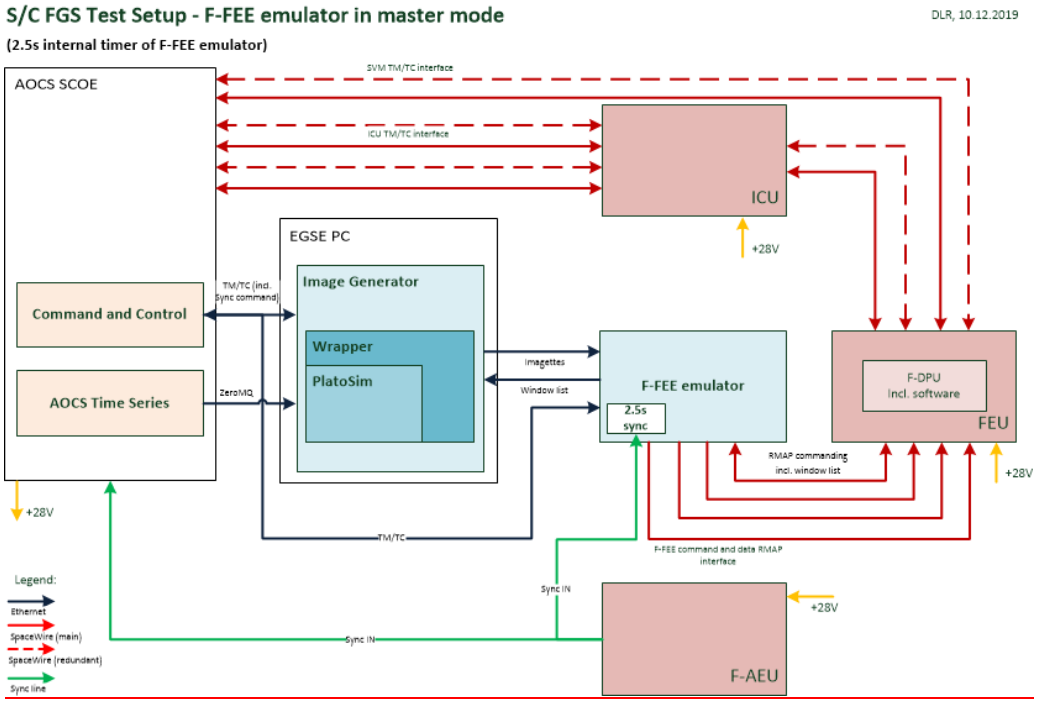
- Target: FEU EM, FEU PFM
- Functional scope:
  - Functional verification of AOCS mission performance.
  - Validation of AOCS-FGS performance requirements.

The test set-up for the closed-loop test of the FGS is illustrated in the figure below.

For the closed-loop FGS verification scenario, the SIS sends to the Image Generator as input a dynamically generated and time-stamped AOCS time series, corresponding to the spacecraft jitter, at a real-time frequency of 8Hz. The image generator then dynamically computes the imagettes and sends them to the F-FEE emulator via the EDEN protocol, together with the window position, window size and star index. The difference to the first configuration described in 3.4.1. is the fact that the AOCS time series is generated dynamically and not statically, and can be used in a closed-loop environment.

**Figure: SVM AIT Test Setup Closed Loop**

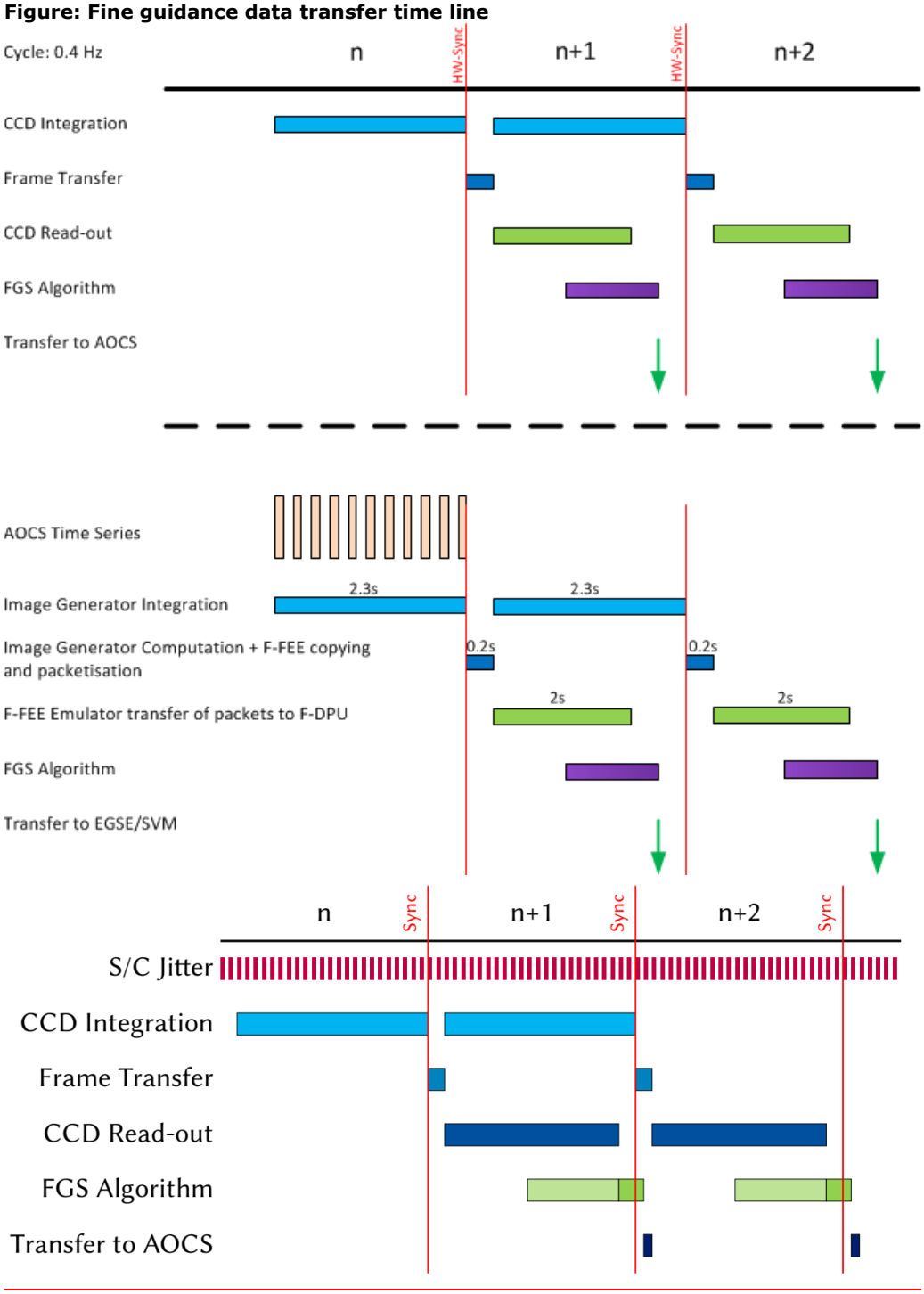


In terms of timing, the image generator integration time corresponds to the CCD integration time of the real fast camera. This means that, in a 2.5 sec cycle, the image generator takes 2.3 sec for integration. The remaining 200msec for the frame transfer are shared between the image generator for computing and sending the series of imagettes and the F-FEE emulator for copying and packetising the windows to the F-DPU. The F-FEE emulator shall take no more than **10 (ten) msec** to perform this task. The CCD readout time corresponds to the transfer of the packets from the F-FEE emulator, so all packets shall have been received by the F-DPU within 2 sec.

The synchronisation mechanism for this ~~use case remains TBD.~~configuration remains to be described in a separate document covering the EGSE configuration at DPS level (AD TBC).

**Figure: Fine guidance data transfer time line**



# 3 Requirements

## 3.1 General Requirements

| | | |
|---|---|---|
| | Title: | SimuCam building blocks |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2528 | The SimuCam shall be made up of two parts:<br>• A main electronic box which is the core of the system and which manages all the real-time aspects of the F-FEE emulation,<br>• A standalone test software client allowing to drive and monitor one or several main electronic boxes for test purposes. | |

## 3.2 Software Requirements

### 3.2.1 General Software Requirements

| | | |
|---|---|---|
| | Title: | SimuCam SSW requirements |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-501 | The Requirement NFEESIM-UR-407 shall be applicable without any modification to the F-FEE emulator | |

## 3.3 MEB General Requirements

### 3.3.1 MEB Communication Interface

| | | |
|---|---|---|
| | Title: | SimuCam MEB communication interface |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2537 | The Requirements NFEESIM-UR-558, NFEESIM-UR-559, and NFEESIM-UR-690 shall be applicable without any modification to the F-FEE emulator. | |

| | | |
|---|---|---|
| | Title: | Usage of PUS TC |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2625 | All commanding of the SimuCam MEB by the client shall be done by PUS TC Packets compliant to [AD07] through the dedicated Ethernet interface. | |

| | | |
|---|---|---|
| | Title: | Usage of PUS TM |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2632 | All telemetry of the SimuCam MEB by the client shall be PUS TM Packets compliant to [AD07], sent through the dedicated Ethernet interface. | |

| | | |
|---|---|---|
| | Title: | EDEN protocol |
| | Verif.: | R |
| | Release: | ~~R1~~R2 |
| FF-SIM-UR-3398 | The SimuCam MEB shall implement the EDEN protocol for the communication via Ethernet as described in AD06. | |

*Note: The EDEN protocol is, in broad terms, PUS packets over Ethernet.*

| | | |
|---|---|---|
| | Title: | Service 1 -Request verification |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2631 | The SimuCam MEB shall implement the standard PUS service 1 "Request Verification" | |

| | | |
|---|---|---|
| | Title: | Service 1 - Subservices |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2630 | The SimuCam MEB shall implement the following PUS Service 1 standard subservices:<br>• TM[1,7] successful completion of execution verification report<br>• TM[1,8] failed completion of execution verification report | |

| | | |
|---|---|---|
| | Title: | Service 3 - Housekeeping |
| | Verif.: | T |
| | Release: | ~~R1~~R2 |
| FF-SIM-UR-2628 | The SimuCam MEB shall implement the standard PUS service 3 "Housekeeping" | |

| | | |
|---|---|---|
| | Title: | Service 3 - Subservices |
| | Verif.: | T |
| | Release: | ~~R1~~R2 |
| FF-SIM-UR-2627 | The SimuCam MEB shall implement the following PUS Service 3 standard subservices:<br>• TC[3,5] enable the periodic generation of housekeeping parameter reports<br>• TC[3,6] disable the periodic generation of housekeeping parameter reports<br>• TM[3,25] housekeeping parameter report<br>• TC[3,27] generate a one shot housekeeping parameter report<br>• TC[3,31] modify the collection interval of housekeeping parameter report | |

| | | |
|---|---|---|
| | Title: | Service 5 - Event reporting |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2638 | The SimuCam MEB shall implement the standard PUS service 5 "Event Reporting" | |

| | | |
|---|---|---|
| | Title: | Service 5 - Subservices |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2626 | The SimuCam MEB shall implement the following PUS Service 5 standard subservices:<br>• TM[5,1] informative event report<br>• TM[5,2] low severity anomaly report<br>• TM[5,3] medium severity anomaly report<br>• TM[5,4] high severity anomaly report<br>• TC[5,6] enable report generation<br>• TC[5,7] disable report generation | |

| | | |
|---|---|---|
| | Title: | Service 9 - Time management |
| | Verif.: | R |

| | | |
|---|---|---|
| | Release: | R2 |
| FF-SIM-UR-2637 | The SimuCam MEB shall implement the standard PUS service 9 "Time Management" | |

| | | |
|---|---|---|
| | Title: | Service 9 - Subservices |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2671 | The SimuCam MEB shall implement the following PUS service 9 mission-specific subservices:<br>• TC[9,129] Set CUC time | |

| | | |
|---|---|---|
| | Title: | Service 17 - Test |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2670 | The SimuCam MEB shall implement the standard PUS service 17 "Test" | |

| | | |
|---|---|---|
| | Title: | Service 17 - Subservices |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2669 | The SimuCam MEB shall implement the following PUS service 17 standard subservices:<br>• TC[17,1] perform an are-you-alive connection test<br>• TM[17,2] are-you-alive connection test report | |

| | | |
|---|---|---|
| | Title: | Service 250 - Mode management |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2664 | The SimuCam MEB shall implement the mission-specific PUS Service 250 "Mode Management" | |

| | | |
|---|---|---|
| | Title: | Service 250 - Subservices |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2678 | The SimuCam MEB shall implement at least the following PUS service 250 subservices:<br>• TC[250,1] MEB Reset<br>• TC[250,2] MEB Config Mode<br>• TC[250,3] MEB Running Mode<br>• TC[250,4] FEE Config Mode<br>• TC[250,5] FEE Standby Mode<br>• TC[250,6] FEE Image Mode<br>• TC[250,7] FEE Window Mode<br>• TC[250,8] FEE Image Test Mode<br>• TC[250,9] FEE Window Test Mode<br>• TC[250,11] Enable Interactive Mode<br>• TC[250,12] Disable Interactive Mode<br>• TC[250,13] Enable Transparent Mode<br>• TC[250,14] Disable Transparent Mode | |

| | | |
|---|---|---|
| | Title: | Service 251 - Configuration |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2675 | The SimuCam MEB shall implement at mission-specific PUS Service 251 "Configuration" | |

| | | |
|---|---|---|
| | Title: | Service 251 - Subservices |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2674 | The SimuCam MEB shall implement at least the following PUS service 251 subservices:<br>• TC[251,1] Configure SpaceWire<br>• TC[251,2] Configure RMAP<br>• TC[251,3] Configure Timing<br>• TC[251,4] Configure Synchronization<br>• TC[251,5] Configure Modes<br>• TC[251,6] Configure Storage<br>• TC[251,7] Configure HK | |

| | | |
|---|---|---|
| | Title: | Service 252 - Failure injection and Link Management |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-2894 | The SimuCam MEB shall implement the mission-specific PUS Service 252 "Failure Injection" | |

| | | |
|---|---|---|
| | Title: | Service 252 - Subservices |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-2895 | The SimuCam MEB shall implement at least the following PUS service 252 subservices:<br>• TC[252,1] Link enable<br>• TC[252,2] Link disable<br>• TC[252,3] Reset sync | |

| | | |
|---|---|---|
| | Title: | Service 253 - SSD management |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2888 | The SimuCam MEB shall implement the mission-specific PUS Service 253 "SSD Management" | |

| | | |
|---|---|---|
| | Title: | Service 253 - Subservices |
| | Verif.: | T |
| | Release: | R2 |

| | |
|---|---|
| FF-SIM-UR-2887 | The SimuCam MEB shall implement at least the following PUS service 253 subservices:<br>• TC[253,1] Erase SSD<br>• TC[253,2] Dump SSD status<br>• TM[253,3] SSD status dump report<br>• TC[253,4] Load image to SSD<br>• TC[253,5] Delete image from SSD<br>• TC[253,6] Report SSD images<br>• TM[253,7] SSD image report<br>• TC[253,8] Load window to SSD<br>• TC[253,9] Delete window from SSD<br>• TC[253,10] Report SSD windows<br>• TM[253,11] SSD windows report |

| | | |
|---|---|---|
| | Title: | Service 254 - Real-time data |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-2673 | The SimuCam MEB shall implement the mission-specific PUS Service 254 "Real-time Data" | |

| | | |
|---|---|---|
| | Title: | Service 254- Subservices |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-2672 | The SimuCam MEB shall implement at least the following PUS service 254 mission-specific subservices:<br>• TC[254,1] Imagette Data | |

### 3.3.2 MEB Modes

| | | |
|---|---|---|
| | Title: | SimuCam MEB modes |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2538 | The Requirements NFEESIM-UR-531 and NFEESIM-UR-537 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | MEB config mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2683 | In MEB_CONFIG mode, the SimuCam MEB shall force all the F-FEE emulation entities in the FFEE_CONFIG state. | |

| | | |
|---|---|---|
| | Title: | Meb config mode - Allowed FEE modes |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2682 | In MEB_CONFIG mode, the SimuCam MEB shall reject the commands setting an F-FEE emulation entity in one of the FFEE_RUNNING states. | |

| | | |
|---|---|---|
| | Title: | Meb running mode - Allowed FEE modes |
| | Verif.: | T |
| | Release: | R1 |

| | |
|---|---|
| FF-SIM-UR-2681 | In MEB_RUNNING mode, the SimuCam MEB shall accept the commands setting an F-FEE emulation entity in one of the FFEE_RUNNING states or in the FFEE_CONFIG state. |

### 3.3.3 F-FEE Emulation Entities

| | | |
|---|---|---|
| | Title: | Number of F-FEE emulation entities |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2539 | The SimuCam MEB shall allow managing 1 F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | Number of SpaceWire links per entity |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2842 | Four SpaceWire links shall be associated to each F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | Number of CCDs per entity |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2841 | Each F-FEE emulation entity shall be able to handle the data of four CCD:<br>• CCD1<br>• CCD2<br>• CDD3<br>• CDD4 | |

| | | |
|---|---|---|
| | Title: | F-FEE entity mode commandability |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2840 | The SimuCam MEB shall allow the user to set individually, via an Ethernet command, each F-FEE emulation entity in one of the following states:<br>• FFEE_CONFIG<br>• FFEE_RUNNING_STANDBY<br>• FFEE_RUNNING_IMAGE<br>• FFEE_RUNNING_WINDOW<br>• FFEE_RUNNING_IMAGE_INTERACTIVE<br>• FFEE_RUNNING_WINDOW_INTERACTIVE<br>• FFEE_RUNNING_IMAGE_TEST<br>• FFEE_RUNNING_WINDOW_TEST | |

| | | |
|---|---|---|
| | Title: | F-FEE entity modes |
| | Verif.: | T |
| | Release: | R1 |

| | |
|---|---|
| FF-SIM-UR-2863 | Each F-FEE emulation entity shall manage the following states:<br>• **FFEE_CONFIG**: the F-FEE emulation entity is disabled (i.e. F-FEE is off) and can be configured<br>• **FFEE_RUNNING_STANDBY**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE STANDBY mode<br>• **FFEE_RUNNING_IMAGE**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE IMAGE mode<br>• **FFEE_RUNNING_WINDOW**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE WINDOW mode<br>• **FFEE_RUNNING_IMAGE_INTERACTIVE**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE IMAGE mode, the Image data is provided in real-time<br>• **FFEE_RUNNING_WINDOW_INTERACTIVE**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE WINDOW mode, the Image data is provided in real-time<br>• **FFEE_RUNNING_IMAGE_TEST**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE IMAGE_TEST mode (same behaviour than FFEE_RUNNING_IMAGE, but the pattern emission mode is forced)<br>• **FFEE_RUNNING_WINDOW_TEST**: the F-FEE emulation entity is enabled (i.e. F-FEE is on) and simulates the F-FEE WINDOW_TEST mode (same behaviour than FFEE_RUNNING_WINDOW, but the pattern emission mode is forced) |

| | | |
|---|---|---|
| | Title: | F-FEE entity configuration |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2839 | The SimuCam MEB shall allow the user to configure an F-FEE emulation entity (SpaceWire / RMAP interface parameters, ...) only when this entity is in the FFEE_CONFIG state. | |

| | | |
|---|---|---|
| | Title: | F-FEE entity config mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2838 | When an F-FEE emulation entity enters in the FFEE_CONFIG, the SimuCam MEB shall:<br>• stop the F-FEE emulation on the associated SpaceWire link,<br>• disable its associated SpaceWire link. | |

| | | |
|---|---|---|
| | Title: | F-FEE running modes |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2837 | When an F-FEE emulation entity enters in one of the FFEE_RUNNING states, the SimuCam MEB shall:<br>• enable its associated SpaceWire link,<br>• start the F-FEE emulation on the associated SpaceWire link. | |

### 3.3.4 Reset and Start-up

| | | |
|---|---|---|
| | Title: | SimuCam MEB reset and start-up |
| | Verif.: | R |
| | Release: | R1 |

| | |
|---|---|
| FF-SIM-UR-2540 | The Requirements NFEESIM-UR-562, NFEESIM-UR-567 and NFEESIM-UR-568 shall be applicable without any modification to the F-FEE emulator |

### 3.3.5 Non-Volatile Memory

| | | |
|---|---|---|
| | Title: | Non-volatile memory |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2541 | The Requirement NFEESIM-UR-496 shall be applicable without any modification to the F-FEE emulator | |

### 3.3.6 Time Management

| | | |
|---|---|---|
| | Title: | Time management |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2688 | The Requirements NFEESIM-UR-591, NFEESIM-UR-660, NFEESIM-UR-693, NFEESIM-UR-695 and NFEESIM-UR-696 shall be applicable without any modification to the F-FEE emulator | |

### 3.3.7 Endianness

| | | |
|---|---|---|
| | Title: | Endianness |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2689 | The Requirements NFEESIM-UR-658 and NFEESIM-UR-708 shall be applicable without any modification to the F-FEE emulator | |

### 3.3.8 MEB Qualification

| | | |
|---|---|---|
| | Title: | SimuCam MEB tests and qualification |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2544 | The Requirements NFEESIM-UR-822 and NFEESIM-UR-823 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | F-FEE emulator test coverage |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2693 | All functionalities of the F-FEE emulator shall be verified by tests. | |

## 3.4 Interface Requirements

### 3.4.1 F-FEE / F-DPU SpaceWire Physical Interface

| | | |
|---|---|---|
| | Title: | F-FEE / F-DPU SpaceWire physical interface |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2560 | The Requirements NFEESIM-UR-826 and NFEESIM-UR-827 shall be applicable without any modification to the F-FEE emulator. | |

### 3.4.2 F-FEE / F-DPU Communication Protocol

| | | |
|---|---|---|
| | Title: | F-FEE / F-DPU communication protocol |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2561 | The SimuCam MEB shall implement the F-FEE / F-DPU communication protocol as defined in [AD02]:<br>• the commands (read or write) sent by the F-DPU are sent as RMAP commands,<br>• the pixels data and periodic HK data are sent by the F-FEE as SpaceWire packets according to a specific format specified in [AD02]. | |

### 3.4.3 SpaceWire / RMAP Interface Configuration

| | | |
|---|---|---|
| | Title: | SpaceWire interface parameters |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2562 | For each F-FEE emulation entity, the SimuCam MEB shall manage the following set of parameters configuring the SpaceWire / RMAP interface:<br>• AutoStart/ LinkStart mode<br>• link speed (expressed in Mbps)<br>• logical address (node address used by the F-DPU to build the SpaceWire packets sent to the F-FEE emulation entity)<br>• destination node address (node address used by the F-FEE emulation entity to build the SpaceWire packets sent to the F-DPU)<br>• time-code generation (enabled / disabled)<br>• RMAP key | |

| | | |
|---|---|---|
| | Title: | Number of SpaceWire interface parameter sets |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2649 | For each F-FEE emulation entity, the SimuCam MEB shall manage one default SpaceWire / RMAP configuration parameter set. | |

| | | |
|---|---|---|
| | Title: | SpaceWire interface parameter set storage |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2648 | The SimuCam MEB shall store in its non-volatile memory the default SpaceWire / RMAP configuration parameter set of each F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | SpaceWire interface parameter changeability |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2647 | In the MEB_CONFIG mode, the SimuCam MEB shall allow the user to change the default SpaceWire / RMAP configuration parameter set of each F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | Default SpaceWire interface parameter set |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2646 | At start-up, the SimuCam MEB shall configure each F-FEE emulation entity with the default SpaceWire / RMAP configuration parameter set stored in the MEB non-volatile | |

| | |
|---|---|
| | memory. |

| | | |
|---|---|---|
| | Title: | Active SpaceWire interface parameter set |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2645 | When an F-FEE emulation entity is in the FFEE_CONFIG state, the SimuCam MEB shall allow the user to change its active SpaceWire / RMAP configuration parameter set. | |

| | | |
|---|---|---|
| | Title: | SpaceWire Link enable/disable command |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2644 | The SimuCam MEB shall allow the user to command the link enable/disable operation of each F-FEE emulation entity by a specific command at any moment when the F-FEE emulation entity is in one of the FFEE_RUNNING states. | |

### 3.4.4 RMAP Protocol Management

| | | |
|---|---|---|
| | Title: | RMAP protocol management |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2563 | The Requirements NFEESIM-UR-638, NFEESIM-UR-640 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | RMAP reply in case of no error |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2865 | If the check shows no errors, the SimuCam MEB shall send a RMAP reply with a 'command executed successfully' status if no SpW error is injected. | |

| | | |
|---|---|---|
| | Title: | RMAP reply in case of error |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2864 | If the check shows errors, the SimuCam MEB shall send a RMAP reply with an error code as specified in [AD02] and [AD10], if no SpW error is injected. | |

### 3.4.5 RMAP Configuration Areas

| | | |
|---|---|---|
| | Title: | RMAP configuration areas |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2656 | The Requirement NFEESIM-UR-699 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | One RMAP configuration area per SpaceWire link |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2564 | The SimuCam MEB shall manage, for each F-FEE emulation entity and in each simulation entity for each SpaceWire link, the following RMAP areas (see [AD02] and [AD05]):<br>• verified configuration areas<br>• unverified configuration areas<br>• housekeeping areas<br>• window definition areas | |

| | | |
|---|---|---|
| | Title: | RMAP configuration area readability |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2658 | The SimuCam MEB shall make readable via RMAP read commands, for each F-FEE emulation entity, all the RMAP configuration areas. | |

| | | |
|---|---|---|
| | Title: | RMAP configuration area writeability |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2657 | The SimuCam MEB shall make writable via RMAP write commands, for each F-FEE emulation entity, all the RMAP configuration and windowing areas. | |

### 3.4.6 SpaceWire Echoing Mode

| | | |
|---|---|---|
| | Title: | SpaceWire echoing mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2566 | The SimuCam MEB shall allow the user to enable / disable, for each F-FEE emulation entity and for each SpaceWire link, a SpaceWire echoing mode. | |

| | | |
|---|---|---|
| | Title: | SpaceWire echoing mode disabled at start-up |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2651 | At start-up, the SimuCam MEB shall disable the RMAP echoing mode for all the F-FEE emulation entities. | |

| | | |
|---|---|---|
| | Title: | SpaceWire forwarding to Ethernet |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2650 | When a RMAP echoing mode is enabled, an F-FEE emulation entity shall forward as Ethernet packet each incoming SpaceWire packet (i.e. RMAP write / read commands) and each outgoing SpaceWire packet (i.e. RMAP write acknowledgements and RMAP read replies). | |

### 3.4.7 SpW Logging Mode

| | | |
|---|---|---|
| | Title: | SpaceWire logging mode |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2653 | The Requirement NFEESIM-UR-706 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | SpaceWire logging mode enable/disable |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2565 | The SimuCam MEB shall allow the user to enable / disable, for each F-FEE emulation entity, a SpaceWire logging mode. | |

| | | |
|---|---|---|
| | Title: | SpaceWire logging mode enabled at start-up |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2655 | At start-up, the SimuCam MEB shall disable the SpaceWire logging mode for all the F-FEE emulation entities. | |

| | | |
|---|---|---|
| | Title: | SpaceWire logging to disk |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2654 | When a SpaceWire logging mode is enabled, an F-FEE emulation entity shall record in a log each incoming SpaceWire packet (i.e. RMAP write / read commands) and each outgoing SpaceWire packet (i.e. RMAP write acknowledgements and RMAP read replies). | |

## 3.5 Timing and Synchronization Requirements

### 3.5.1 F-FEE Timing Configuration

| | | |
|---|---|---|
| | Title: | Exposure and CCD readout timing |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2567 | The SimuCam MEB shall manage the following parameters defining the CCD readout sequence for an F-FEE emulation entity:<br>• exposure period = EP (default value = 2.5 sec., min value = 1.0 sec., max value = 60 sec.)<br>• CCD readout time = RT (default value = 2.0 sec.) | |

| | | |
|---|---|---|
| | Title: | F-FEE timing configuration |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2659 | The Requirement NFEESIM-UR-829 shall be applicable without any modification to the F-FEE emulator. | |

| | | |
|---|---|---|
| | Title: | Maximum real-time data latency |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2893 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state and the FFEE_RUNNING_WINDOW_INTERACTIVE state, the SimuCam MEB shall be capable of sending the imagettes received from the Ethernet interface towards the F-DPU not later then 10ms after receiving them. | |

### 3.5.2 Synchronization Signal

| | | |
|---|---|---|
| | Title: | Synchronization signal period |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2660 | The SimuCam MEB shall be able to generate an internal synchronization signal every EP seconds. | |

| | | |
|---|---|---|
| | Title: | Synchronization signal |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2568 | The Requirements NFEESIM-UR-633, NFEESIM-UR-634, NFEESIM-UR-635 and NFEESIM-UR-636 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | External synchronization signal output |
| | Verif.: | T |
| | Release: | R1 |

| | |
|---|---|
| FF-SIM-UR-2694 | The SimuCam MEB shall be able to use as EP synchronization signal an external synchronization signal provided by another SimuCam MEB system. |

| | |
|---|---|
| | Title: External synchronization signal input |
| | Verif.: T |
| | Release: R1 |
| FF-SIM-UR-2870 | The SimuCam MEB shall be able to use as EP synchronization signal an external synchronization signal provided by an F-AEU. |

| | |
|---|---|
| | Title: Synchronization signal propagation |
| | Verif.: T |
| | Release: R1 |
| FF-SIM-UR-2869 | The SimuCam MEB shall be able to propagate its internal EP synchronization signal to other SimuCam MEB systems. |

| | |
|---|---|
| | Title: External synchronization signal generation |
| | Verif.: T |
| | Release: R1 |
| FF-SIM-UR-2868 | The SimuCam MEB shall generate an external synchronization signal with the same timing as the Clk_F_ccdread signal specified in [AD01]. |

| | |
|---|---|
| | Title: Synchronization signal in and output |
| | Verif.: T |
| | Release: R1 |
| FF-SIM-UR-2867 | The SimuCam MEB shall provide two HW interfaces (input and output) for EP synchronization signal retrieving and propagating. |

| | |
|---|---|
| | Title: Synchronisation signal PUS command - F-FEE emulator master |
| | Verif.: T |
| | Release: R2 |
| FF-SIM-UR-3424 | The SimuCam MEB shall provide for every internally generated sync pulse a PUS command IMGEN_START_READOUT, which it sends to another EGSE component via Ethernet. |
| | Title: Synchronisation signal PUS command - F-FEE emulator slave |
| | Verif.: T |
| | Release: R2 |
| FF-SIM-UR-3425 | The SimuCam MEB shall provide for every sync pulse received on the SYNC IN interface a PUS command IMGEN_START_READOUT, which it sends to another EGSE component via Ethernet. |

### 3.5.3 Time Code Management

| | |
|---|---|
| | Title: Time-code management |
| | Verif.: R |
| | Release: R1 |
| FF-SIM-UR-2695 | The Requirements NFEESIM-UR-486, NFEESIM-UR-489 shall be applicable without any modification to the F-FEE emulator. |

| | |
|---|---|
| | Title: Time-code management DELETED |
| | Verif.: R |
| | Release: R1 |
| FF-SIM-UR- | The Requirements NFEESIM-UR-488, NFEESIM-UR-838 shall **NOT** be applicable to the |

| | |
|---|---|
| 2871 | F-FEE emulator and are deleted in this context. |

| | | |
|---|---|---|
| | Title: | Time-code SpaceWire link selection |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2872 | The SimuCam MEB shall allow the user to select, via an Ethernet command, which SpaceWire link to use for time-code transmission. | |

### 3.5.4 Readout Order

| | | |
|---|---|---|
| | Title: | Readout order DELETED |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2662 | The Requirements NFEESIM-UR-839, NFEESIM-UR-842 shall **NOT** be applicable to the F-FEE emulator and are deleted in this context. | |

### 3.5.5 Synchronization Reset

| | | |
|---|---|---|
| | Title: | Synchronization reset |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2571 | The Requirement NFEESIM-UR-709 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | Auto-reset mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2699 | The SimuCam MEB shall handle an auto-reset mode in which the internal synchronization signal is reset each time a given F-FEE emulation enters the FFEE_RUNNING_IMAGE or FFEE_RUNNING_WINDOW state. | |

| | | |
|---|---|---|
| | Title: | Auto-reset mode enable/disable |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2698 | The SimuCam MEB shall allow the user to enable and disable this auto-reset mode thanks to an Ethernet command:<br>• A parameter shall allow setting which F-FEE emulation is the master. | |

| | | |
|---|---|---|
| | Title: | Synchronization reset effect |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2697 | Upon reception of a synchronization reset command, the SimuCam MEB shall:<br>• stop the data transmission on all the F-FEE emulation entities<br>• put all the F-FEE emulation entities in the FFEE_RUNNING_STANDBY state excepted if the F-FEE emulation entity is in the FFEE_CONFIG mode<br>• wait SYNCH_DELAY milliseconds where SYNCH_DELAY is a parameter of the synchronization reset command (SYNCH_DELAY is in [0,60000])<br>• release a synchronization signal<br>• reset the time-code counter (set to 0)<br>• start a new synchronization and acquisition cycle. | |

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## 3.6 SSD Management Requirements

### 3.6.1 SSD Storage Unit

| | | |
|---|---|---|
| | Title: | SSD storage unit |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2700 | The Requirements NFEESIM-UR-412, NFEESIM-UR-430 and NFEESIM-UR-597 shall be applicable without any modification to the F-FEE emulator | |

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### 3.6.2 Full image Storage Management

| | | |
|---|---|---|
| | Title: | SSD full image storage management |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2701 | The Requirements NFEESIM-UR-431, NFEESIM-UR-432, NFEESIM-UR-433, NFEESIM-UR-435, NFEESIM-UR-439, NFEESIM-UR-454, NFEESIM-UR-455, NFEESIM-UR-456, NFEESIM-UR-548, NFEESIM-UR-600, NFEESIM-UR-676 and NFEESIM-UR-714 shall be applicable without any modification to the F-FEE emulator | |

### 3.6.3 Window Stack Storage Management

| | | |
|---|---|---|
| | Title: | SSD window stack storage management |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2702 | The Requirements NFEESIM-UR-601, NFEESIM-UR-602, NFEESIM-UR-603, NFEESIM-UR-604, NFEESIM-UR-605, NFEESIM-UR-606, NFEESIM-UR-607, NFEESIM-UR-608, NFEESIM-UR-609, NFEESIM-UR-610, NFEESIM-UR-678 and NFEESIM-UR-717 shall be applicable without any modification to the F-FEE emulator | |

## 3.7 Standby Mode Simulation

| | | |
|---|---|---|
| | Title: | F-FEE standby mode simulation |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2575 | In the FFEE_RUNNING_STANDBY state, the F-FEE emulation entities shall simulate the behaviour of a real F-FEE running in STANDBY mode as defined in [AD01] [AD02] and [AD05]. | |

| | | |
|---|---|---|
| | Title: | No data transmission in standby mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2707 | When entering the FFEE_RUNNING_STANDBY state, the F-FEE emulation entities shall stop the transmission of the data (images or window segments) to the F-DPU. | |

| | | |
|---|---|---|
| | Title: | Time-code generation in standby mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2706 | In the FFEE_RUNNING_STANDBY state, the F-FEE emulation entities shall generate the time-code. | |

| | | |
|---|---|---|
| | Title: | Standby mode commanding |
| | Verif.: | T |
| | Release: | R1 |

| | |
|---|---|
| FF-SIM-UR-2705 | Upon reception of a SpaceWire command as specified in [AD02] from the F-DPU and if the F-FEE emulation entity is in any of the RUNNING states, the F-FEE emulation entity shall enter the FFEE_RUNNING_STANDBY state. |

## 3.8 Full image Mode Simulation

### 3.8.1 Full image Mode Management

| | | |
|---|---|---|
| | Title: | F-FEE full image mode management DELETED |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2873 | The Requirement NFEESIM-UR-444 shall **NOT** be applicable to the F-FEE emulator and is deleted in this context. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode simulation |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2594 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entities shall simulate the behaviour of a real F-FEE running in IMAGE mode as defined in [AD01] [AD02] and [AD05]. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode commanding |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2716 | Upon reception of the ad-hoc SpaceWire command from the F-DPU and if the F-FEE emulation entity is in the FFEE_RUNNING_STANDBY state and the interactive state is not preselected by Ethernet command, or if the entity is in the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall enter the FFEE_RUNNING_IMAGE state. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode transition at sync signal |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2715 | The effective transition to the FFEE_RUNNING_IMAGE state shall be performed depending on the synchronization signal and by fulfilling the timing specified in [AD01] [AD02] and [AD05]. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode CCD side selection |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2714 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall select the CCD side (right or left) to transmit according to the content of the ad-hoc SpaceWire command received from the F-DPU. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode cycle |
| | Verif.: | T |
| | Release: | R1 |

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|---|---|
| FF-SIM-UR-2713 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall transmit to the F-DPU, every EP seconds, a **full-CCD image of one selected CCD** by fulfilling timing similar to those implemented in the real F-FEE and according to the following cycle:<br>• t0 on SpW1: Transmission of CCD1, side E<br>• t0 on SpW2: Transmission of CCD1, side F<br>• t0+EP on SpW1: Transmission of CCD1, side E<br>• t0+EP on SpW2: Transmission of CCD1, side F<br>• etc. |

*Note: Please note that the light sensitive area of the CCDs in the F-cameras is 4510px X 2255px.*

| | | |
|---|---|---|
| | Title: | F-FEE full image mode CCD selection |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-3402 | The CCD from which the full image is chosen to be transmitted shall be settable by request. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode transmission start |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2712 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall start the transmission of a new CCD image to the F-DPU at each release of the EP synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode maximum transmission time |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2711 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall have completed the transmission of the entire CCD image RT seconds after the release of the EP synchronization signal. | |

*Note: RT corresponds to the CCD readout time.*

| | | |
|---|---|---|
| | Title: | F-FEE full image mode data generation |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2710 | In the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall be able to manage the two following modes of data generation:<br>• F-FEE full image / pattern mode<br>• F-FEE full image / SSD image mode | |

| | | |
|---|---|---|
| | Title: | F-FEE full image mode default |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2709 | At start-up, by default, the SimuCam MEB shall use the F-FEE full image / pattern mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image test mode |
| | Verif.: | T |
| | Release: | R1 |

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|---|---|
| FF-SIM-UR-2708 | The F-FEE emulation entity shall manage the FFEE_RUNNING_IMAGE_TEST state in the same way as the FFEE_RUNNING_IMAGE mode, except that the pattern mode is always forced. |

### 3.8.2 Full Image - Pattern Mode

| | | |
|---|---|---|
| | Title: | F-FEE full image pattern mode |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2595 | The SimuCam MEB shall allow the user to configure, via an Ethernet command, an F-FEE emulation entity to work in the F-FEE full image / pattern mode. | |

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|---|---|---|
| | Title: | F-FEE full image pattern definition |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2717 | When the F-FEE full image / pattern mode is activated, the F-FEE emulation entity shall build, on the fly, CCD images which are filled with patterns according to [AD03]. | |

### 3.8.3 Full image / SSD Image Mode

| | | |
|---|---|---|
| | Title: | F-FEE full image SSD mode management |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2596 | The SimuCam MEB shall allow the user to configure, via an Ethernet command, an F-FEE emulation entity to work in the F-FEE full image / SSD image mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image SSD mode data source |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2725 | When the F-FEE full image / SSD image mode is activated, the F-FEE emulation entity shall use full images from the SSD as data sent to the F-DPU. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image SSD mode parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2724 | For each F-FEE emulation entity, the SimuCam MEB shall allow to manage the following parameters driving the F-FEE full image / SSD image mode:<br>• Number of exposures: EN where 1 < EN < 65536<br>• Selection of CCDx<br>• List of the CCD full image ID: CCDx_ID1, CCDx_ID2, ..., CCDx_IDEN. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image SSD mode default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2723 | For each F-FEE emulation entity, the SimuCam MEB shall manage and store in its non-volatile memory a default set of parameters driving the F-FEE full image / SSD image mode (CCD ID list). | |

| | | |
|---|---|---|
| | Title: | F-FEE full image SSD mode change default commanding |
| | Verif.: | T |
| | Release: | R2 |

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|---|---|
| FF-SIM-UR-2722 | For each F-FEE emulation entity in NFEE_CONFIG state, the SimuCam MEB shall allow the user to change the default set of parameters driving the F-FEE full image / SSD image mode (CCD ID list). |

| | |
|---|---|
| Title: | F-FEE full image SSD mode active parameters |
| Verif.: | T |
| Release: | R2 |
| FF-SIM-UR-2721 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the active set of parameters driving the F-FEE full image / SSD image mode (CCD ID list). |

| | |
|---|---|
| Title: | F-FEE full image SSD mode start-up parameters |
| Verif.: | T |
| Release: | R2 |
| FF-SIM-UR-2720 | For each F-FEE emulation entity, at start-up, the SimuCam MEB shall use the default set of parameters driving the F-FEE full image / SSD image mode (CCD ID list) as active set of parameters. |

| | |
|---|---|
| Title: | F-FEE full image SSD mode cycle |
| Verif.: | T |
| Release: | R2 |
| FF-SIM-UR-2719 | When the F-FEE full image / SSD image mode is activated in an F-FEE emulation entity, the SimuCam MEB shall transmit to the F-DPU the selected CCD full image according to the active full image ID list and according to the following cycle (t0 is the start of the cycle):<br>• t0 on SpW1: CCD_ID1, side E<br>• t0 on SpW2: CCD_ID1, side F<br>• t0+EP on SpW1: CCD_ID2, side E<br>• t0+EP on SpW2: CCD2_ID2, side F<br>• etc. |

| | |
|---|---|
| Title: | F-FEE full image SSD mode cycle wraparound |
| Verif.: | T |
| Release: | R2 |
| FF-SIM-UR-2718 | When an F-FEE emulation entity has reached the end of the ID list, it shall start again at the beginning of the ID list. |

### 3.8.4 Full image Interactive Mode Management

| | |
|---|---|
| Title: | F-FEE full image interactive mode simulation |
| Verif.: | T |
| Release: | R2 |
| FF-SIM-UR-2794 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entities shall simulate the behaviour of a real F-FEE running in IMAGE mode as defined in [AD01]. Additionally to the functionality of the FFEE_RUNNING_IMAGE mode the full images sent to the F-DPU shall be patched with data received from Ethernet. |

*Note: The data received via Ethernet is from the Image Generator [RD09].*

| | |
|---|---|
| Title: | F-FEE full image interactive mode commanding |
| Verif.: | T |
| Release: | R2 |

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| | |
|---|---|
| FF-SIM-UR-2825 | Upon reception of a ad-hoc SpaceWire command from the F-DPU, if the F-FEE emulation entity is in the FFEE_RUNNING_STANDBY and the interactive state is preselected by Ethernet command or the F-FEE emulation entity is in the FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall enter the FFEE_RUNNING_IMAGE_INTERACTIVE state. |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode transition at sync signal |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2824 | The effective transition to the FFEE_RUNNING_IMAGE_INTERACTIVE state shall be performed depending on the synchronization signal and by fulfilling the timing specified in [AD01] [AD02] and [AD05]. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode timing |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2823 | In FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall transmit the data to the F-DPU with timing identical to the real F-FEE one. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode transmission start |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2822 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall start the transmission of a new CCD image to the F-DPU at each release of the EP synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode maximum transmission time |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2821 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall have completed the transmission of the entire CCD image RT seconds after the release of the EP synchronization signal. | |

*Note: RT corresponds to the CCD readout time.*

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode cycle |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2820 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall transmit to the F-DPU, every EP seconds, a **full-image of a selected CCD** by fulfilling timing similar to those implemented in the real F-FEE and according to the following cycle:<br>• t0 on SpW1: Transmission of CCDx, side E<br>• t0 on SpW2: Transmission of CCDx, side F<br>• t0+EP on SpW1: Transmission of CCDx, side E<br>• t0+EP on SpW2: Transmission of CCDx, side F<br>• etc. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode data generation |
| | Verif.: | T |
| | Release: | R2 |

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| | |
|---|---|
| FF-SIM-UR-2819 | In the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall be able to manage the following mode of data generation:<br>• F-FEE full image interactive / Imagettes transfer mode |

### 3.8.5 Full image Interactive Mode

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode static data source |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2781 | When the F-FEE full image interactive / Imagettes transfer mode is activated, the F-FEE emulation entity shall use full images from the SSD as input data for the interactive patching operation. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode dynamic data source |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2801 | When the F-FEE full image interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall use data received through an Ethernet command to patch the full images to be sent to the F-DPU. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode error when no data is received |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2799 | When the F-FEE full image interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall send an error message if it did not receive a set of imagettes from Ethernet since the last synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode error when window list mismatch |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2892 | When the F-FEE full image interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall sent an error message if the windowlist commanded by the F-DPU does not match the imagette data received from the Ethernet interface. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2798 | Specific Parameters to be set for full image interactive / Imagettes transfer mode, TBD. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2797 | For each F-FEE emulation entity, the SimuCam MEB shall manage and store in its non-volatile memory a default set of parameters driving the F-FEE full image interactive / Imagettes transfer mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode change default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2796 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the default set of parameters driving the F-FEE full image interactive / Imagettes transfer mode. | |

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|---|---|---|
| | Title: | F-FEE full image interactive mode active parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2877 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the active set of parameters driving the F-FEE full image interactive / Imagettes transfer mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE full image interactive mode start-up parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2876 | For each F-FEE emulation entity, at start-up, the SimuCam MEB shall use the default set of parameters driving the F-FEE full image interactive / Imagettes transfer mode as active set of parameters. | |

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|---|---|---|
| | Title: | F-FEE full image interactive mode patching algorithm |
| | ~~Verif.:~~ | ~~T~~ |
| FF-SIM-UR-2875 | Deleted | |

## 3.9 Windowing Mode Simulation

### 3.9.1 Windowing Mode Management

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|---|---|---|
| | Title: | F-FEE window mode simulation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2597 | In the FFEE_RUNNING_WINDOW state, an F-FEE emulation entity shall simulate the behaviour of a real F-FEE running in WINDOW mode as defined in [AD01] [AD02] and [AD05]. | |

| | | |
|---|---|---|
| | Title: | F-FEE window mode commanding |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2748 | Upon reception of the ad-hoc SpaceWire command from the F-DPU and if the F-FEE emulation entity is in the FFEE_RUNNING_STANDBY state and the interactive state is not preselected by Ethernet command, or the entity is in the FFEE_RUNNING_IMAGE state, the F-FEE emulation entity shall enter the FFEE_RUNNING_WINDOW state. | |

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|---|---|---|
| | Title: | F-FEE window mode transition at sync signal |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2747 | The effective transition to the FFEE_RUNNING_WINDOW state shall be performed depending on the synchronization signal and by fulfilling the timing specified in [AD01] [AD02] and [AD05]. | |

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|---|---|---|
| | Title: | F-FEE window mode cycle |
| | Verif.: | T |
| | Release: | R2 |

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|---|---|
| FF-SIM-UR-2746 | In the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall transmit to the F-DPU every EP seconds:<br>• a HK packet<br>• a set of window segments corresponding to the window position list<br>• OLN overscan lines<br>• The Y-position in the CCD image of the first overscan line to be transmitted is given by the parameter OLY<br>• The Y-position in the CCD image of the last overscan line to be transmitted is given by the parameter OLY+OLN-1 |

| | | |
|---|---|---|
| | Title: | F-FEE window mode parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2745 | The SimuCam MEB shall allow the user to change, for each F-FEE emulation entity, by the way of an Ethernet command, the value of:<br>• OLN parameter: number of overscan line<br>• OLN default value = TBD<br>• OLY parameter: Y-position of the first overscan line<br>• OLY default value = TBD | |

| | | |
|---|---|---|
| | Title: | F-FEE window mode transmission start |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2744 | In the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall start the transmission to the F-DPU of a new set of window segments and overscan lines at each release of the EP synchronization signal. | |

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|---|---|---|
| | Title: | F-FEE window mode maximum transmission time |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2743 | In the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall have completed the transmission of all the window segments and overscan lines RT seconds after the release of the EP synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE window mode maximum transmission volume |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2742 | In the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall be able to transmit over RT seconds a maximum amount of data corresponding to:<br>• 325 36-pixel star windows plus 100 16-pixel background windows (TBC)<br>• OLN overscan lines (which contains the smearing data and offset data (TBC)) | |

| | | |
|---|---|---|
| | Title: | F-FEE window extraction simulation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2741 | In FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall simulate the window extraction functionality implemented by the real F-FEE. | |

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| | Title: | F-FEE window transmission timing |

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| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2740 | In FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall transmit the data to the F-DPU with the same timing as the real F-FEE. | |

| | | |
|---|---|---|
| | Title: | F-FEE window mode data generation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2739 | In FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall be able to manage the following modes of data generation:<br>• F-FEE windowing / pattern mode<br>• F-FEE windowing / SSD image mode<br>• F-FEE windowing / SSD window mode | |

| | | |
|---|---|---|
| | Title: | F-FEE window mode default data generation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2738 | At start-up, by default, each F-FEE emulation entity shall use the F-FEE windowing / pattern mode. | |

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|---|---|---|
| | Title: | F-FEE window test mode |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2737 | The F-FEE emulation entity shall manage the FFEE_RUNNING_WINDOW_TEST state in the same way than the FFEE_RUNNING_WINDOW state, with the exception that the pattern mode is always forced. | |

### 3.9.2 Window List Management

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|---|---|---|
| | Title: | Window list management |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2598 | In FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall use window position lists as defined in [AD02] to:<br>• extract the window segments from the full image injected as inputs,<br>• assembly them in SpaceWire packets sent to the F-DPU. | |

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|---|---|---|
| | Title: | One window list per CCD |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2753 | In the FFEE_RUNNING_WINDOW state, the F-FEE emulation entity shall be able to manage, for each CCD, one window position list allowing to define the following amount of windows:<br>• 325 36-pixel star windows (TBC)<br>• 100 16-pixel windows (TBC) | |

| | | |
|---|---|---|
| | Title: | Window list update timing |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2752 | In any of the FFEE_RUNNING states, the F-FEE emulation entity shall be able to change dynamically the content of its current window position lists by processing the ad-hoc SpaceWire / RMAP commands sent by the F-DPU during the idle time (i.e. | |

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| | time between two readout phases). |

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|---|---|---|
| | Title: | Default window list |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2751 | When entering the FFEE_CONFIG state, the F-FEE emulation entity shall set as current window position lists a set of default window position lists stored in its non-volatile memory. | |

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|---|---|---|
| | Title: | Default window list updating |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2750 | The SimuCam MEB shall allow the user to change the default window position lists of a given F-FEE emulation entity. | |

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| | Title: | Window list reporting |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2749 | The SimuCam MEB shall allow the user to request, via a specific Ethernet command, the window position lists managed by each F-FEE emulation entity. | |

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| | Title: | Forward window list |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-3846 | The SimuCam MEB shall forward the window list to the Image Generator via Ethernet. | |

### 3.9.3 Windowing / Pattern Mode

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|---|---|---|
| | Title: | F-FEE window pattern mode commanding |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2599 | The SimuCam MEB shall allow the user to configure, via an Ethernet command, an F-FEE emulation entity to work in the F-FEE windowing / pattern mode. | |

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|---|---|---|
| | Title: | F-FEE window pattern definition |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2754 | When the F-FEE windowing / pattern mode is activated, the F-FEE emulation entity shall build on the fly, using patterns as defined in [AD03], the full images which are used as input of the windowing operation. | |

### 3.9.4 Windowing / SSD Image Mode

| | | |
|---|---|---|
| | Title: | F-FEE window SSD image mode commanding |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2600 | The SimuCam MEB shall allow the user to configure, via an Ethernet command, an F-FEE emulation entity to work in the F-FEE windowing / SSD image mode. | |

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| | Title: | F-FEE window SSD image data source |
| | Verif.: | T |
| | Release: | R2 |

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| FF-SIM-UR-2755 | When the F-FEE windowing / SSD image mode is activated, the F-FEE emulation entity shall use, as input of the windowing operation, full images from the SSD according to the active full image ID list and according to the cycle described in NFEESIM-UR-522 of [RD01]. |

### 3.9.5 Windowing / SSD Window Mode

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|---|---|---|
| | Title: | F-FEE window SSD window mode commanding |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2601 | The SimuCam MEB shall allow the user to configure, via an Ethernet command, an F-FEE emulation entity to work in the F-FEE windowing / SSD window mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE window SSD window data source |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2764 | When the F-FEE Windowing / SSD window mode is activated, the F-FEE emulation entity shall use full images patched with windows from the SSD as data sent to the F-DPU. | |

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| | Title: | F-FEE window SSD window mode parameters |
| | Verif.: | T |
| | Release: | R2 |

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| FF-SIM-UR-2763 | For each F-FEE emulation entity, the SimuCam MEB shall allow to manage the following parameters driving the F-FEE windowing / SSD window mode:<br>• Number of exposures: EN where 1 < EN < 65536<br>• Maximal number of windows to be patched by CCD: PN_MAX = TBD<br>• ID of the CCD full image which will be patched: CCD1_ID, CCD2_ID, CCD3_ID, CCD4_ID<br>• Number of windows to be patched in CCD1: PN1 where 0 < PN1 < PN_MAX<br>• Number of windows to be patched in CCD2: PN2 where 0 < PN2 < PN_MAX<br>• Number of windows to be patched in CCD3: PN3 where 0 < PN3 < PN_MAX<br>• Number of windows to be patched in CCD4: PN4 where 0 < PN4 < PN_MAX<br>• List of the window stack ID and window positions for the CCD1:<br>• CCD1_WS_ID1, CCD1_WS_X1, CCD1_WS_Y1<br>• CCD1_WS_ID2, CCD1_WS_X2, CCD1_WS_Y2<br>• …<br>• CCD1_WS_IDPN1, CCD1_WS_XPN1, CCD1_WS_YPN1<br>• List of the window stack ID and window positions for the CCD2:<br>• CCD2_WS_ID1, CCD2_WS_X1, CCD2_WS_Y1<br>• CCD2_WS_ID2, CCD2_WS_X2, CCD2_WS_Y2<br>• …<br>• CCD2_WS_IDPN2, CCD2_WS_XPN2, CCD2_WS_YPN2<br>• List of the window stack ID and window positions for the CCD3:<br>• CCD3_WS_ID1, CCD3_WS_X1, CCD3_WS_Y1<br>• CCD3_WS_ID2, CCD3_WS_X2, CCD3_WS_Y2<br>• …<br>• CCD3_WS_IDPN3, CCD3_WS_XPN3, CCD3_WS_YPN3<br>• List of the window stack ID and window positions for the CCD4:<br>• CCD4_WS_ID1, CCD4_WS_X1, CCD4_WS_Y1<br>• CCD4_WS_ID2, CCD4_WS_X2, CCD4_WS_Y2<br>• …<br>• CCD4_WS_IDPN4, CCD4_WS_XPN4, CCD4_WS_YPN4 |

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|---|---|---|
| | Title: | F-FEE window SSD window mode default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2762 | For each F-FEE emulation entity, the SimuCam MEB shall manage and store in its non-volatile memory a default set of parameters driving the F-FEE windowing / SSD window mode (window stack lists). | |

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|---|---|---|
| | Title: | F-FEE window SSD window mode change default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2761 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the default set of parameters driving the F-FEE windowing / SSD window mode (window stack lists). | |

| | | |
|---|---|---|
| | Title: | F-FEE window SSD window mode active parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2760 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the active set of parameters driving the F-FEE windowing / SSD window mode (window stack lists). | |

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| | Title: | F-FEE window SSD window mode check parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2759 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall check each new programmed active set of parameters driving the F-FEE windowing / SSD window mode and reject it if:<br>• the number of entries of each window stack is not the same,<br>• EN is greater than the number of entries of each window stack | |

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| | Title: | F-FEE window SSD window mode start-up parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2758 | For each F-FEE emulation entity, at start-up, the SimuCam MEB shall use the default set of parameters driving the F-FEE windowing / SSD window mode (CCD ID list) as active set of parameters. | |

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|---|---|---|
| | Title: | F-FEE window SSD window mode cycle |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2757 | When the F-FEE windowing / SSD window mode is activated, the F-FEE emulation entity shall use, as input of the windowing process, full images built according to the following cycle and operations (t0 is the start of the cycle):<br>• t0 on SpW1: full image CCD1_ID patched with windows from the window stacks CCD1_WS_ID1_E1, CCD1_WS_ID2_E1, ..., CCD1_WS_IDPN1_E1 where E1 correspond to the entry #1 in each stack.<br>• t0 on SpW2: full image CCD2_ID patched with windows from the window stacks CCD2_WS_ID1_E1, CCD2_WS_ID2_E1, ..., CCD2_WS_IDPN2_E1 where E1 correspond to the entry #1 in each stack.<br>• t0 on SpW3: full image CCD3_ID patched with windows from the window stacks CCD3_WS_ID1_E1, CCD3_WS_ID2_E1, ..., CCD3_WS_IDPN3_E1 where E1 correspond to the entry #1 in each stack.<br>• t0 on SpW4: full image CCD4_ID patched with windows from the window stacks CCD4_WS_ID1_E1, CCD4_WS_ID2_E1, ..., CCD4_WS_IDPN4_E1 where E1 correspond to the entry #1 in each stack.<br>• t0+EP on SpW1: full image CCD1_ID patched with windows from the window stacks CCD1_WS_ID1_E2, CCD1_WS_ID2_E2, ..., CCD1_WS_IDPN1_E2 where E2 correspond to the entry #2 in each stack.<br>• t0+EP on SpW2: full image CCD2_ID patched with windows from the window stacks CCD2_WS_ID1_E2, CCD2_WS_ID2_E2, ..., CCD2_WS_IDPN2_E2 where E2 correspond to the entry #2 in each stack.<br>• t0+EP on SpW3: full image CCD3_ID patched with windows from the window stacks CCD3_WS_ID1_E2, CCD3_WS_ID2_E2, ..., CCD3_WS_IDPN2_E2 where E2 correspond to the entry #2 in each stack.<br>• t0+EP on SpW4: full image CCD4_ID patched with windows from the window stacks CCD4_WS_ID1_E2, CCD4_WS_ID2_E2, ..., | |

CCD4_WS_IDPN4_E2 where E2 correspond to the entry #2 in each stack.

- ...
- t0+(EN-1)EP on SpW1: full image CCD1_ID patched with windows from the window stacks CCD1_WS_ID1_EEN, CCD1_WS_ID2_EEN, ..., CCD1_WS_IDPN1_EEN where EEN correspond to the entry #EN in each stack.
- t0+(EN-1)EP on SpW2: full image CCD1_ID patched with windows from the window stacks CCD2_WS_ID1_EEN, CCD2_WS_ID2_EEN, ..., CCD2_WS_IDPN2_EEN where EEN correspond to the entry #EN in each stack.
- t0+(EN-1)EP on SpW3: full image CCD1_ID patched with windows from the window stacks CCD3_WS_ID1_EEN, CCD3_WS_ID2_EEN, ..., CCD3_WS_IDPN3_EEN where EEN correspond to the entry #EN in each stack.
- t0+(EN-1)EP on SpW4: full image CCD1_ID patched with windows from the window stacks CCD4_WS_ID1_EEN, CCD4_WS_ID2_EEN, ..., CCD4_WS_IDPN4_EEN where EEN correspond to the entry #EN in each stack.
- t0+(EN)EP on SpW1: full image CCD1_ID patched with windows from the window stacks CCD1_WS_ID1_E1, CCD1_WS_ID2_E1, ..., CCD1_WS_IDPN1_E1 where E1 correspond to the entry #1 in each stack.
- t0+(EN)EP on SpW2: full image CCD2_ID patched with windows from the window stacks CCD2_WS_ID1_E1, CCD2_WS_ID2_E1, ..., CCD2_WS_IDPN2_E1 where E1 correspond to the entry #1 in each stack.
- t0+(EN)EP on SpW3: full image CCD3_ID patched with windows from the window stacks CCD3_WS_ID1_E1, CCD3_WS_ID2_E1, ..., CCD3_WS_IDPN3_E1 where E1 correspond to the entry #1 in each stack.
- t0+(EN)EP on SpW4: full image CCD4_ID patched with windows from the window stacks CCD4_WS_ID1_E1, CCD4_WS_ID2_E1, ..., CCD4_WS_IDPN4_E1 where E1 correspond to the entry #1 in each stack.
- ...

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| | Title: | F-FEE window SSD window mode cycle wraparound |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2756 | When an F-FEE emulation entity has reached the end of the entry #EN, it shall start again at the entry #1. | |

### 3.9.6 Windowing Interactive Mode Management

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|---|---|---|
| | Title: | F-FEE window interactive mode simulation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2782 | In the FFEE_RUNNING_WINDOW_INTERACTIVE state, an F-FEE emulation entity shall simulate the behaviour of a real F-FEE running in WINDOW mode as defined in [AD01] [AD02] and [AD05]. The data sent to the F-DPU shall be received through the Ethernet interface in real-time. | |

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| | Title: | F-FEE window interactive mode commanding |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2835 | Upon reception of the ad-hoc SpaceWire command from the F-DPU, if the F-FEE | |

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| | emulation entity is in the FFEE_RUNNING_STANDBY and the interactive state is preselected by Ethernet command or the F-FEE emulation entity is in the FFEE_RUNNING_IMAGE_INTERACTIVE state, the F-FEE emulation entity shall enter the FFEE_RUNNING_WINDOW_INTERACTIVE state. |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode transition at sync signal |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2834 | The effective transition to the FFEE_RUNNING_WINDOW_INTERACTIVE state shall be performed depending on the synchronization signal and by fulfilling the timing specified in [AD01] [AD02] and [AD05]. | |

| | | |
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| | Title: | F-FEE window interactive mode timing |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2833 | In FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall transmit the data to the F-DPU with timing identical to the real F-FEE one. | |

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| | Title: | F-FEE window interactive mode transmission start |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2832 | In the FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall start the transmission to the F-DPU of a new set of window segments and overscan lines at each release of the EP synchronization signal. | |

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|---|---|---|
| | Title: | F-FEE window interactive mode maximum transmission time |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2831 | In the FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall have completed the transmission of all the window segments and overscan lines RT seconds after the release of the EP synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode cycle |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2830 | In the FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall transmit to the F-DPU every EP seconds:<br>• a HK packet<br>• a set of window segments corresponding to the window position list<br>• OLN overscan lines<br>• The Y-position in the CCD image of the first overscan line to be transmitted is given by the parameter OLY<br>• The Y-position in the CCD image of the last overscan line to be transmitted is given by the parameter OLY+OLN-1 | |

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|---|---|---|
| | Title: | F-FEE window interactive mode parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2829 | The SimuCam MEB shall allow the user to change, for each F-FEE emulation entity, by the way of an Ethernet command, the value of:<br>• OLN parameter: number of overscan line<br>• OLN default value = TBD | |

| | |
|---|---|
| | • OLY parameter: Y-position of the first overscan line<br>• OLY default value = TBD |

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|---|---|---|
| | Title: | F-FEE window interactive mode maximum transmission volume |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2828 | In the FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall be able to transmit over RT seconds a maximum amount of data corresponding to:<br>• 60 (TBC) 36-pixel star windows plus 10 (TBC) 16-pixel background windows<br>• OLN overscan lines (which contains the smearing data and offset data (TBC)) | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive extraction simulation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2827 | In FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall mimic the window extraction functionality implemented by the real F-FEE. | |

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|---|---|---|
| | Title: | F-FEE window interactive data generation |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2826 | In FFEE_RUNNING_WINDOW_INTERACTIVE state, the F-FEE emulation entity shall be able to manage the following mode of data generation:<br>• F-FEE windowing interactive / Imagettes transfer mode | |

### 3.9.7 Windowing Interactive Mode

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode dynamic data source |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2783 | When the F-FEE windowing interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall use sets of imagettes received from Ethernet as data to be sent to the F-DPU | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode error when no data is received |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2808 | When the F-FEE windowing interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall send an error message if it did not receive a set of imagettes from the Ethernet since the last synchronization signal. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode error when window list mismatch |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2891 | When the F-FEE windowing interactive / Imagettes transfer mode is active, the F-FEE emulation entity shall sent an error message if the windowlist commanded by the F-DPU does not match the imagette data received from the Ethernet interface. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive  mode parameters |
| | Verif.: | T |
| | Release: | R2 |

| | |
|---|---|
| FF-SIM-UR-2806 | Specific Parameters to be set for Imagettes transfer through Ethernet, TBD. |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2805 | For each F-FEE emulation entity, the SimuCam MEB shall manage and store in its non-volatile memory a default set of parameters driving the F-FEE windowing interactive / Imagettes transfer mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode change default parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2804 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the default set of parameters driving the F-FEE windowing interactive / Imagettes transfer mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode active parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2803 | For each F-FEE emulation entity in FFEE_CONFIG state, the SimuCam MEB shall allow the user to change the active set of parameters driving the F-FEE windowing interactive / Imagettes transfer mode. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode start-up parameters |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2884 | For each F-FEE emulation entity, at start-up, the SimuCam MEB shall use the default set of parameters driving the F-FEE windowing interactive / Imagettes transfer mode as active set of parameters. | |

| | | |
|---|---|---|
| | Title: | F-FEE window interactive mode patching algorithm |
| | ~~Verif.:~~ | ~~T~~ |
| FF-SIM-UR-2883 | Deleted | |

## 3.10 Transparent Mode Requirements

### 3.10.1 Transparent Mode Management

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode |
| | Verif.: | R |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-2602 | In all FFEE_RUNNING states, the F-FEE emulator shall implement a TRANSPARENT mode in which it receives packets via EDEN and directly transmits them via one of the four available SpaceWire channels to the F-DPU. | |

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode enable |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3406 | It shall be possible to enable the TRANSPARENT mode via telecommand. | |

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode disable |

| | | |
|---|---|---|
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3407 | It shall be possible to disable the TRANSPARENT mode via telecommand. | |

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode disable - SpaceWire links |
| | Verif.: | T |
| | Release: | ~~R2~~R3 |
| FF-SIM-UR-3413 | When the TRANSPARENT mode is disabled, the SimuCam MEB shall be able to use all 8 SpaceWire links for F-FEE entities emulation. | |

Merged Cells
Split Cells

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode enable - SpaceWire links |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3414 | When the TRANSPARENT mode is enabled, the SimuCam MEB shall be able to use only 4 SpaceWire links for one F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode SpaceWire channel |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3408 | The SpaceWire channel chosen for the transfer of packets to and from the F-DPU shall not coincide with one that is used for full image/ window mode simulation. | |

### 3.10.2 Transparent Mode

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode operations |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3409 | When the TRANSPARENT mode is enabled, the SimuCam MEB shall allow the simultaneous operation of the t transferring packets to and from the F-DPU *and* the FFEE states simulating the standby and full image/ window modes of one real F-FEE. | |

*Note: The use cases are described in the sections above. This mode is desired for F-DPU software development and verification activities.*

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode - Ethernet interface |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3410 | When the TRANSPARENT mode is enabled, the SimuCam MEB shall receive packets via the EDEN protocol, shall strip the EDEN-specific header and directly forward the PUS packet via the chosen SpaceWire link to the F-DPU. | |

*Note: EDEN is an encapsulation protocol, the packets are PUS packets with an additional header.*

| | | |
|---|---|---|
| | Title: | F-FEE transparent mode - SpaceWire interface |
| | Verif.: | T |
| | Release: | ~~R1~~R3 |
| FF-SIM-UR-3412 | When the TRANSPARENT mode is enabled, the SimuCam MEB shall receive PUS telemetry from the F-DPU via the same chosen SpaceWire channel and transmit them via EDEN to the external EGSE. | |

## 3.11 Housekeeping Requirements

| | | |
|---|---|---|
| | Title: | F-FEE periodic housekeeping data |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2603 | In any of the FFEE_RUNNING states, the F-FEE emulation entity shall transmit to the F-DPU every EP seconds a SpaceWire packet containing a simulated F-FEE HK block (the expected behaviour is defined in [AD02]). | |

| | | |
|---|---|---|
| | Title: | F-FEE request housekeeping data |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2734 | In any of the FFEE_RUNNING states, the F-FEE emulation entity shall be able to transmit to the F-DPU, on reception of a RMAP request, a RMAP response containing a simulated F-FEE HK block. | |

| | | |
|---|---|---|
| | Title: | F-FEE housekeeping data specification |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2733 | The F-FEE emulation entity shall manage autonomously, depending on the simulation state, the values of the F-FEE HK parameters belonging to the following categories:<br>• F-FEE mode<br>• SpaceWire status<br>• CCD status<br>• full List is specified in [AD02]. | |

| | | |
|---|---|---|
| | Title: | F-FEE housekeeping data update |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2732 | The SimuCam MEB shall allow, for each F-FEE emulation entity, whatever its state, to set by an Ethernet command the values of the F-FEE HK parameters belonging to the following categories:<br>• F-FEE mode<br>• SpaceWire status<br>• CCD status<br>• full List is specified in [AD02]. | |

| | | |
|---|---|---|
| | Title: | F-FEE default housekeeping data |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2731 | At start-up, the SimuCam MEB shall configure the values of the F-FEE HK parameters with default values stored in its non-volatile memory. | |

| | | |
|---|---|---|
| | Title: | F-FEE change default housekeeping data |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2730 | The SimuCam MEB shall allow the user to change the values of the default F-FEE HK parameters stored in its non-volatile memory. | |

## 3.12 Error Injection Requirements

### 3.12.1 Error Injection Management

| | | |
|---|---|---|
| | Title: | Error injection management |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2604 | The Requirements NFEESIM-UR-419 and NFEESIM-UR-723 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | Error injection per SpaceWire link |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2729 | The SimuCam MEB shall allow the user to generate errors independently on each F-FEE simulation link. | |

### 3.12.2 SpaceWire Errors

| | | |
|---|---|---|
| | Title: | SpaceWire errors |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2605 | The Requirement NFEESIM-UR-418 shall be applicable without any modification to the F-FEE emulator | |

### 3.12.3 RMAP Errors

| | | |
|---|---|---|
| | Title: | RMAP errors |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2606 | The Requirement NFEESIM-UR-420 shall be applicable without any modification to the F-FEE emulator | |

### 3.12.4 Time-Code Errors

| | | |
|---|---|---|
| | Title: | Time-code errors |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2607 | The Requirement NFEESIM-UR-481 shall be applicable without any modification to the F-FEE emulator | |

### 3.12.5 Full image Transmission Errors

| | | |
|---|---|---|
| | Title: | Full image transmission errors |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2608 | The Requirement NFEESIM-UR-421 shall be applicable without any modification to the F-FEE emulator | |

### 3.12.6 Window Transmission Errors

| | | |
|---|---|---|
| | Title: | Window transmission errors |
| | Verif.: | R |
| | Release: | R2 |

| | |
|---|---|
| FF-SIM-UR-2609 | The Requirement NFEESIM-UR-480 shall be applicable without any modification to the F-FEE emulator |

| | | |
|---|---|---|
| | Title: | Window list enable/disable |
| | Verif.: | T |
| | Release: | R2 |
| FF-SIM-UR-2736 | In MEB_RUNNING mode, the SimuCam MEB shall allow the user to enable / disable, via a specific Ethernet command, the current window position list of a given F-FEE emulation entity. | |

## 3.13 Status / Event / Log Reporting Requirements

### 3.13.1 Status Reporting

| | | |
|---|---|---|
| | Title: | Status reporting |
| | Verif.: | R |
| | Release: | R1 |
| FF-SIM-UR-2610 | The Requirements NFEESIM-UR-427, NFEESIM-UR-465, NFEESIM-UR-466 and NFEESIM-UR-546 shall be applicable without any modification to the F-FEE emulator | |

| | | |
|---|---|---|
| | Title: | Periodic status reporting |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2726 | The SimuCam MEB shall report periodically, as an Ethernet packet, its global status and the status of each F-FEE emulation entity. | |

| | | |
|---|---|---|
| | Title: | Status reporting data |
| | Verif.: | T |
| | Release: | R1 |
| FF-SIM-UR-2735 | The F-FEE emulation entity status shall contain at least the following information:<br>• active mode<br>• SpaceWire link state<br>• packet statistics: count of incoming packets, count of outgoing packets<br>• failure statistics<br>• last RMAP command<br>• time of the last RMAP command<br>• last error / warning ID or label<br>• time of the last error / warning | |

### 3.13.2 Event Reporting

| | | |
|---|---|---|
| | Title: | Event reporting |
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2611 | The Requirements NFEESIM-UR-467, NFEESIM-UR-468, NFEESIM-UR-469, NFEESIM-UR-470 and NFEESIM-UR-724 shall be applicable without any modification to the F-FEE emulator | |

### 3.13.3 Log Reporting

| | | |
|---|---|---|
| | Title: | Log reporting |

Merged Cells

| | | |
|---|---|---|
| | Verif.: | R |
| | Release: | R2 |
| FF-SIM-UR-2727 | The Requirements NFEESIM-UR-726 and NFEESIM-UR-727 shall be applicable without any modification to the F-FEE emulator | |

Split Cells

Merged Cells

## 3.14 Spacewire Requirements

### 3.14.1 General

#### 3.14.1.1 Bit / Byte Numbering Convention

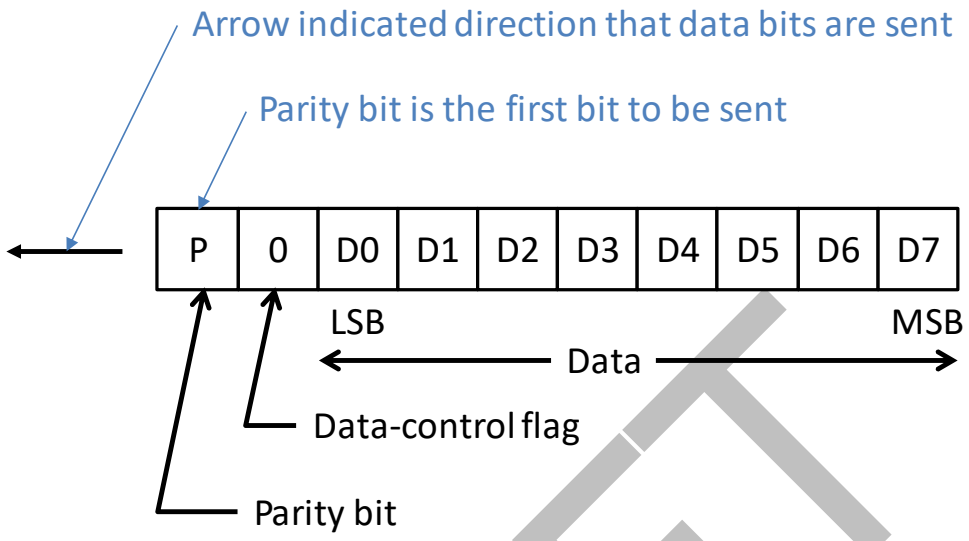
| | | |
|---|---|---|
| | Title: | **Bit And Byte Order** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3439 | For communication using Spacewire interfaces bit 0 in a byte shall be the least significant bit and bit 0 shall be transmitted first.<br><br>Note: For RMAP and CCSDS packet transfer, bytes shall be transmitted as per [AD11] and [AD12] protocol standards. | |

| | | |
|---|---|---|
| | Title: | **Bit and Byte Numbering** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3440 | For SpaceWire interfaces, the bit/byte numbering conventions as defined in requirement SpW-41-1 shall apply. | |

#### 3.14.1.2 Order of sending bits in symbols

| | | |
|---|---|---|
| | Title: | **Parity Bit Position** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3442 | The first bit of a data symbol or control symbol to be sent first shall be the parity bit. The data bits of a data symbol shall sent least significant bit first.<br>Note: An arrow is added to relevant diagrams to illustrate the direction that the data moves and which bit is sent first as shown in Figure 4.2-1. | |

Figure 4.2-1: Convention for first bit to be sent




3.14.1.3 Numeral Convention

In this document, numbers are written with a suffix as indicated in the following table:

| Numeral System | Indicatif | Examples |
|---|---|---|
| Binary | (b) | 1010(b) = 10(dec) |
| Decimal | (dec) | 10(dec) = A(hex) |
| Hexadecimal | (hex) | A(hex) = 1010(b) |

## 3.14.2 SpW Protocols

| | | |
|---|---|---|
| | Title: | **Applicable Spacewire Protocols** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3465 | For SimuCam [AD09], [AD10] and [AD11] shall be applicable. | |

## 3.14.3 SpW Physical Layer

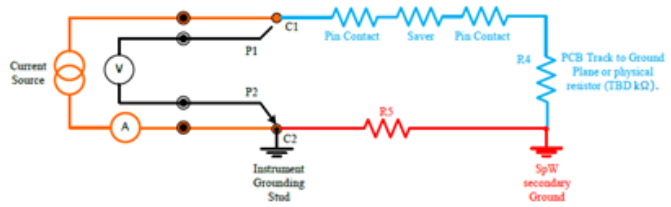
3.14.3.1 Printed Circuit Board (PCB) & Backplane Tracking

| | | |
|---|---|---|
| | Title: | **Chassis Grounding** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3472 | The DC resistance of the bonding value of the LVDS secondary ground to the chassis shall be less than 10 mOhm.<br><br>For the SpW secondary Ground Measurement, the method indicated below shall be used. | |

The below schematic illustrates a typical PIN3 implementation and bonding values breakdown when the bonding measurement is performed across the PIN3 and the chassis.

The relevant bonding value is R5 only, that gives the required correct bonding value, and drives the correct performances of the SpW signals.

R5 cannot be derived simply from a direct measurement from the Pin 3 to the chassis.




The equivalent bonding circuit is illustrated below with the identification of the measurement points (C1, C2, C3).
With a series of three measurements it is possible to derive the R5 (Secondary ground bonding resistance) independently of Rr and Rn that are not known and not necessarily identical.

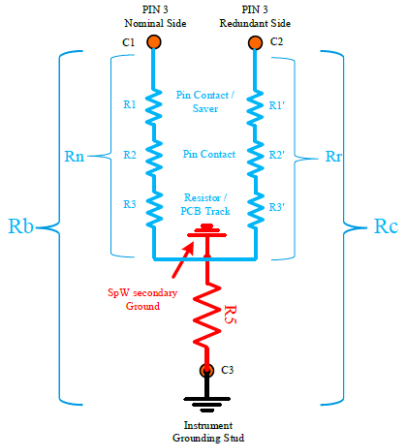



**Figure An-2**

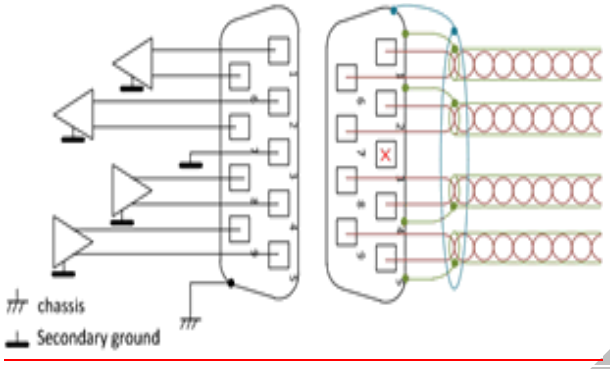
Measurements:
1) R between C1 and C2 = Ra = Rn + Rr
2) R Between C1 and C3 = Rb= Rn + R5
3) R Between C2 and C3 = Rc= Rr + R5

$$R5 = \frac{Rb + Rc - Ra}{2}$$

| | | |
|---|---|---|
| | Title: | **Connector Ground on PCB** |
| | Verif.: | R |
| | Release: | R3 |

| | |
|---|---|
| FF-SIM-UR-3476 | On the PCB, the pin 3 shall be directly connected to the secondary ground of the LVDS as indicated in figure 5.5-1. |

Figure 5.5-1




| | | |
|---|---|---|
| | Title: | **Harness Routing** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3479 | The Spacewire harness shall be routed as closed as possible to the conductive structure. In case of a several harness bundle configuration, the spacewire harness has to be located at the bottom of this configuration | |

### 3.14.3.2 LVDS PCB Tracks

| | | |
|---|---|---|
| | Title: | **PCB Tracks Impedance** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3481 | When using LVDS signals, the PCB tracks shall be differential tracks with a differential impedance of (100 ± 1) Ohm.<br><br>Note: the +/- 1 Ohm is related to the Ohmic impedance apportioned to the PCB tracks on the driver and receiver side | |

| | | |
|---|---|---|
| | Title: | **Length Difference of Track Pairs** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3482 | The difference in length between the two tracks forming a differential pair shall be less than 3 mm. | |

| | | |
|---|---|---|
| | Title: | **Length Difference of Data/Strobe** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3483 | The difference in length between the pair of tracks used for data and the pair of tracks used for strobe shall be less than 5 mm. | |

| | | |
|---|---|---|
| | Title: | **PCB Tracks Approval** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3484 | The use of vias for LVDS PCB tracks shall be agreed by prime and ESA prior to usage.<br>Note: The use of vias for LVDS PCB tracks should be minimised | |

The distance from an external termination resistor to the inputs of a line receiver should be kept as
short as possible and less than 20 mm

3.14.3.3 Flying lead connectors

| | | |
|---|---|---|
| | Title: | **Flying Lead Connectors** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3487 | Flying lead connectors shall be used for connection to a PCB. | |

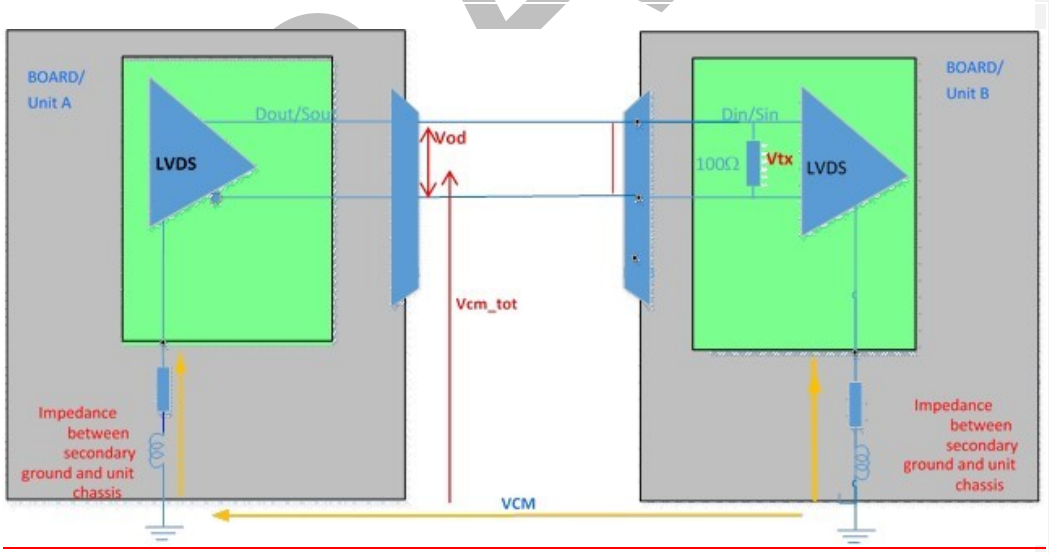
| | | |
|---|---|---|
| | Title: | **Cropping of Flying Lead Connectors** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3488 | Flying lead connectors used for connection to a PCB shall have all the leads cropped to the same short length (less than 25 mm) and the wires comprising the differential signal pairs shall be twisted together.<br>NOTE: This helps to minimize the discontinuity in impedance caused by the connector. | |

## 3.14.4 Signal Layer

3.14.4.1 SpW Signal Introduction

Space Wire Links are point-to-point data links and the SpW electrical signals are driven across the link using Low Voltage Differential Signaling [AD-5], as presented by Figure 6.1-1

Figure 6.1-1: SpW Link & LVDS Transceivers




| | | |
|---|---|---|
| | Title: | **Terminology for Electrical Parameters** |
| | Verif.: | T |
| | Release: | R3 |

FF-SIM-UR-3497 The following terminology shall be used to specify the electrical parameters:
• Vod: the driver differential output voltage (value expressed in peak)
• Vtx: the receiver differential input voltage (value expressed in peak)
• VCM, the CM voltage between the 2 grounds (AC value expressed in peak)
• Vcm_int_TX, the CM voltage inside the driver hardware (AC value expressed in peak)
• Vcm_int_RX, the CM voltage inside the receiver hardware (AC value expressed in peak)
• Vcm_tot , the magnitude of the driver offset voltage with respect to the secondary ground including the contribution of the Vos static, the Vos dynamic and the delta Vos static.

**Figure 6.1-2: LVDS line driver output differential signals Out+ and Out-**

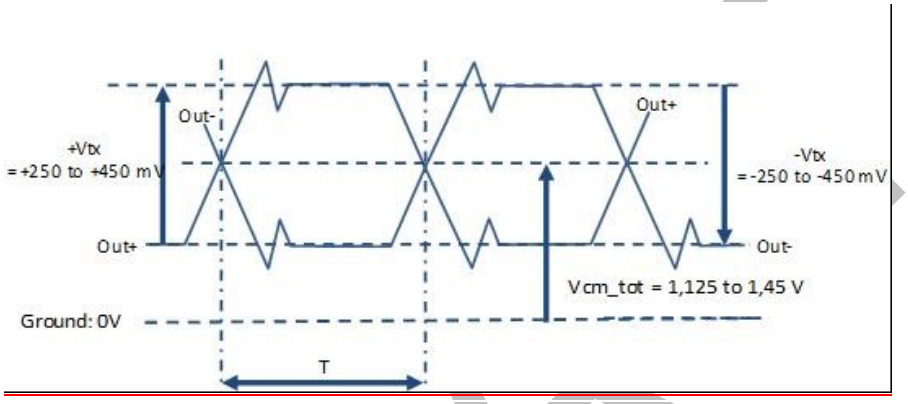
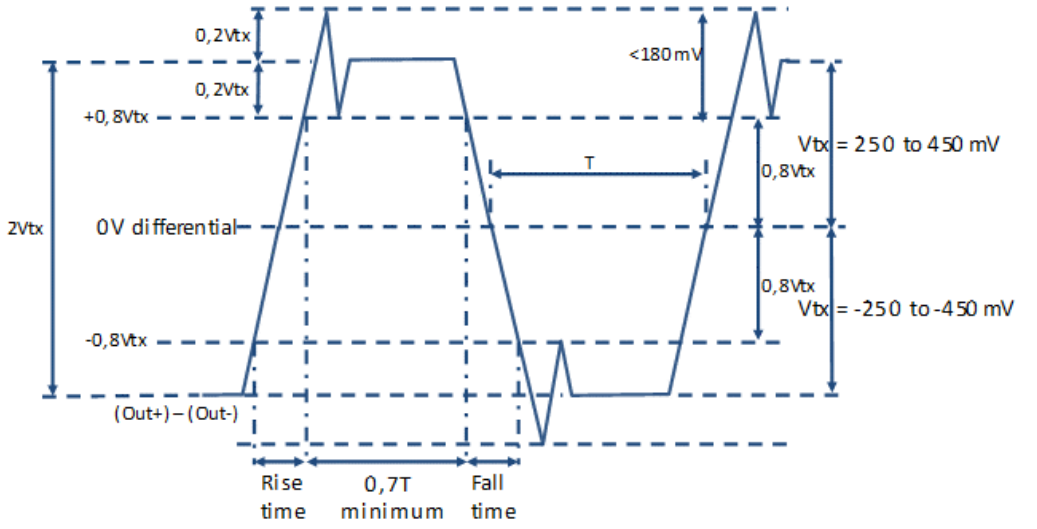



**Figure 6.1-3: Ringing on the output of the line driver Out+**

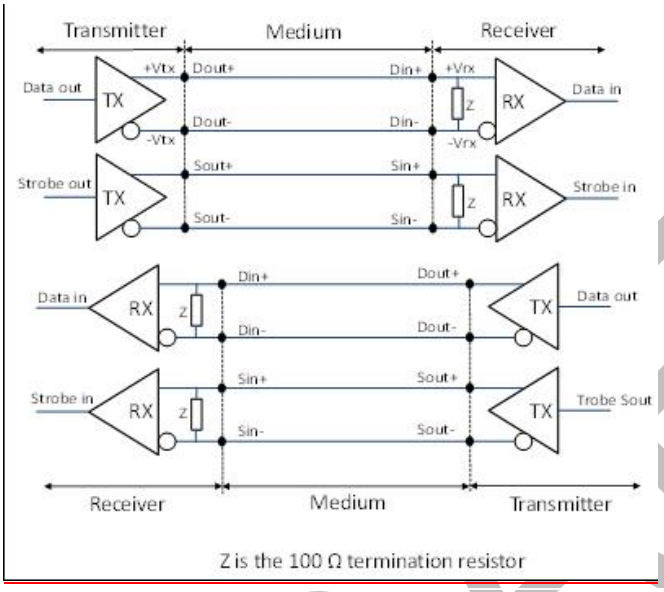



3.14.4.2 SpW Low Voltage Differential Signaling (LVDS)

| | | |
|---|---|---|
| | Title: | **LVDS for Spacewire Links** |
| | Verif.: | R |

| | |
|---|---|
| | Release: R3 |
| FF-SIM-UR-3503 | All the SpaceWire links shall use Low-Voltage Differential Signaling (LVDS) with electrical characteristics as specified in section 7.4.3 and 7.4.4 for driving SpaceWire data and strobe signals over SpaceWire cable assemblies (medium) as illustrated in Figure 6.2-1. |

Figure 6.2-1.: SpW point-to-point Link




### 3.14.4.3 SpW LVDS Driver

| | |
|---|---|
| Title: | **LVDS Driver Constrains** |
| Verif.: | T |
| Release: | R3 |

| | |
|---|---|
| FF-SIM-UR-3508 | When terminated, for measurement purposes, by a 100 Ohm termination resistor, the two outputs of the LVDS line driver (Out+ and Out-) shall have amplitude, Vtx, in the range (+247 to +454) mV, as illustrated in Figure 6.1-2, and a differential amplitude (Out+ minus Out-) of 2 Vtx, as illustrated in Figure 6.1-3:.<br>If a logic 1 is expected to be transmitted, +Vtx shall be greater than –Vtx.<br>1. If a logic 0 is expected to be transmitted, +Vtx shall be less than –Vtx.<br>2. The steady state difference in magnitude of the common mode voltage, Vcm, when transmitting a logic 1 compared to when transmitting a logic 0 shall be less than 50 mV.<br>3. The steady state difference in magnitude of +Vtx or –Vtx when transmitting logic 1 compared to when transmitting logic 0 shall be less than 50 mV.<br>4 The differential output of the line driver, Out+ - Out-, shall rise and fall monotonically with a rise time (Tr) and fall time (Tf) of at least 260 ps and less than 0.3 times the bit period (T), as illustrated in Figure 6.1-3.<br>5. The differential output of the line driver, Out+ - Out-, shall have a rise time in the range from 20 % to 80 % of the difference between the two steady state values.<br>6. The differential output of the line driver, Out+ - Out-, should rise and fall monotonically with a rise time (Tr) and fall time (Tf) of less than 3 ns.<br>NOTE : The 3 ns limit is an additional recommended constraint to [AD-6] so that for slow data rate the edge speed is sufficiently fast to ensure correct operation of the line receiver in a noisy environment.<br>7. Ringing on the differential output of the line driver, Out+ - Out-, shall be between -0.2 Vtx and 0.2 Vtx.<br>The maximum dynamic difference (or ringing) in magnitude between +Vtx or –Vtx shall be less than 150 mV |

### 3.14.4.4 SpW LVDS Receiver

| | | |
|---|---|---|
| | Title: | **LVDS Receiver Constrains** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3510 | 1. The receive signals shall be terminated by a (100 ±1) Ohm termination resistor.<br>2. A differential signal greater than +100 mV shall result in logic 1 at the line receiver output.<br>NOTE 1: A differential signal greater than +100 mV means that +Vrx is greater than –Vrx by more than 100 mV.<br><br>3. A differential signal less than -100 mV shall result in logic 0 at the line receiver output.<br>NOTE: A differential signal lower than -100 mV means that +Vrx is less than –Vrx by more than 100 mV.<br>4. The line receiver shall maintain correct operation for differential input voltages of up to 600 mV magnitude.<br>NOTE: This corresponds to the maximum permitted receiver differential signal in clause 4.2.4 of [AD38].<br><br>5. The line receiver shall tolerate a voltage on the receiver inputs in the range 0 V to +2,4 V relative to the line receiver ground and operate correctly.<br>6. The line receiver should operate correctly in case a voltage on the line receiver inputs exceeds the range 0 V to +2,4 V relative to the line receiver ground.<br>NOTE: This recommendation is to have a line receiver more tolerant to voltage difference in the grounds between the line driver and the line receiver | |

### 3.14.4.5 SpW LVDS Power Supply

| | | |
|---|---|---|
| | Title: | **3.3V LVDS Devices** |
| | Verif.: | R |

| | | |
|---|---|---|
| | Release: | R3 |
| FF-SIM-UR-3512 | LVDS Transmitter and receiver circuits shall use 3.3V power supply devices. | |

| | | |
|---|---|---|
| | Title: | **Overvoltage Protection** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3513 | All SpW LVDS external interface circuitry shall be overvoltage protected at 3.9 V.<br>Note: This will ensure 0.1V below the circuit's absolute maximum supply voltage rating. | |

| | | |
|---|---|---|
| | Title: | **Fault Voltage Emission** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3516 | Following a single failure of the LVDS power supply, the LVDS interface power supply shall not emit a voltage outside the range of 0 – 3.9V.<br><br>Note: This requirement takes precedence on SAVOIR.OBC.IF.SPW.10 | |

### 3.14.4.6 Potential difference between two ends of SpaceWire link

| | | |
|---|---|---|
| | Title: | **Common Potential Immunity** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3518 | SpW links shall be immune to common potential difference between receiver ground and driver ground up to +/- 1V. | |

| | | |
|---|---|---|
| | Title: | **Common Potential Test** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3519 | Requirement FF-SIM-UR-3518 shall be verified by the procedure specified in section 15. The test set-up shall make use of the "SpW Repeater" to perform the measurements.<br>Note: if the common mode voltage is greater than specified in FF-SIM-UR-3518, this can expose the LVDS line receiver inputs to voltage exceeding the maximum rating indicated by the manufacturer datasheet causing the devices replacement. | |

### 3.14.4.7 Signal Coding

| | | |
|---|---|---|
| | Title: | **Applicable Standard For Spacewire Signal Coding** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3537 | The signal coding requirements of [AD09] sections 6.3, 6.4 and 6.5 shall apply. | |

### 3.14.4.8 SpW Data Signaling rate

| | | |
|---|---|---|
| | Title: | **Applicable Standard For Spacewire Links** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3544 | The SpaceWire link requirements of [AD09] sections 6.6 shall apply | |

| | | |
|---|---|---|
| | Title: | **Link Initialisation** |
| | Verif.: | R |

| | | |
|---|---|---|
| | Release: | R3 |
| FF-SIM-UR-3545 | After a power on or a disconnect the SpaceWire link transmitter shall initially commence operating at a data signaling rate of [10 ± 1] Mbps | |

| | | |
|---|---|---|
| | Title: | **Minimum Signaling Rate** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3546 | The lower limit to data signaling rate shall be 2 Mbps.<br>Note: the standard requires it to be > 1.18 Mbps, i.e., 1/850ns that is the disconnect detection time-out. | |

| | | |
|---|---|---|
| | Title: | **Maximum Signaling Rate** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3547 | The upper limit to data signaling rate shall be 100 Mbps | |

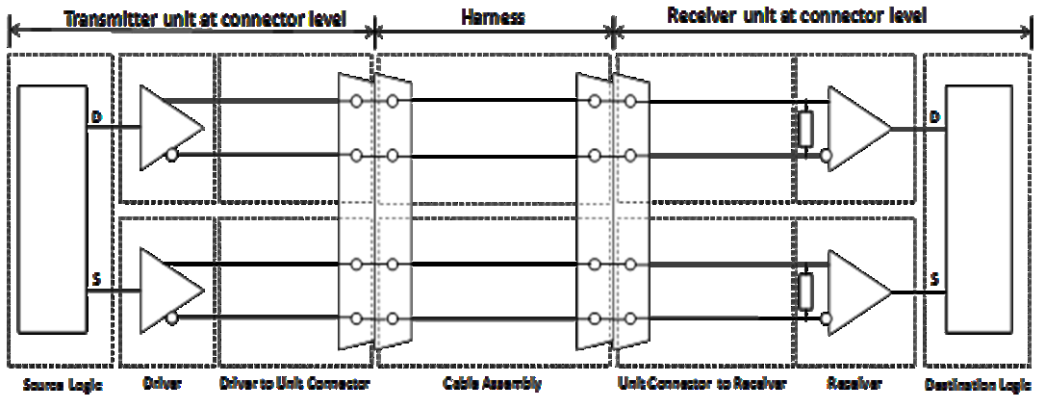
| | | |
|---|---|---|
| | Title: | **Link Specific Signaling Rate** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3548 | The SpaceWire transmission signaling rates for the PLATO units shall be as defined in the following table.<br>Note: The link in one direction can operate at a different data signaling rate to the same link in opposite direction. Links within a system can operate at different data signaling rates. | |

| From Unit A | To Unit B | Signaling Rate (Mbps +/- 5%) |
|---|---|---|
| F-DPU | SimuCam | 40 |
| SimuCam | F-DPU | 100 |

3.14.4.9 Data-Strobe timing budget

The components of the data-strobe timing across a SpaceWire link are separated into the following contributions: Transmitter (TX), Cable Assembly and Receiver (RX). This is illustrated by Figure 6.11-1.

Figure 6.11-1.



| | | |
|---|---|---|
| | Title: | **Jitter and Skew Budget** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3598 | The jitter and skew budget shall be according the table below. | |

| | **Data jitter (ns)** | **Strobe jitter (ns** | **Skew (ns)** | **Min edge separation (ns)** | **Total** |
|---|---|---|---|---|---|
| Encoder skew | | | 0.50 | | |
| Encoder jitter | 0.50 | 0.50 | | | |
| PCB skew | | | 0.05 | | |
| Driver skew | | | 1.00 | | |
| Driver jitter | 0.50 | 0.50 | | | |
| PCB/connector skew | | | 0.10 | | |
| **Total transmitter** | **1.00** | **1.00** | **1.65** | | **3.65** |
| Cable jitter | 0.50 | 0.50 | | | |
| Cable skew | | | 1.00 | | |
| **Total cable** | **0.50** | **0.50** | **1.00** | | **2.00** |
| PCB/connector skew | | | 0.10 | | |
| Receiver skew | | | 1.50 | | |
| Receiver jitter | 0.50 | 0.50 | | | |
| PCB skew | | | 0.05 | | |
| Decoder clock delay and hold | | | | 1.00 | |
| **Total receiver** | **0.50** | **0.50** | **1.65** | **1.00** | **3.65** |
| **Total system** | **2.00** | **2.00** | **4.30** | | **8.30** |
| Margin | | | | | 1.70 |

| | | |
|---|---|---|
| | Title: | **Transmitter Skew Budget** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3733 | In accordance with the definition of skew budget, jitter and margin as per note of requirement FF-SIM-UR-3598 the total (worst case) transmitter Data-Strobe skew including Data and Strobe jitter measured at the interface connector shall be < 3.65 ns | |

| | | |
|---|---|---|
| | Title: | **Receiver Skew Budget** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3734 | In accordance with the definition of skew budget, jitter and margin as per note of requirement FF-SIM-UR-3598 the total (worst case) receiver Data-Strobe skew including Data and Strobe jitter measured at the interface connector shall be < 3.65 ns. | |

### 3.14.5 Character Layer

Bits are transmitted as groups called 'characters'. They represent the smallest usable unit of information. Characters are used by the higher layers of the protocol to transmit data or to control the transmission of a continuous sequence of characters on the link. For detailed descriptions, see [AD09] section 4.4.
Note: Where verification by review is specified, character layer requirements may be considered as verified if it can be shown that the design correctly incorporates the ESA SpaceWire codec or an equivalent validated IP core

#### 3.14.5.1 Data Characters, Control Characters and Codes

| | | |
|---|---|---|
| | Title: | **Applicable Standard For Spacewire Data Character** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3742 | The data character, control character and control code requirements of [AD09] sections 7.2 and 7.3 shall apply. | |

| | | |
|---|---|---|
| | Title: | **Bit Endianess** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3743 | Each byte shall be transmitted "little endian" 'i.e. least significant bit LSB first, most significant bit MSB last.<br>Note: NULL is transmitted whenever a link is established and not sending data or control tokens, to keep the link active and to support link disconnect. | |

#### 3.14.5.2 Parity Coverage

| | | |
|---|---|---|
| | Title: | **Parity Bit Coverage** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3745 | The parity bit coverage requirements of [AD09] section 7.4 shall apply | |

#### 3.14.5.3 First Null Token after Power On or Link Error

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Transmit Bit Patterns** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3747 | The requirements in section 7.5 of [AD09] shall apply. | |

#### 3.14.5.4 Host Interface to transmitter and receiver

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Host Interface** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3749 | The requirements in section 7.6 of [AD09] shall apply. | |

#### 3.14.5.5 Time Interface

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Time Interface** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3751 | The requirements in sections 7.7 and 8.12 shall apply. | |

### 3.14.6 Exchange Layer

The exchange level is responsible for making a connection across a link and for managing the flow of data across the link.
Note: Where verification by review is specified, exchange layer requirements may be considered as verified if it can be shown that the design correctly incorporates the ESA SpaceWire codec or an equivalent validated IP core.

#### 3.14.6.1 Link Characters & Nominal Characters

| | | |
|---|---|---|
| | Title: | **Separation Of L-Chars And N-Chars** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3755 | The requirements related to the separation of SpaceWire L-Chars and N-Chars as specified in [AD09] section 8.2 shall apply, i.e.:<br>- L-Chars = used by exchange layer and not passed to the next layer, "Packet Layer":<br>- Flow Control Token (FCT)<br>- Escape (ESC)<br>- NULL = ESC + FCT<br>- Time Code = ESC + Data Character<br>- N-Chars = passed to the "Packet Layer":<br>- Data Characters<br>- Normal End Of Packet (EOP)<br>- Error End Of Packet (EEP) | |

| | | |
|---|---|---|
| | Title: | **Parity Check On Reception** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3756 | Received character shall have parity checked before acted upon | |

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Character Actions** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3757 | The requirements in sections 8.2.2 of [AD09] shall apply | |

#### 3.14.6.2 Flow Control

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Flow Control** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3759 | The requirements in section 8.3 of [AD09] shall apply | |

#### 3.14.6.3 Encode-decoder State Machine

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Encode/Decoder** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3763 | The requirements in section 8.4 of [AD09] shall apply for the SpW Encode-decoder state machine. | |

| | | |
|---|---|---|
| | Title: | **Power-On-Reset Of TX/RX buffer** |
| | Verif.: | R |

| | | |
|---|---|---|
| | Release: | R3 |
| FF-SIM-UR-3764 | Any power on reset of the SpW Encoder-Decoder shall be complemented by the flushing of the associated TX/RX buffer.<br><br>NOTE: It is strongly recommended to avoid software commanded reset as it causes a link disconnect and it is considered as a failure propagation to the vis-à-vis unit and it should be addressed at FDIR system level | |

### 3.14.6.4 Autostart/Link Initialisation

| | | |
|---|---|---|
| | Title: | **Link Initialization Sequence** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3766 | The initialization sequence indicated by Figure 8-5 of [AD09] shall apply when unit A SpW link is LinkStart configuration and unit B SpW link is in autostart configuration | |

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Link Initialization** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3767 | The requirements related to the SpaceWire link autostart and the SpW link initialisation as specified in [AD09] sections 8.6 and 8.7 shall apply. | |

| | | |
|---|---|---|
| | Title: | **Spacewire Codec Configurations** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3768 | The SpW Codec of the SimuCam shall be configured in Autostart mode.<br><br>Note: It is important to use the disabling capability of the SpW discrete LVDS for all the SpW I/fs configured in "LinkStart" in order to allow the SpW-time codes broadcast only upon reception of TC requesting it | |

### 3.14.6.5 Nomal Operation

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Normal Operation** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3789 | The normal operation described in [AD09] section 8.8 shall apply. | |

### 3.14.6.6 Error Detection

| | | |
|---|---|---|
| | Title: | **List of Errors to Detect** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3791 | On exchange level, a SpaceWire node shall detect the following errors and react in resetting and re-initialising to recover character synchronisation and flow control:<br>· Disconnect Error : No RX clock transition for more than 850 ns<br>· Parity Error : Parity bit error<br>· Escape Error :<br>- ESC character should only be used to form a NULL (ESC, FCT) or time-code (ESC, Data)<br>- ESC followed by any character other than FCT or data character is an error<br>· Credit Error : If there is no room in SpaceWire link interface RX buffer for data received then an error must have occurred which affected the FCTs<br>· Error End of Packet : Used to indicate that an error occurred in the current packet | |

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Error Detection** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3792 | The requirements related to the SpaceWire error detection as specified in [AD09] sections 8.9 shall apply. | |

| | | |
|---|---|---|
| | Title: | **Exchange Of Silence Procedure** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3793 | The "exchange of silence" procedure - upon error detection the initialisation state machine disables the transmitter and receiver therefore causing a disconnection and error recovery at the other end of the SpaceWire link - shall be implemented in accordance with [AD09] section 8.9.4 and its performance made visible to upper SpaceWire protocol layers | |

| | | |
|---|---|---|
| | Title: | **Upper Level Error Reporting** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3794 | The reporting of errors to the upper levels - packet and network layers - shall be done in accordance with [AD09] section 8.9.5 | |

| | | |
|---|---|---|
| | Title: | **Synchronization Relevant Errors** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3795 | Errors, that can affect the synchronization on packet level (i.e. transaction number) and network level (i.e SpW-Router specific device errors), shall be reported to the relevant level | |

### 3.14.6.7 Exeption Conditions

| | | |
|---|---|---|
| | Title: | **Exception Conditions** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3797 | The exception conditions related to the SpaceWire link exception conditions described in [AD09] section 8.10 shall apply | |

### 3.14.6.8 Link Timing

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Link Timing** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3799 | The requirements related to the SpaceWire link timing specified in [AD09] section 8.11 shall apply. | |

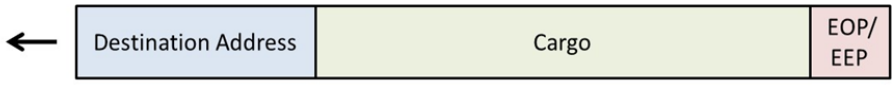
### 3.14.6.9 System Time Distribution

| | | |
|---|---|---|
| | Title: | **Applicable Standard On Time Distribution** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3801 | The requirements related to the SpaceWire system time distribution specified in [AD09] section 8.12 shall apply.<br><br>NOTE: see further requirements in section 7.5. | |

### 3.14.7 Packet Layer

Packets and their component fields are represented graphically as shown in figure 9.1-1. The arrow indicates the direction that the packet is travelling, so the destination field is sent first.

Figure 9.1-1: Graphical packet notation




3.14.7.1 SPaceWire Packet Composition

| | | |
|---|---|---|
| | Title: | **SpaceWire Packet Alignment** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3807 | The "cargo area" of a SpaceWire packet as defined in section 9.2.1 of [AD09] shall always consist of an even number of TBD-bit words delivered by the successive "data characters".<br><br>Note: This requirement is supporting the deserialization of the SpW packet to parallel bus and the related data alignment in the memory for read and/or write operations | |

### 3.14.8 Network Level

This section is addressing only the SpW packets dealing with the TCs commanding the units and the TMs collected from them. This section does not address the SpW packets used to configure internally or externally a unit (e.g. remote loading SW or SpW routers configuration).

The data flow definition considered in this chapter is as follows (see Figure 1-1):
· SVM Data Flow : This is the data flow between:
  o The ICU and the SVM (OBC and Mass Memory)
  o The FEU and the SVM (OBC)
· Data Flow 3: This is the data flow between the FEEs and the DPUs
· Data Flow 4: This is the data flow between the MEUs, N-AEUs, F-AEUs, and FEU

3.14.8.1 SpW Logical Addressing

| | | |
|---|---|---|
| | Title: | **End-of-Packet Marker** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3811 | As specified in [AD09] all SpaceWire packets shall be delimited by the End-of-Packet marker (EOP). | |

### 3.14.9 SpaceWire Standard Supporting Devices

3.14.9.1 SMSC & IEEE-1355 Standard

| | | |
|---|---|---|
| | Title: | **European SMCS332 Circuits** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3814 | Any SpaceWire implementation shall not use the existing European SMCS332 and circuits due to known anomalies. Furthermore, these circuits do not support transmission of SpaceWire Time Code. | |

3.14.9.2 SMSC & SpaceWire Standard

| | | |
|---|---|---|
| | Title: | **SpW-SMCS332 Circuits for Multichannel Communications** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3816 | If a SpW node requires multichannel communications, the SpW-SMCS332 shall be the used device | |

3.14.9.3 SpaceWire Devices

| | | |
|---|---|---|
| | Title: | **External LVDS Transceivers** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3818 | Any use of SpaceWire ASIC or FPGA housing the SpW CoDec shall be accompanied by the usage of external LVDS transceivers when addressing external SpW unit interfaces | |

## 3.14.10 PLATO Payload SpaceWire Network Initialisation

| | | |
|---|---|---|
| | Title: | **Interface Initialisation by SimuCam** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3821 | The PLATO SimuCam shall perform all the HW and SW initialisation tasks prior to any attempt to activate any SpW data links connected to the SVM.<br>NOTE: The PLATO SimuCam shall send to the SVM only complete initialization report | |

## 3.14.11 PLATO Payload SpaceWire Network FDIR

3.14.11.1 Data link layer management parameters

| | | |
|---|---|---|
| | Title: | **SpW Data Link Layer Management** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3826 | The SpW data link layer shall be controlled using the following management parameters:<br>1. Enable (port), which when asserted allows the specified SpaceWire port to operate.<br>NOTE The Enable condition is the inverse of the Disable condition.<br>2. LinkStart (port), which when asserted causes the specified SpaceWire port to attempt to start the SpaceWire link by sending Nulls, provided that port is enabled.<br>3. AutoStart (port), which when asserted causes the specified SpaceWire port to start the SpaceWire link as soon as a Null is received, provided that port is enabled.<br>NOTE This is the minimum set of management parameters to allow operation of the SpaceWire link. | |

| | | |
|---|---|---|
| | Title: | **Link Layer Status Information** |
| | Verif.: | R |
| | Release: | R3 |

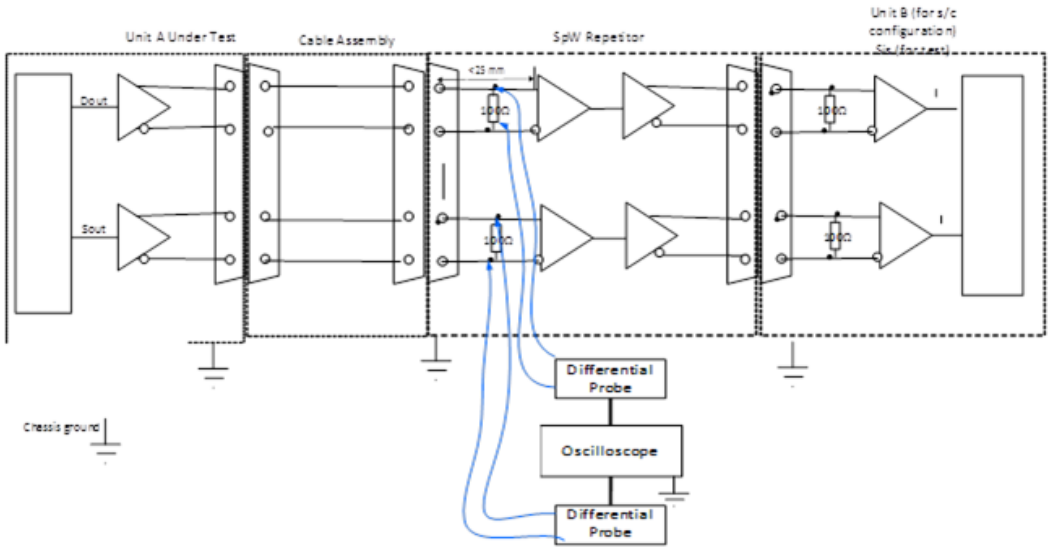
| | |
|---|---|
| FF-SIM-UR-3827 | All the SpW data link layer shall provide the following status information when enabled:<br>1. Link state (port), which is the current state of the data link layer state machine for the specified port;<br>2. Error flags (port), which is the current state of the following error flags:<br>a.Disconnect;<br>b. Parity Error;<br>c. ESC Error;<br>d. Credit Error;<br>e. EOP/EEP;<br>f. Invalid address<br>3. The transaction number for all the TC SpW packets |

| | | |
|---|---|---|
| | Title: | **Individual Link Disabling** |
| | Verif.: | R |
| | Release: | R3 |
| FF-SIM-UR-3828 | It shall be possible, individually, to disable the SpW data link layer status parameter reporting w.r.t all the parameters listed in SpW-142-2 | |

### 3.14.12 SpaceWire Electrical Tests

| | | |
|---|---|---|
| | Title: | **SpW Repetitor Use For Tests** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3830 | The test set up for the SpW electrical tests shall be based on a SpW repetitor as shown in Figure 15-1.<br>Note: The SpW Repetitor ground shall be connected to the chassis ground of UnitA and Unit B | |

**Figure 15-1: Test set-up for Driver Differential Output Measurement**



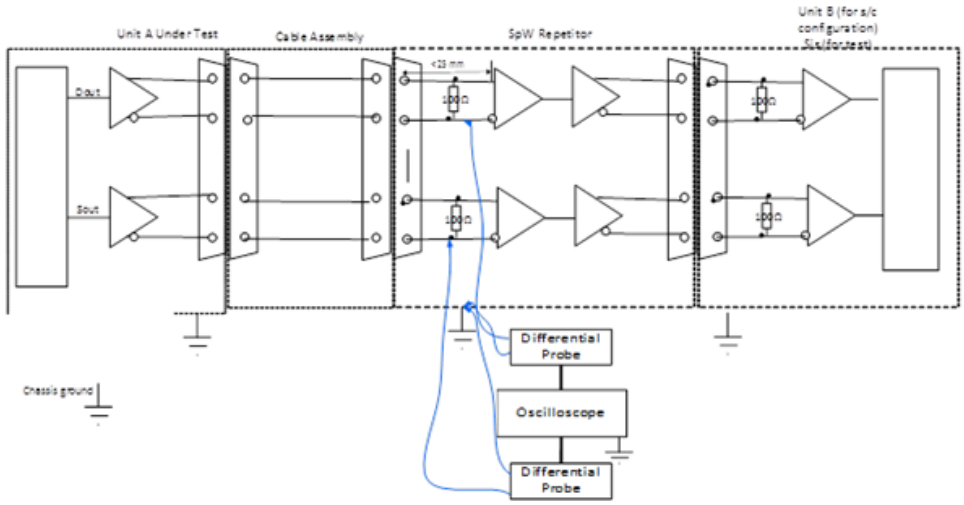

| | | |
|---|---|---|
| | Title: | **Received Signal Measurement** |
| | Verif.: | T |
| | Release: | R3 |

| | |
|---|---|
| FF-SIM-UR-3833 | The received signal shall be measured across the line receiver termination resistor of the "SpW Repetitor" using an oscilloscope and differential probes which have bandwidths of at least 1.05 times the inverse of the signal rise time, i.e. Bandwidth = 1.05/(signal rise time);<br><br>NOTE: The factor of 1.05 is a rule of thumb requiring the bandwidth of the oscilloscope and probe to include the third harmonic of the signal edge bandwidth. The signal edge bandwidth is given by 0.35/rise-time (the bandwidth of a signal is 0.35/rise-time). The fastest signal rise time for LVDS is specified in [AD09] to be 260 ps, resulting in a minimum oscilloscope and probe bandwidth of 4 GHz. Allowing some margin gives a recommended oscilloscope and probe bandwidth of 5 GHz which is the figure recommended in [AD09] |

| | | |
|---|---|---|
| | Title: | **Output Voltage Measurement** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3834 | The driver differential output voltage (value expressed in peak) "Vod" shall be measured with a differential probe for the Data and the Strobe as indicated in Figure 15-1. | |

| | | |
|---|---|---|
| | Title: | **Common Mode Voltage Measurement** |
| | Verif.: | T |
| | Release: | R3 |
| FF-SIM-UR-3835 | The Common Mode "VCM" voltage, in the range of 1.125 V to 1.45 V, shall be measured with a differential probe for the Data and the Strobe as indicated in Figure 15-2.<br>Note: The (-) of the differential probe shall be connected to the ground | |

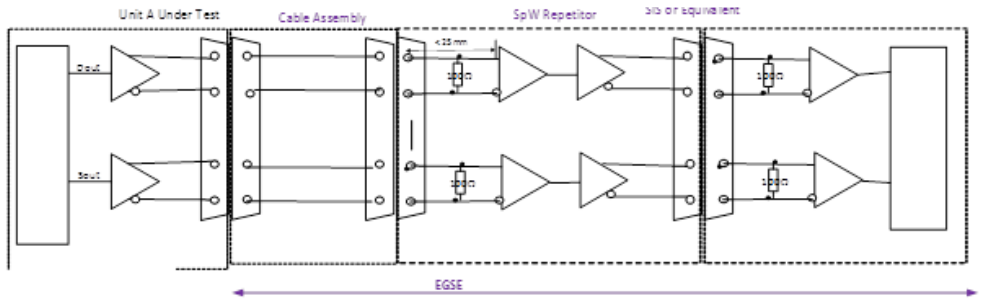
**Figure 15-2: Test set-up for Common Mode Measurement**



### 3.14.13 SpaceWire EGSE

| | | |
|---|---|---|
| | Title: | **SpW Repetitor Use in EGSE** |
| | Verif.: | I |
| | Release: | R3 |
| FF-SIM-UR-3839 | Any EGSE shall include a "SpW Repetitor" as indicated by Figure 16-1. | |

**Figure 16-1: EGSE Composition**



# 4 Deliveries and Schedule

Four main releases are foreseen for the F-FEE emulator. The table below gives for each F-FEE emulator
release, the related F-DPU ASW version, the delivery date and some comments about the purpose of the release:

| SimuCam Release | Delivery Date | Features | FEE-EMU Release | Use cases |
|---|---|---|---|---|
| R1 | September 2019 | - Full image mode (pattern)<br>- Transparent mode | R1 | - F-DPU ASW development v0.4<br>- DPS SW v0.4 tests |
| Delta-R1 | December 2019 | - any missing functionality from R1 delivery | Delta-R1 | - F-DPU ASW development v0.4<br>- DPS SW v0.4 tests |
| R2 | Mar 2020 | - Full image mode (SSD images)<br>- Full image interactive mode<br>- Windowing mode (SSD images)<br>- Windowing interactive mode<br>- Error injection | R2 | - F-DPU FGS development<br>- FGS open loop test setup<br>- DPS SW v0.8 tests incl. FGS algorithm |
| R3 | June 2020 | - All modes<br>- Representative timing<br>- Representative HK | R3 | - DPS SW v1.0 tests |
| R4 | Mar 2021 | - Bug-fixing and maintenance | R4 | - DPS SW v1.2 tests |

# 5 Requirement Allocation

| ID | ~~Requirement~~ Title | Allocation |
|---|---|---|
| FF-SIM-UR-2528 | SimuCam building blocks | R1 |
| FF-SIM-UR-501 | SimuCam SSW requirements | R1 |
| FF-SIM-UR-2537 | SimuCam MEB communication interface | R1 |
| FF-SIM-UR-2625 | Usage of PUS TC | R1 |
| FF-SIM-UR-2632 | Usage of PUS TM | R1 |
| FF-SIM-UR-3398 | EDEN protocol | ~~R1~~R2 |
| FF-SIM-UR-2631 | Service 1 -Request verification | R1 |
| FF-SIM-UR-2630 | Service 1 - Subservices | R1 |
| FF-SIM-UR-2628 | Service 3 - Housekeeping | ~~R1~~R2 |
| FF-SIM-UR-2627 | Service 3 - Subservices | ~~R1~~R2 |
| FF-SIM-UR-2638 | Service 5 - Event reporting | R2 |
| FF-SIM-UR-2626 | Service 5 - Subservices | R2 |
| FF-SIM-UR-2637 | Service 9 - Time management | R2 |
| FF-SIM-UR-2671 | Service 9 - Subservices | R2 |
| FF-SIM-UR-2670 | Service 17 - Test | R1 |
| FF-SIM-UR-2669 | Service 17 - Subservices | R1 |
| FF-SIM-UR-2664 | Service 250 - Mode management | R1 |
| FF-SIM-UR-2678 | Service 250 - Subservices | R1 |
| FF-SIM-UR-2675 | Service 251 - Configuration | R1 |
| FF-SIM-UR-2674 | Service 251 - Subservices | R1 |
| FF-SIM-UR-2894 | Service 252 - Failure injection and Link Management | R3 |
| FF-SIM-UR-2895 | Service 252 - Subservices | R3 |
| FF-SIM-UR-2888 | Service 253 - SSD management | R2 |
| FF-SIM-UR-2887 | Service 253 - Subservices | R2 |
| FF-SIM-UR-2673 | Service 254 - Real-time data | R3 |
| FF-SIM-UR-2672 | Service 254- Subservices | R3 |
| FF-SIM-UR-2538 | SimuCam MEB modes | R1 |
| FF-SIM-UR-2683 | MEB config mode | R1 |
| FF-SIM-UR-2682 | Meb config mode - Allowed FEE modes | R1 |
| FF-SIM-UR-2681 | Meb running mode - Allowed FEE modes | R1 |
| FF-SIM-UR-2539 | Number of F-FEE emulation entities | R1 |
| FF-SIM-UR-2842 | Number of SpaceWire links per entity | R1 |
| FF-SIM-UR-2841 | Number of CCDs per entity | R1 |
| FF-SIM-UR-2840 | F-FEE entity mode commandability | R1 |
| FF-SIM-UR-2863 | F-FEE entity modes | R1 |
| FF-SIM-UR-2839 | F-FEE entity configuration | R1 |
| FF-SIM-UR-2838 | F-FEE entity config mode | R1 |
| FF-SIM-UR-2837 | F-FEE running modes | R1 |
| FF-SIM-UR-2540 | SimuCam MEB reset and start-up | R1 |
| FF-SIM-UR-2541 | Non-volatile memory | R1 |
| FF-SIM-UR-2688 | Time management | R1 |

| | | |
|---|---|---|
| FF-SIM-UR-2689 | Endianness | R1 |
| FF-SIM-UR-2544 | SimuCam MEB tests and qualification | R1 |
| FF-SIM-UR-2693 | F-FEE emulator test coverage | R1 |
| FF-SIM-UR-2560 | F-FEE / F-DPU SpaceWire physical interface | R1 |
| FF-SIM-UR-2561 | F-FEE / F-DPU communication protocol | R1 |
| FF-SIM-UR-2562 | SpaceWire interface parameters | R1 |
| FF-SIM-UR-2649 | Number of SpaceWire interface parameter sets | R1 |
| FF-SIM-UR-2648 | SpaceWire interface parameter set storage | R1 |
| FF-SIM-UR-2647 | SpaceWire interface parameter changeability | R1 |
| FF-SIM-UR-2646 | Default SpaceWire interface parameter set | R1 |
| FF-SIM-UR-2645 | Active SpaceWire interface parameter set | R1 |
| FF-SIM-UR-2644 | SpaceWire Link enable/disable command | R1 |
| FF-SIM-UR-2563 | RMAP protocol management | R1 |
| FF-SIM-UR-2865 | RMAP reply in case of no error | R1 |
| FF-SIM-UR-2864 | RMAP reply in case of error | R1 |
| FF-SIM-UR-2656 | RMAP configuration areas | R1 |
| FF-SIM-UR-2564 | One RMAP configuration area per SpaceWire link | R1 |
| FF-SIM-UR-2658 | RMAP configuration area readability | R1 |
| FF-SIM-UR-2657 | RMAP configuration area writeability | R1 |
| FF-SIM-UR-2566 | SpaceWire echoing mode | R1 |
| FF-SIM-UR-2651 | SpaceWire echoing mode disabled at start-up | R1 |
| FF-SIM-UR-2650 | SpaceWire forwarding to Ethernet | R1 |
| FF-SIM-UR-2653 | SpaceWire logging mode | R1 |
| FF-SIM-UR-2565 | SpaceWire logging mode enable/disable | R1 |
| FF-SIM-UR-2655 | SpaceWire logging mode enabled at start-up | R1 |
| FF-SIM-UR-2654 | SpaceWire logging to disk | R1 |
| FF-SIM-UR-2567 | Exposure and CCD readout timing | R1 |
| FF-SIM-UR-2659 | F-FEE timing configuration | R1 |
| FF-SIM-UR-2893 | Maximum real-time data latency | R1 |
| FF-SIM-UR-2660 | Synchronization signal period | R1 |
| FF-SIM-UR-2568 | Synchronization signal | R1 |
| FF-SIM-UR-2694 | External synchronization signal output | R1 |
| FF-SIM-UR-2870 | External synchronization signal input | R1 |
| FF-SIM-UR-2869 | Synchronization signal propagation | R1 |
| FF-SIM-UR-2868 | External synchronization signal generation | R1 |
| FF-SIM-UR-2867 | Synchronization signal in and output | R1 |
| FF-SIM-UR-3424 | Synchronisation signal PUS command - F-FEE emulator master | R2 |
| FF-SIM-UR-3425 | Synchronisation signal PUS command - F-FEE emulator slave | R2 |
| FF-SIM-UR-2695 | Time-code management | R1 |
| FF-SIM-UR-2871 | Time-code management DELETED | R1 |
| FF-SIM-UR-2872 | Time-code SpaceWire link selection | R1 |
| FF-SIM-UR-2662 | Readout order DELETED | R1 |
| FF-SIM-UR-2571 | Synchronization reset | R1 |
| FF-SIM-UR-2699 | Auto-reset mode | R1 |
| FF-SIM-UR-2698 | Auto-reset mode enable/disable | R1 |

| | | |
|---|---|---|
| FF-SIM-UR-2697 | Synchronization reset effect | R1 |
| FF-SIM-UR-2700 | SSD storage unit | R2 |
| FF-SIM-UR-2701 | SSD full image storage management | R2 |
| FF-SIM-UR-2702 | SSD window stack storage management | R2 |
| FF-SIM-UR-2575 | F-FEE standby mode simulation | R1 |
| FF-SIM-UR-2707 | No data transmission in standby mode | R1 |
| FF-SIM-UR-2706 | Time-code generation in standby mode | R1 |
| FF-SIM-UR-2705 | Standby mode commanding | R1 |
| FF-SIM-UR-2873 | F-FEE full image mode management DELETED | R1 |
| FF-SIM-UR-2594 | F-FEE full image mode simulation | R1 |
| FF-SIM-UR-2716 | F-FEE full image mode commanding | R1 |
| FF-SIM-UR-2715 | F-FEE full image mode transition at sync signal | R1 |
| FF-SIM-UR-2714 | F-FEE full image mode CCD side selection | R1 |
| FF-SIM-UR-2713 | F-FEE full image mode cycle | R1 |
| FF-SIM-UR-3402 | F-FEE full image mode CCD selection | R1 |
| FF-SIM-UR-2712 | F-FEE full image mode transmission start | R1 |
| FF-SIM-UR-2711 | F-FEE full image mode maximum transmission time | R1 |
| FF-SIM-UR-2710 | F-FEE full image mode data generation | R1 |
| FF-SIM-UR-2709 | F-FEE full image mode default | R1 |
| FF-SIM-UR-2708 | F-FEE full image test mode | R1 |
| FF-SIM-UR-2595 | F-FEE full image pattern mode | R1 |
| FF-SIM-UR-2717 | F-FEE full image pattern definition | R1 |
| FF-SIM-UR-2596 | F-FEE full image SSD mode management | R2 |
| FF-SIM-UR-2725 | F-FEE full image SSD mode data source | R2 |
| FF-SIM-UR-2724 | F-FEE full image SSD mode parameters | R2 |
| FF-SIM-UR-2723 | F-FEE full image SSD mode default parameters | R2 |
| FF-SIM-UR-2722 | F-FEE full image SSD mode change default commanding | R2 |
| FF-SIM-UR-2721 | F-FEE full image SSD mode active parameters | R2 |
| FF-SIM-UR-2720 | F-FEE full image SSD mode start-up parameters | R2 |
| FF-SIM-UR-2719 | F-FEE full image SSD mode cycle | R2 |
| FF-SIM-UR-2718 | F-FEE full image SSD mode cycle wraparound | R2 |
| FF-SIM-UR-2794 | F-FEE full image interactive mode simulation | R2 |
| FF-SIM-UR-2825 | F-FEE full image interactive mode commanding | R2 |
| FF-SIM-UR-2824 | F-FEE full image interactive mode transition at sync signal | R2 |
| FF-SIM-UR-2823 | F-FEE full image interactive mode timing | R2 |
| FF-SIM-UR-2822 | F-FEE full image interactive mode transmission start | R2 |
| FF-SIM-UR-2821 | F-FEE full image interactive mode maximum transmission time | R2 |
| FF-SIM-UR-2820 | F-FEE full image interactive mode cycle | R2 |
| FF-SIM-UR-2819 | F-FEE full image interactive mode data generation | R2 |
| FF-SIM-UR-2781 | F-FEE full image interactive mode static data source | R2 |
| FF-SIM-UR-2801 | F-FEE full image interactive mode dynamic data source | R2 |
| FF-SIM-UR-2799 | F-FEE full image interactive mode error when no data is received | R2 |
| FF-SIM-UR-2892 | F-FEE full image interactive mode error when window list mismatch | R2 |
| FF-SIM-UR-2798 | F-FEE full image interactive  mode parameters | R2 |
| FF-SIM-UR-2797 | F-FEE full image interactive  mode default parameters | R2 |

| | | |
|---|---|---|
| FF-SIM-UR-2796 | F-FEE full image interactive mode change default parameters | R2 |
| FF-SIM-UR-2877 | F-FEE full image interactive mode active parameters | R2 |
| FF-SIM-UR-2876 | F-FEE full image interactive mode start-up parameters | R2 |
| FF-SIM-UR-2875 | F-FEE full image interactive mode patching algorithm | |
| FF-SIM-UR-2597 | F-FEE window mode simulation | R2 |
| FF-SIM-UR-2748 | F-FEE window mode commanding | R2 |
| FF-SIM-UR-2747 | F-FEE window mode transition at sync signal | R2 |
| FF-SIM-UR-2746 | F-FEE window mode cycle | R2 |
| FF-SIM-UR-2745 | F-FEE window mode parameters | R2 |
| FF-SIM-UR-2744 | F-FEE window mode transmission start | R2 |
| FF-SIM-UR-2743 | F-FEE window mode maximum transmission time | R2 |
| FF-SIM-UR-2742 | F-FEE window mode maximum transmission volume | R2 |
| FF-SIM-UR-2741 | F-FEE window extraction simulation | R2 |
| FF-SIM-UR-2740 | F-FEE window transmission timing | R2 |
| FF-SIM-UR-2739 | F-FEE window mode data generation | R2 |
| FF-SIM-UR-2738 | F-FEE window mode default data generation | R2 |
| FF-SIM-UR-2737 | F-FEE window test mode | R2 |
| FF-SIM-UR-2598 | Window list management | R2 |
| FF-SIM-UR-2753 | One window list per CCD | R2 |
| FF-SIM-UR-2752 | Window list update timing | R2 |
| FF-SIM-UR-2751 | Default window list | R2 |
| FF-SIM-UR-2750 | Default window list updating | R2 |
| FF-SIM-UR-2749 | Window list reporting | R2 |
| FF-SIM-UR-3846 | Forward window list | R2 |
| FF-SIM-UR-2599 | F-FEE window pattern mode commanding | R2 |
| FF-SIM-UR-2754 | F-FEE window pattern definition | R2 |
| FF-SIM-UR-2600 | F-FEE window SSD image mode commanding | R2 |
| FF-SIM-UR-2755 | F-FEE window SSD image data source | R2 |
| FF-SIM-UR-2601 | F-FEE window SSD window mode commanding | R2 |
| FF-SIM-UR-2764 | F-FEE window SSD window data source | R2 |
| FF-SIM-UR-2763 | F-FEE window SSD window mode parameters | R2 |
| FF-SIM-UR-2762 | F-FEE window SSD window mode default parameters | R2 |
| FF-SIM-UR-2761 | F-FEE window SSD window mode change default parameters | R2 |
| FF-SIM-UR-2760 | F-FEE window SSD window mode active parameters | R2 |
| FF-SIM-UR-2759 | F-FEE window SSD window mode check parameters | R2 |
| FF-SIM-UR-2758 | F-FEE window SSD window mode start-up parameters | R2 |
| FF-SIM-UR-2757 | F-FEE window SSD window mode cycle | R2 |
| FF-SIM-UR-2756 | F-FEE window SSD window mode cycle wraparound | R2 |
| FF-SIM-UR-2782 | F-FEE window interactive mode simulation | R2 |
| FF-SIM-UR-2835 | F-FEE window interactive mode commanding | R2 |
| FF-SIM-UR-2834 | F-FEE window interactive mode transition at sync signal | R2 |
| FF-SIM-UR-2833 | F-FEE window interactive mode timing | R2 |
| FF-SIM-UR-2832 | F-FEE window interactive mode transmission start | R2 |
| FF-SIM-UR-2831 | F-FEE window interactive mode maximum transmission time | R2 |
| FF-SIM-UR-2830 | F-FEE window interactive mode cycle | R2 |

Deleted Cells

| | | |
|---|---|---|
| FF-SIM-UR-2829 | F-FEE window interactive mode parameters | R2 |
| FF-SIM-UR-2828 | F-FEE window interactive mode maximum transmission volume | R2 |
| FF-SIM-UR-2827 | F-FEE window interactive extraction simulation | R2 |
| FF-SIM-UR-2826 | F-FEE window interactive data generation | R2 |
| FF-SIM-UR-2783 | F-FEE window interactive mode dynamic data source | R2 |
| FF-SIM-UR-2808 | F-FEE window interactive mode error when no data is received | R2 |
| FF-SIM-UR-2891 | F-FEE window interactive mode error when window list mismatch | R2 |
| FF-SIM-UR-2806 | F-FEE window interactive mode parameters | R2 |
| FF-SIM-UR-2805 | F-FEE window interactive mode default parameters | R2 |
| FF-SIM-UR-2804 | F-FEE window interactive mode change default parameters | R2 |
| FF-SIM-UR-2803 | F-FEE window interactive mode active parameters | R2 |
| FF-SIM-UR-2884 | F-FEE window interactive mode start-up parameters | R2 |
| FF-SIM-UR-2883 | F-FEE window interactive mode patching algorithm | |
| FF-SIM-UR-2602 | F-FEE transparent mode | ~~R1~~R3 |
| FF-SIM-UR-3406 | F-FEE transparent mode enable | ~~R1~~R3 |
| FF-SIM-UR-3407 | F-FEE transparent mode disable | ~~R1~~R3 |
| FF-SIM-UR-3413 | F-FEE transparent mode disable - SpaceWire links | ~~R2~~R3 |
| FF-SIM-UR-3414 | F-FEE transparent mode enable - SpaceWire links | ~~R1~~R3 |
| FF-SIM-UR-3408 | F-FEE transparent mode SpaceWire channel | ~~R1~~R3 |
| FF-SIM-UR-3409 | F-FEE transparent mode operations | ~~R1~~R3 |
| FF-SIM-UR-3410 | F-FEE transparent mode - Ethernet interface | ~~R1~~R3 |
| FF-SIM-UR-3412 | F-FEE transparent mode - SpaceWire interface | ~~R1~~R3 |
| FF-SIM-UR-2603 | F-FEE periodic housekeeping data | R1 |
| FF-SIM-UR-2734 | F-FEE request housekeeping data | R1 |
| FF-SIM-UR-2733 | F-FEE housekeeping data specification | R1 |
| FF-SIM-UR-2732 | F-FEE housekeeping data update | R1 |
| FF-SIM-UR-2731 | F-FEE default housekeeping data | R1 |
| FF-SIM-UR-2730 | F-FEE change default housekeeping data | R1 |
| FF-SIM-UR-2604 | Error injection management | R2 |
| FF-SIM-UR-2729 | Error injection per SpaceWire link | R2 |
| FF-SIM-UR-2605 | SpaceWire errors | R2 |
| FF-SIM-UR-2606 | RMAP errors | R2 |
| FF-SIM-UR-2607 | Time-code errors | R2 |
| FF-SIM-UR-2608 | Full image transmission errors | R2 |
| FF-SIM-UR-2609 | Window transmission errors | R2 |
| FF-SIM-UR-2736 | Window list enable/disable | R2 |
| FF-SIM-UR-2610 | Status reporting | R1 |
| FF-SIM-UR-2726 | Periodic status reporting | R1 |
| FF-SIM-UR-2735 | Status reporting data | R1 |
| FF-SIM-UR-2611 | Event reporting | R2 |
| FF-SIM-UR-2727 | Log reporting | R2 |
| FF-SIM-UR-3439 | Bit And Byte Order | R3 |
| FF-SIM-UR-3440 | Bit and Byte Numbering | R3 |
| FF-SIM-UR-3442 | Parity Bit Position | R3 |
| FF-SIM-UR-3465 | Applicable Spacewire Protocols | R3 |

Deleted Cells

| | | |
|---|---|---|
| FF-SIM-UR-3472 | Chassis Grounding | R3 |
| FF-SIM-UR-3476 | Connector Ground on PCB | R3 |
| FF-SIM-UR-3479 | Harness Routing | R3 |
| FF-SIM-UR-3481 | PCB Tracks Impedance | R3 |
| FF-SIM-UR-3482 | Length Difference of Track Pairs | R3 |
| FF-SIM-UR-3483 | Length Difference of Data/Strobe | R3 |
| FF-SIM-UR-3484 | PCB Tracks Approval | R3 |
| FF-SIM-UR-3487 | Flying Lead Connectors | R3 |
| FF-SIM-UR-3488 | Cropping of Flying Lead Connectors | R3 |
| FF-SIM-UR-3497 | Terminology for Electrical Parameters | R3 |
| FF-SIM-UR-3503 | LVDS for Spacewire Links | R3 |
| FF-SIM-UR-3508 | LVDS Driver Constrains | R3 |
| FF-SIM-UR-3510 | LVDS Receiver Constrains | R3 |
| FF-SIM-UR-3512 | 3.3V LVDS Devices | R3 |
| FF-SIM-UR-3513 | Overvoltage Protection | R3 |
| FF-SIM-UR-3516 | Fault Voltage Emission | R3 |
| FF-SIM-UR-3518 | Common Potential Immunity | R3 |
| FF-SIM-UR-3519 | Common Potential Test | R3 |
| FF-SIM-UR-3537 | Applicable Standard For Spacewire Signal Coding | R3 |
| FF-SIM-UR-3544 | Applicable Standard For Spacewire Links | R3 |
| FF-SIM-UR-3545 | Link Initialisation | R3 |
| FF-SIM-UR-3546 | Minimum Signaling Rate | R3 |
| FF-SIM-UR-3547 | Maximum Signaling Rate | R3 |
| FF-SIM-UR-3548 | Link Specific Signaling Rate | R3 |
| FF-SIM-UR-3598 | Jitter and Skew Budget | R3 |
| FF-SIM-UR-3733 | Transmitter Skew Budget | R3 |
| FF-SIM-UR-3734 | Receiver Skew Budget | R3 |
| FF-SIM-UR-3742 | Applicable Standard For Spacewire Data Character | R3 |
| FF-SIM-UR-3743 | Bit Endianess | R3 |
| FF-SIM-UR-3745 | Parity Bit Coverage | R3 |
| FF-SIM-UR-3747 | Applicable Standard On Transmit Bit Patterns | R3 |
| FF-SIM-UR-3749 | Applicable Standard On Host Interface | R3 |
| FF-SIM-UR-3751 | Applicable Standard On Time Interface | R3 |
| FF-SIM-UR-3755 | Separation Of L-Chars And N-Chars | R3 |
| FF-SIM-UR-3756 | Parity Check On Reception | R3 |
| FF-SIM-UR-3757 | Applicable Standard On Character Actions | R3 |
| FF-SIM-UR-3759 | Applicable Standard On Flow Control | R3 |
| FF-SIM-UR-3763 | Applicable Standard On Encode/Decoder | R3 |
| FF-SIM-UR-3764 | Power-On-Reset Of TX/RX buffer | R3 |
| FF-SIM-UR-3766 | Link Initialization Sequence | R3 |
| FF-SIM-UR-3767 | Applicable Standard On Link Initialization | R3 |
| FF-SIM-UR-3768 | Spacewire Codec Configurations | R3 |
| FF-SIM-UR-3789 | Applicable Standard On Normal Operation | R3 |
| FF-SIM-UR-3791 | List of Errors to Detect | R3 |
| FF-SIM-UR-3792 | Applicable Standard On Error Detection | R3 |

| | | |
|---|---|---|
| FF-SIM-UR-3793 | Exchange Of Silence Procedure | R3 |
| FF-SIM-UR-3794 | Upper Level Error Reporting | R3 |
| FF-SIM-UR-3795 | Synchronization Relevant Errors | R3 |
| FF-SIM-UR-3797 | Exception Conditions | R3 |
| FF-SIM-UR-3799 | Applicable Standard On Link Timing | R3 |
| FF-SIM-UR-3801 | Applicable Standard On Time Distribution | R3 |
| FF-SIM-UR-3807 | SpaceWire Packet Alignment | R3 |
| FF-SIM-UR-3811 | End-of-Packet Marker | R3 |
| FF-SIM-UR-3814 | European SMCS332 Circuits | R3 |
| FF-SIM-UR-3816 | SpW-SMCS332 Circuits for Multichannel Communications | R3 |
| FF-SIM-UR-3818 | External LVDS Transceivers | R3 |
| FF-SIM-UR-3821 | Interface Initialisation by SimuCam | R3 |
| FF-SIM-UR-3826 | SpW Data Link Layer Management | R3 |
| FF-SIM-UR-3827 | Link Layer Status Information | R3 |
| FF-SIM-UR-3828 | Individual Link Disabling | R3 |
| FF-SIM-UR-3830 | SpW Repetitor Use For Tests | R3 |
| FF-SIM-UR-3833 | Received Signal Measurement | R3 |
| FF-SIM-UR-3834 | Output Voltage Measurement | R3 |
| FF-SIM-UR-3835 | Common Mode Voltage Measurement | R3 |
| FF-SIM-UR-3839 | SpW Repetitor Use in EGSE | R3 |