Title: **RF SCOE (X-Band) Specification**

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Issue	Date	Sheet	Description of Change
1	27.11.2008	all	first issue
2	12.01.2009	all	This issue is completely revised w.r.t. the existing specification for Sentinel 2. The two Doors modules have been combined to one common module.
3	05.03.2010	23,24,25	Updated §2.1.11 "Data Distribution and Storage" to detail the interface to X-Band SCOE towards the I-EGSE.

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1 INTRODUCTION

1.1 Scope

This document comprises the contractually relevant technical requirements and constraints for the X-Band SCOE to be used for Earthcare AIT and higher level ground operation. The X-Band SCOE is one part of the RF SCOE which is composed of S-Band SCOE and X-Band SCOE. The document and its applicable documents establish the functional, design, performance, interface and verification requirements of the X-Band SCOE for Earthcare, in the remainder of this document called *the project*.

1.1.1 EC Background

Earth Explorer Core Missions are an element of the Earth Observation Envelope Programme. They are defined as major missions led by ESA to cover primary research objectives set out in the Living Planet Program (ESA, 1998). The Earth Clouds, Aerosols and Radiation Explorer Mission (EarthCARE) has been approved for implementation as the third Earth Explorer Core Mission.

EarthCARE is a cooperative mission between ESA and JAXA, where JAXA will provide a Cloud Profiling Radar. ESA is responsible for the entire system including the Spacecraft, three instruments, the Launcher and the Ground Segment.

The EarthCARE Mission will help in determining the Earth radiation budget by providing global observations of vertical cloud and aerosol profiles. The mission is centred on the synergetic use of the data provided by an instrument suite consisting of an ATmospheric LIDar (ATLID), a Cloud Profiling Radar (CPR), a Multi-Spectral Imager (MSI) and a Broad Band Radiometer (BBR).

1.2 Purpose

The EGSE will be used for electrical and software integration as well as functional testing of the satellite.

The X-Band SCOE integrated into the overall EGSE system is shown in Figure 1.2-1.

House-Keeping and science telemetry data from the satellite shall be received from a test cap at the X-Band antenna (X-Band Link) or via a bypass link (Digital Bypass Out). To serve the interfaces to this antenna and this bypass link is the task of the X-Band SCOE. This SCOE will allow to test the X-Band RF chain functionality. The X-Band SCOE will demodulate the signal and extract the data from the RF signal. The digital processing section of the X-Band SCOE will reconstruct source packets and will send them via LAN to their processing destination.

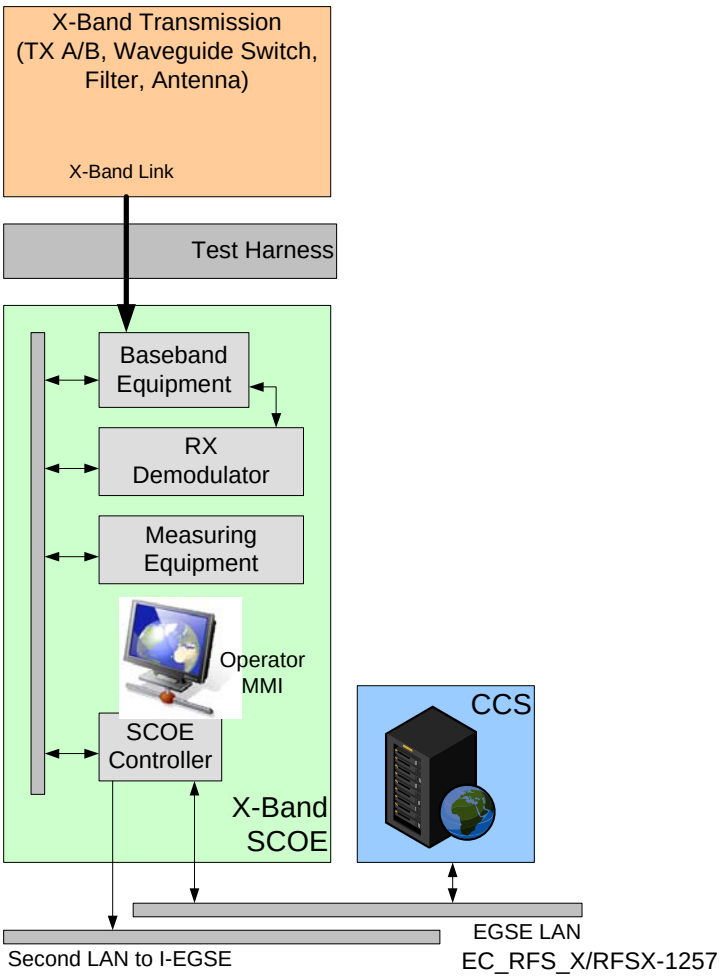

Figure 1.2-1: EGSE Configurations for X-Band SCOE

In theses higher level specifications the RF SCOE is split into X-Band SCOE and the S-Band SCOE . Each SCOE shall have its own set of measurement devices, which are needed for functional and performance measurements.

1.2.1 General Description

The communication with the satellite will be performed either by bypassing the RF link via a bypass link or communicating via the nominal RF-Link for RF tests and during overall system tests. For X-Band bypass there is an internal Switch Unit in the SCOE.

In case of direct RF Link communication the telemetry transmitted is

•either received from a test cap on the X-Band antenna (test setup identified by wording “with cap”)

•or directly fed from the X-Band antenna connector to the RF SCOE input while the X-Band antenna is disconnected (test setup identified by wording “without cap”).

To serve this RF interface and allow to test the RF chain functionality is the task of the X-Band SCOE.

The X-Band SCOE receives science and recorded HK TM (stored in the MMFU) and stores it in the SCOE. All date shall be available by FT access to the SCOE, specific VCs (e.g. HK) will be routed on request to CCS directly.

The X-Band SCOE is constituted of the following functional blocks as outlined in Figure 1.2-2 below:

- RF Interface Unit
- Test output port for the RF downlink signal (used for XSVE)
- Bypass Interface
- Measurement Equipment
- X-Band Receiver
- SCOE Controller
- Switching unit
- Front-End stage
- Mass Memory Unit
- Date Processing Unit
- Data Distribution Unit
- RF Harness for RF and Bypass Interface

The X-Band SCOE receives from the satellite the RF downlink antenna signal, demodulates the TM signal and provides it to the Front End Equipment and stores it on internal memory.

RF measurements are performed providing appropriate Measurement Devices:

- Spectrum analysis on the down-link signal.
- RF power measurement on the down-link signal to deduce the actual output power or input power at cable end.
- Frequency measurement on the down-link signal.

The RF Interface Unit establishes all the connections between the different access points of the equipment and all the different measurement devices.

For all AIT/AIV activities the X-Band SCOE is embedded in a fully automated test set-up. As are all connected front-ends and SCOEs, also the X-Band SCOE is remotely controlled by the CCS. The communication shall be performed via an Ethernet link using the TCP/IP protocol. The X-Band SCOE Controller also supports local operation via a local GUI. The X-Band SCOE controller operated in local or remote mode provides functions for controlling and monitoring of the RF equipment as follows:

- Connection of test equipment to RF path within the RF Interface unit
- Setting / configuration of the RF test equipment (e.g. spectrum analyser, power meter, frequency counter, attenuator settings, switch positions, ...)
- Read out of parameters from RF test equipment
- Control of receiver
- Read out of parameters from the receiver

•Switch control of the RF Interface unit

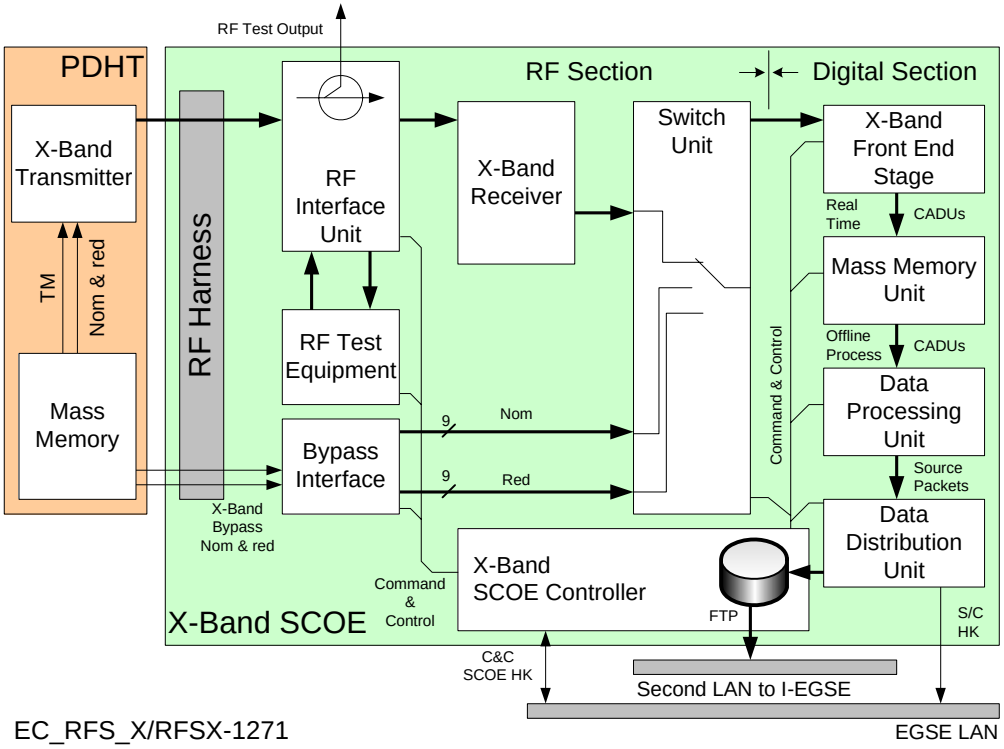

Figure 1.2-2: Full X-Band SCOE Block Diagram

For the option "digial processing part only" the following figure shows the required X-Band SCOE parts:

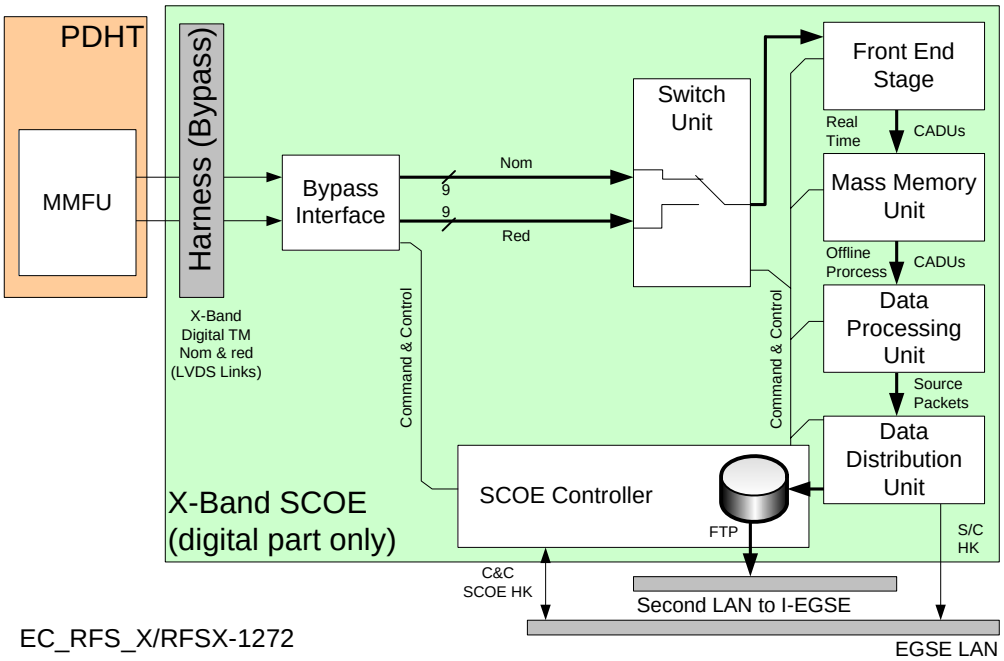

Figure 1.2-3: X-Band SCOE Block Diagram (Digital SCOE without RF)

1.3 Requirements Definition

Each requirement is preceded by a summary line with the format:

YY-XXXX/ZZZZ/V/P

Where

YY is a prefix used for all requirements in this specification

XXXX is a unique number for the requirement assigned consecutively by DOORS

ZZZZ shows the parent requirement

V is the intended Verification Method

P is a code used at ASD for management of the DOORS module (not relevant for the contractor)

The Intended Verification Methods are coded as follows:

- **A** - Analysis
- **I** - Inspection
- **R** - Review of design
- **T** - Test

All verification methods indicated for a dedicated requirement are applicable.

The requirement text follows the summary line. If tables are considered as part of the requirement they are referenced clearly in the text, inserted after, separated from the requirement and are managed as free text attached to the identifier requirement.

1.4 Terms and Definitions

Term	Definition
AIT/AIV Data Base	Database containing all definitions for all data structures (TM/TC packets, TM/TC parameters, monitoring definitions, calibration curves, limit sets, e.t.c) subject to the spacecraft and all EGSE Front End / SCOE units.
Automated Procedure	Test program (application) written by the user in a high level command language to control the execution of a test. Contains statements to send commands to the spacecraft and to other EGSE items and to process the telemetry and other data coming from the S/C and other EGSE items. (synonym: Test Sequence, Control File)
C&C Message	ASCII data structure replacing the entire source packet "Application Data Field" of a standard TC Source Packet. These packets are used to exchange commands and feedback data between the CCS and SCOE´s / Front End Equipment / Instrument EGSE.
Feedback Data	Data from a SCOE representing either measurement data from the spacecraft or data directly measured at a dedicated spacecraft interface.

Term	Definition
Functional Verification Environment	Constituted by development configurations in their early stages using pure S/W simulation models for the S/C and the unit(s) under test (e.g. the SVF having no hardware in the loop). In a next step hardware in the loop is used (e.g. the on-board processor) whereas other units are still represented by software simulation models (e.g. the RTB operating at least the real on-board processor hardware connecting its real physical and electrical interfaces via the Simulation FE and simulating the spacecraft environment by means of the RTS).
SCOE	Set of (electronic, magnetic, optical, etc.) equipment to stimulate and/or simulate the S/C's interfaces like sensors and actuators and/or other units (e.g. sun, batteries, ...)
Script	A list of procedure language commands stored in an ASCII disk file. During a Test Session a script can be called by file name and the commands contained are interpreted and executed sequentially (similar to DOS batch file).
Stimuli Commands	Command to a SCOE to execute a stimulation of a spacecraft interface.
Structure Identifier	Field within the "Application Data Field" of a TM/TC Source Packet identifying the data structure provided with this packet.
TC Source Packet	Packet according to [ND-001] CCSDS Packet Telecommand definition for commanding the spacecraft.
Test Environment	Contains the executables of all (user-) data to conduct a test. It mainly comprises a configuration specific sub-set of AIT/AIV Data Base data for the spacecrafts actual as-built-configuration, the relevant automated procedures and synoptics.
Test Session	Running a test at "Run-Time" using a dedicated Test Environment.
TM Source Packet	Packet according to [ND-104] CCSDS Packet Telemetry Standard providing housekeeping data either from the spacecraft or from any other SCOE / Front End Equipment / Instrument EGSE.

1.5 References

1.5.1 Applicable Documents

The following documents form part of this specification as specified herein.

In case that no issue of the applicable document is stipulated, the latest issue in effect has to be taken.

AD-1	EC.RS.ASD.SY.00002	Product Assurance and Safety Requirements for Subcontractors
AD-2	ES.TN.ASD.SY.00095	Archive File Format for X-Band data
AD-105	EC.ICD.ASD.SY.00002	EGSE ICD for EC
AD-108	EC.IRD.ASD.SY.00003	SRDB Data Population Requirements
AD-110	EC.STD.ASD.SY.00001	EC Packet Utilization Standard

1.5.2 Reference Document

The following documents provide further information.

[RD-002]	X-Band Transmission Subsystem Requirement Specification	EC.RS.ASD.SY.00021
[RD-004]	Space To Ground Icd	EC.ICD.ASD.SY.00010
[RD-100]	Abbreviation List	EC.LI.ASD.SY.00001

1.5.3 Normative Documents

The following standards, also if not explicitly referenced in the following chapters, shall be used in executing the work. The applicability of Level 1 ECSS Standards (Policy and Principles) extends implicitly to the lower level standards. In some cases, this document refers explicitly to lower level standards.

[ND-001]	Telecommand - Summary of Concept and Rationale	CCSDS 200.0-G-6
[ND-002]	Info processing Systems - Open Systems Interconnection - Basic Reference Model part 2: security architecture, first edition 1989-02-15	ISO 7498-2
[ND-104]	Packet Telemetry Standard (ISO 13419)	CCSDS 102.0-B-5-S
[ND-117]	Advanced Orbiting Systems Space Data Links Protocols	CCSDS 732.0-B-1
[ND-143]	Telemetry Synchronization and Channel Coding	ECSS-E-50-0C
[ND-147]	Radio frequency and modulation	ECSS-E-50-05A

1.6 List of Acronyms

General *project* abbreviations are in [RD-100].

2 X-BAND SCOE REQUIREMENTS

2.1 X-Band SCOE Functional and Performance Requirements

2.1.1 General

RFSX-188/ /R

The X-Band SCOE in principal shall be constituted of the following functional blocks as outlined in Section 1.2.1:

RF -Section:

- *RF Harness*
- *Bypass Harnes*
- *RF Interface Unit*
- *X-Band Receivers*
- *RF Test Equipment (spectrum analyser, power meter, frequency counter, attenuator)*
- *Switch Unit*
- *Bypass Interface*

Digital Section:

- *X-Band Front End Stage*
- *Mass Memory Unit*
- *Data Processing Unit*
- *Data Distribution Unit*
- *X-Band SCOE Controller*

2.1.2 RF Harness

RFSX-190/ /R

The X-band SCOE shall include coaxial RF harness between the spacecraft and the SCOE.

Note: The cable shall be selected taking into account adequate amplitude and phase stability versus flexure and temperature and overall path attenuation (sensitivity of receiver and measurement equipment).

RFSX-192/ /R

The RF cables shall interface with the X-Band subsystem either via antenna test cap to the antenna or directly to the waveguide adapter.

RFSX-1346/ /R

The X-Band SCOE shall provide the signal harness for bypass, between spacecraft test connectors (nominal and redundant) and the bypass interface in the X-Band SCOE rack.

2.1.3 RF Interface Unit

RFSX-195/ /T

The X-Band RF interface shall contain a DC-blocker for galvanic isolation to the spacecraft to prevent ground loops.

RFSX-196/ /R

Calibrated couplers shall be provided to allow connection of the measuring devices described.

RFSX-197/ /R

A test output shall be provided by means of a High Directivity Coupler tuning out the RF signal. This output shall be accessible from the X-Band SCOE front panel. The connector shall be of type N (TBC).

RFSX-198/ /R

The RF signal path to the X-Band receiver unit shall be accessible by RF test equipment as outlined in the sections below.

The RF interface unit shall provide switches to connect the measuring devices to the RF path.

RFSX-199/ /T

The switch positions shall be able to be remotely controlled from the SCOE controller / CCS as well as operated locally / manually.

If remotely commanded, switch positions shall be monitored (i.e. acquired and displayed) by the SCOE controller.

RFSX-200/ /T

The mechanical design of the RF interface unit shall be such, that it is possible to bypass signal distribution switches and directly route the RF signal to the RF test equipment. It shall be possible to perform such manual connection without the need to dismount the unit from the X-Band SCOE rack.

RFSX-1273/ /T

The signal levels shall be matched to the input range of each measurement equipment either by internal or separate fixed / variable attenuators. Especially in case of the X-band receiver input the attenuator(s) shall be variable in 1dB/step and 10dB/step with a complete range of 60dB minimum. Furthermore it shall be ensured by fixed attenuation that neither the X-band receiver nor the RF test equipment will be damaged by any internal wrong setting considering a maximum RF power at the SCOE input (including RF harness) of +38dBm

RFSX-202/ /T

It shall be possible to control the variable attenuators remotely by the SCOE controller / CCS and by local / manual operation.

If remotely commanded, attenuator settings shall be monitored (i.e. acquired and displayed) by the SCOE controller.

2.1.4 X-Band Receivers

RFSX-1274/ /R

For the RF SCOE one X-Band receiver shall be provided.

RFSX-1275/ /T

The X-Band receiver shall down convert and demodulate the X-Band channel with a fixed carrier frequency f = 8100 MHz.

RFSX-1276/ /T

The SCOE input power at the S/C interface is in the range of +38dBm with direct connection to the XBS (without antenna) and 18dBm TBC with connection to an antenna test cap.

The X-band receivers input signal shall be adjusted w.r.t. the sensitivity / dynamic range of the selected receiver.

RFSX-1277/ /T

The X-band receivers design shall comply with a data rate of 150 Mbps. The data are Reed-Solomon coded (I=5) and OQPSK modulated [ND-147].

RFSX-1278/ /T

The X-Band receivers design shall comply to the on-board X-Band system which provides OQPSK modulation [ND-147].

RFSX-209/ /T

The receivers carrier lock status and data lock status shall be displayed at the X-Band receiver front panel and shall be visible in SCOE HK TM for the CCS.

RFSX-210/ /T

The reference frequency stability of the X-Band receivers shall be better than $\pm$10 ppm.

RFSX-211/ /T

A search range of $\pm$20 kHz around the centre frequency shall be provided to eliminate the frequency uncertainties.

RFSX-212/ /T

The receiver loop bandwidth shall be selectable at least between 3 different ranges. As a goal, the following ranges shall be used:

fo < 3 kHz

fo < 1 kHz

fo < 0.1 kHz

RFSX-213/ /T

The degradation of the Bit Error Rate by the receiver shall be less than 3 dB with respect to the theoretically achievable demodulator / receiver performance

RFSX-1279/ /T

The X-Band receivers shall demodulate and decode OQPSK modulated signals [ND-147].

RFSX-1280/ /R

*The X-Band receiver output signal shall consist of 9 NRZ-L, LVDS lines (8 * data plus clock). For interface specification see Section 5.2.5.4.10.4 and Section 5.2.5.4.15.*

RFSX-1245/T

The X-Band receivers shall be capable to start an initial synchronisation search process for getting synchronised. The initial sync search shall be commanded form local or remote. The search shall also take into account all permutations of data and signal. After synchronisation the settings shall be stored for getting a fast sync in case of a sync-loss.

RFSX-1246/T

In case of sync loss an automatic sync search shall start using the stored default settings by the initial search process (see RFSX-1245).

2.1.5 RF Measurements

2.1.5.1 General

RFSX-217/ /R

The X-Band SCOE shall be able to perform the following measurements of the downlink signal:

- *Total RF-power*
- *Phase noise measurement of the downlink carrier*
- *Measurement and analysis of power spectra (out-of-band spurious, occupied bandwidth)*
- *Measurement of downlink frequency*

Note: The above performance requirements shall include characteristics of RF couplers, switches and other SCOE assembly internal interface hardware. If the requirements are met by data correction routines (e.g. adding calibration data or cable loss factors) running in the SCOE controller, this would be acceptable.

RFSX-1210/I/T

The X-Band SCOE shall allow simultaneous RF measurements on all devices.

RFSX-1209/ /T

The X-Band SCOE shall support the following measurements with automated routines. The accuracy for these measurements shall be:

- *total RF-power for downlink: ± 0,3 dB*
- *measurement and plot of power spectra: amplitude accuracy ± 0,5 dB*
- *measurement of frequencies: ± 1 Hz*

2.1.5.2 Measurement Devices

The X-Band SCOE shall have one set of measurement devices which are needed for functional and performance measurement of the X-Band.

RFSX-1212/I/R

RF measurement device settings as well as measurement data read-out shall be possible via remote control from the X-Band SCOE controller.

RFSX-1213/I/R

The spectrum analysis shall be of a high quality standard and shall have the following characteristics:

- *Frequency Range 9 kHz (tbc) to 40 GHz*
- *Noise Floor <= -100 dBm.*
- *Dynamic Range > 70 dB.*
- *Spectral Purity better than -80 dBc/Hz, 1 kHz offset*

RFSX-1214/I/R

Measurement of the RF power level shall be supported over the whole frequency range:

- *Frequency Range 10 MHz (tbc) to 24 GHz*
- *Accuracy better than ± 0.2 dB*
- *Power Level at the end of the test cables: -135 dBm to +40 dBm.*

(different power shall be found either by direct measurement, or by calculation (insertion of adequate attenuators)

RFSX-1215//R

In order to enable accurate power measurements in vicinity of the transmission subsystem, it shall be possible to remove the power meter from the SCOE rack or to use a probe with a long cable (length as in Section 2.2.2).

Note: If the power meter is to be removed from the rack for such measurement, it is not required that the power meter is remote controllable from the X-Band SCOE controller.

RFSX-1217//I

For power level measurement at the end of the interface cable one cable of 2 meter length shall be provided for the direct measurement on the SCOE.

RFSX-1218//R

The frequency counter shall count frequencies up to 10GHz with a resolution of 1 Hz. The internal stability of the counter shall be better than 1 x 10^{-8} under normal operational environment (i.e. lab) conditions.

RFSX-1219//R

All mesurement equipment shall be synchronised to one frequency source (e.g. 10 MHz of RF synthesiser).

In addition the 10 MHz signal shall be made available for external use.

RFSX-1220//R

As far as possible the measurement devices shall provide the capability for "self-calibration" (e.g. power meter zeroing) commanded / controlled from the local GUI.

2.1.5.3 Calibration Equipment

RFSX-1222//R

For calibration of the group delay measurement a mobile "reflective transponder" shall be provided.

RFSX-218/ /T

The RF Test equipment shall include a signal source which allows calibration of the signal chain from the connector at the spacecraft side down to the interface at the X-Band receiver and the RF Test equipment. Calibration shall be done by either using a calibrated source or using the calibrated measurement devices (e.g. power meter, spectrum analyser) in conjunction with an uncalibrated source.

RFSX-219/ /T

The calibrated source operation frequency shall cover the nominal operation frequency range of the X-Band link with a bandwidth significantly higher than the telemetry signal bandwidth.

Note: In case that the supplier proposes a design without calibration this shall be subject to customer approval.

RFSX-1224//T

All data resulting from the calibration of the X-Band SCOE shall be available and shall be automatically taken into account for the measurements and equipment settings.

2.1.6 Bypass Interface

RFSX-1281/ /R

The X-Band SCOE shall provide a bypass signal receiver to receive and condition the digital telemetry bypass:

- *Mass Memory Unit playback data channel (nominal) - 8*data plus clock*
- *Mass Memory Unit playback data channel (redundant) - 8*date plus clock*

See Section 5.2.5.4.10.4 for X-Band Digital TM interfcae (XTM) specification and Section 5.2.5.4.15 for LVDS specification. For interface grounding see Section 5.5.5.2.4.

RFSX-223/ /T

The bypass interface shall fulfil the following grounding requirements below:

- *The ground reference of the bypass signal input shall be galvanically isolated from any other ground of the X-Band SCOE by more than 1MOhm.*
- *The LVDS receiver signal ground shall be connected to the structure of the bypass interface with an extreme low impedance (for frequencies up to 100 MHz).*
- *The bypass interface shall provide a grounding stud to allow bonding to the spacecraft with an extreme low impedance (for frequencies up to 100 MHz).*

RFSX-1285/ /T

*The bypass interface shall deliver output signal consisting of 9 NRZ-L, LVDS lines (8 * data plus clock) to the switch unit for nominal and redundant. The interface type shall be 5V, this clarifies the requirement RFSX-939 in chapter 5.*

2.1.7 Switch Unit

RFSX-1347/ /T

The switch unit shall allow to select routing of one of the three input telemetry data streams (X-Band receiver, Bypass nominal or Bypass redundant), to the X-Band front end frame stage.

Note: The switch unit for the SCOE without RF part (used for option "digital SCOE only"), will only route bypass signals redundant or nominal to the digital section (see Figure 1.2-3).

RFSX-227/ /T

- *It shall be possible to control the switch remotely by the SCOE controller / CCS and also to operate locally / manually.*
- *If remotely commanded, the switch position shall be monitored (i.e. acquired and displayed) by the SCOE controller.*

2.1.8 X-Band Front End Stage

RFSX-229/ /T

Filler Transfer Frames (VCDUs) (i.e. Idle Frames downlinked via dedicated virtual channel, see Section 2.1.10.2) shall be discarded here for any further processing.

RFSX-1287/ /T

The retrieved CADUs shall be delivered to the X-Band SCOE mass memory unit.

Note: The channel contains complete packets which are subject of the Instrument data evaluation.

Note: The transfer frames are according to [ND-117] CCSDS standard (see Figure 2.1-1), which is different

to the S-Band data that uses ECSS standard.

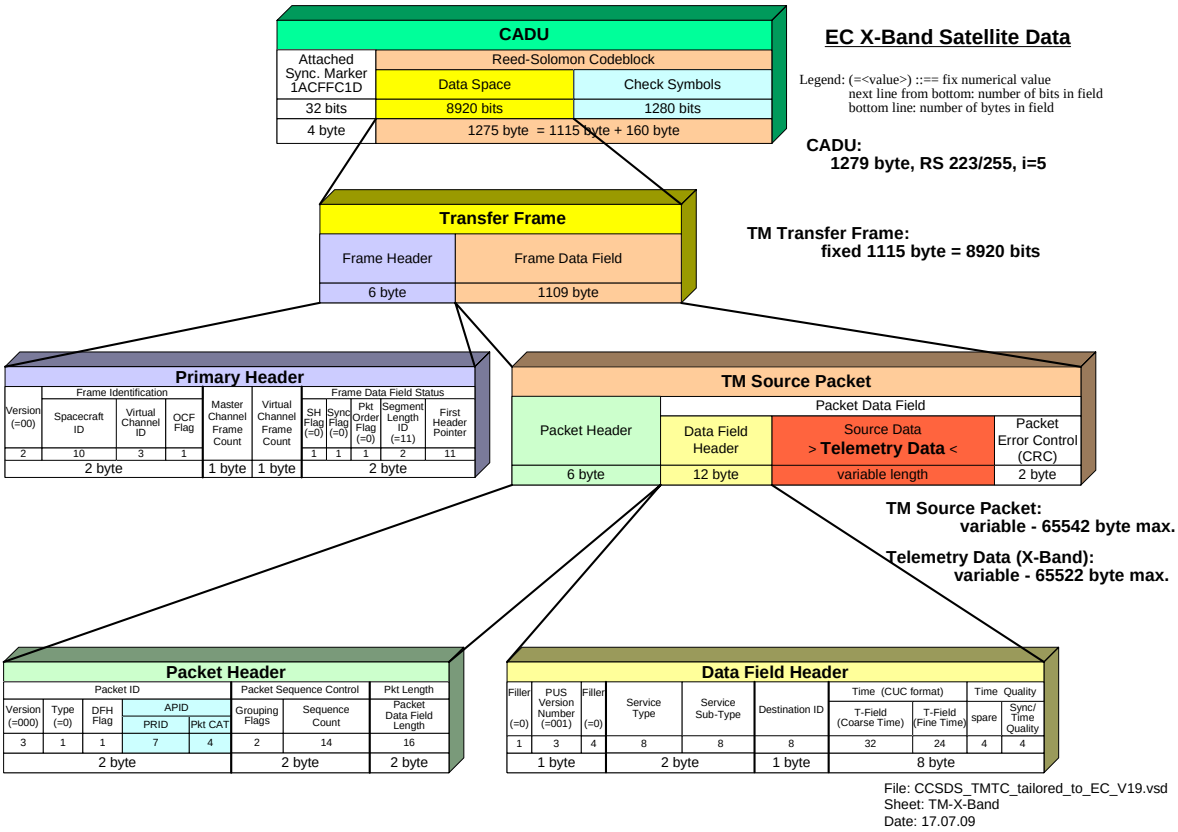

Figure 2.1-1: X-Band Telemetry Data Structure

2.1.9 Mass Memory Unit

RFSX-1290/ /T

The Mass Memory Unit shall record the X-Band data stream of 131 Mbps.

RFSX-1291/ /R

*The mass memory unit shall provide sufficient capacity to store at least two full dumps (2 * 1,8 Tbit) of the on-board memory module plus margin (i.e. at least 3,6 Tbit (~450 GByte) without the need to exchange the storage medium).*

RFSX-235/ /T

The probability of bit error between recorded and replayed data shall be less than 10^{-9}.

RFSX-236/ /T

All data sets shall be stored together with auxiliary data (such as date, time) to ease the later search.

RFSX-237/ /T

It shall be possible to retrieve the recorded X-Band data either completely from begin of recording or selectively based on selection criteria given by the auxiliary data as specified in the requirement above.

RFSX-238/ /T

The mass memory unit shall provide utilities to export selected portions of any of the recorded data on a portable medium.

RFSX-239/ /T

The mass memory unit shall be fully operable under control of the SCOE controller in local mode and via the CCS in remote mode.

2.1.10 X-Band Data Processing Unit

RFSX-1345//A,R

For the date extraction and analysis online and offline processing is foreseen. The preferred processing method is the online processing. For the offline processing the data extraction / analysis shall start as early as possible and in parallel to the online process. Processing a full mass memory downlink 1,8 Tbit (see RFSX-1291 above in Section 2.1.9) should not last longer than 1 hour after real-time downlink is finished.

2.1.10.1 Reed Solomon Decoding

RFSX-242/ /T

The Data Processing Unit shall receive X-Band data retrieved from the mass memory unit in an off-line processing mode (i.e. not linked with / not in real-time with the data transmission from spacecraft to ground).

RFSX-243/ /T

CADU synchronisation shall be performed based on the synchronisation marker in accordance to [ND-104]. In case of sync loss an automaic sync search shall be started.

RFSX-1247//T

CADU sync errors shall be detected in realtime.

RFSX-244/ /T

Reed Solomon errors shall be detected and corrected in realtime by the data processing unit. Uncorrectable frames shall be counted. The following statistic counters shall be at least reported in SCOE HK:

- *Frames with RS error*
- *Corrected Frames*
- *Frames without error*

Note: Detailed information about counters will be discussed with selected supplier.

RFSX-246/ /T

The data space of the X-Band CADUs shall be descrambled taking into account the scrambling procedure according to [ND-117].

RFSX-247/ /T

The Data Processing Unit shall maintain a programmable Transfer Frame assignment table listing all allowed Transfer Frame identifiers. It shall be possible to configure this by the user.

RFSX-248/ /T

All fields in the Transfer Frame header shall be subjected to consistency checks with respect to the following header entries in accordance to [ND-104]:

- *Version No.*
- *Error control fields*
- *Transfer Frame (VCDU) ID*

- *Continuity of counters*
  - *Transfer Frame (VCDU) counter*
  - *VC Frame counter*
- *Signalling Field*
- *etc.*

Errors shall be detected and reported to the SCOE controller. In case of multiple detectable errors all shall be reported (see also RFSX-1243).

RFSX-1292/ /T

The CVCDUs shall be subjected to an error detection procedure using the Reed Solomon check symbols in the CVCDU trailer. Detected errors shall be reported to the SCOE controller in local mode and in addition to the CCS in remote mode identifying

- *EGSE Timestamp (to identify the frame in the archive for furter analysis)*
- *Correctable errors / Uncorrectable errors*
- *Transfer Frame (VCDU) ID*
- *Transfer Frame (VCDU) Counter*

Note: Check symbols are generated in accordance to [ND-104] (255, 239) with an interleaving depth I = 5 in accordance with [ND-104].

2.1.10.2 Source Packets Recovery

RFSX-253/ /T

Transfer Frames shall be subjected to a demultiplexing process, controlled by the virtual channel ID.

Note: The Transfer Frame Data Unit Zone is not synchronised to the packet length. Therefore it may contain complete packets or parts of packets. The first header pointer shall be used to retrieve the CCSDS [ND-117] source packets.

RFSX-1284/ /T

The Data Processing unit shall maintain an assignment table of data sources to virtual channels ID´s (VCID table).

For X-Band data transmission the following Virtual Channel IDs are used by default but must be reorderable:

Virtual Channel - X-Band Downlink	VC ID
Near – Realtime (TBC)	0
Spare (TBC)	1
MIL-STD-1553 bus data (HK) (Packet Store #2)	2
ATLID interface data (Packet Store #3)	3
BBR interface data (Packet Store #4)	4
MSI interface data (Packet Store #5)	5
CPR interface data (Packet Store #6)	6
Idle Frame	7

Table 2.1-1: Virtual Channels used for X-Band

RFSX-287/ /T

It shall be possible to change VCID table by a new table downloaded from the SCOE controller.

RFSX-288/ /T

The Data Processing Unit shall extract the data which are sent according to the Packet Telemetry Standard [ND-104].

RFSX-1248//T

The logged timestamps for packets shall be identical to the timestamps of the frame that completes the packets.

Note: This is required to have a direct correlation of the packets to the frame.

RFSX-1249//T

For each APID a counter shall be implemented to count the received packets. The counter shall be resetable by local or remote command, individualy for each APID or for all APIDs. The counters shall be reported by HK TM.

RFSX-1250//T

All packet fields have to be checked for correct content and/or continuously counting, depending on the type of field. In case of multiple detectable errors all shall be reported (see also RFSX-1243).

Note: In case of CRC errors / packet length errors further checks of the corrupted packet are not needed.

2.1.11 Data Distribution and Storage

RFSX-290/ /T

It shall be possible to select / deselect packets (by APID) and/or a whole VCs, for packet distribution to the CCS (EGSE LAN) and/or the storage in the X-Band SCOE. This operation shall be commandable from the SCOE controller in local mode and via the CCS in remote mode.

RFSX-1226//T

It shall be possible to save and reload a set of deselected packets (APID/VC) as a filter by name. It shall be possible to have at least 128 different filters.

Note: Packet distribution to the EGSE is routed through the standard TM socket according to the EGSE ICD [AD-105].

Note: It is assumed that for specific test cases the playback TM will be routed to the CCS.

RFSX-292/ /T

Deselected packets for storing in X-Band SCOE and CCS distribution shall be ignored for any further processing.

RFSX-1293/ /T

The X-band SCOE shall provide the capability to filter the incoming packets according to any combination of VCID, APID, Service Type and Service Subtype (from the DFH) and store them into files and/or send them to a TCP/IP server port.

RFSX-1349//T

The X-Band SCOE shall represent the TCP-server side of the LAN communication towards the instrument EGSE's Data Acquisition and Processing Block. The electrical interface and communication protocol shall be according to [AD-105].

RFSX-1350//T

The X-Band SCOE shall allow to configure at least 8 different TCP-Server ports to which packets according the filter criteria defined in RFSX-1293 are offered.

Note: Typically the VCs with the dedicated instrument data will be routed 1:1 to a TCP/IP server port.

RFSX-1351//T

The X-Band SCOE shall start to distribute filtered packets on TCP server ports as soon as a client is connected and data is available. No additional client subscribe mechanism beyond the standard TCP/IP protocol behaviour is required.

RFSX-1352//T

In case a client connects to the X-Band SCOE's TCP server port, the data distribution shall always start with the begin of the next CCSDS source packet. The same is true after a link breakdown and reconnection of a client.

RFSX-1354//T

The X-Band SCOE shall also implement a TCP/IP read request on the server ports - this allows to realise that a client has disconnected or the link broke down even without a data distribution being in progress.

RFSX-1355//T

The X-Band SCOE shall allow to configure the TCP send-buffer and receive buffer size of each port.

RFSX-1356//T

The X-Band SCOE shall make use of the TCP/IP socket option "SO_KEEPALIVE".

RFSX-1353//T

In case of a TCP/IP link loss the X-Band SCOE shall allow to reconnect on the same server port latest 1 second after detection of the link loss.

RFSX-1310//T

The X-band SCOE shall be capable to define filters of VCs / APID / Service Type / SubType combinations for being recorded in a file. Different filter lists shall be able to be configured / created / selected by local MMI and by remote commanding from the CCS.

RFSX-1359//T

It shall be possible to record at least 5 to different files according to the filter settings. These files shall have the archive format as provided in [AD-2].

Note: The recorded data (e.g. for a specific VC that reflect an instrument) will be exchanged via ftp to the dedicated instrument ESGE and processed there offline.

RFSX-1308//T

It shall be possible to configure a maximum file size or maximum number of packets per file, until a new file has to be created.

RFSX-1309//T

For each TM entry at least the VC and the time stamp shall be recorded when the packet (frame) is received by the system.

RFSX-1315//T

The SCOE shall provide a playback capability for replay of stored data to the CCS (over the EGSE LAN).

RFSX-1357//T

The X-Band SCOE shall provide a playback capability for replay of stored data to the Instrument EGSE's DAPB part on the DATA-LAN. The data shall be offered in the same manner (on TCP server port) as the realtime data.

RFSX-1358//R

The SCOE shall have two LAN interfaces for data access/distribution:

- *EGSE-LAN: For packet distribution and C&C to/from the CCS.*
- *DATA-LAN: For instrument data file access vie FTP as well as for realtime and playback data distribution.*

RFSX-296/ /T

Source Packet distribution to the EGSE LAN shall be performed with a data rate up to 10 Mbps. It shall be possible to limit the data rate for avoiding an overload of the CCS and/or the EGSE LAN.

The data access (FTP) from the I-EGSE LAN shall be at least 250 Mbps (1000 Mbps).

RFSX-1243//T,R

All kind of errors detected during online and offline processing shall be logged. All error log entries shall be correlated to specific data set. The correlation shall be done by time stamp or any other identical method to find the source data set.

RFSX-1244//T,R

A archive browser shall be provided to access and review the logged data. The archive browser shall be capable to show full frames as also single packets. The archive browser shall support the export of a set of data specified by the user.

2.2 X-Band SCOE Interface Requirements

2.2.1 On-Board Interfaces

RFSX-299/ /R

The X-band RF Interface Connector:

Connector to spacecraft at cable: N-type / male

RFSX-300/ /R

The X-band Bypass Interface Connector:

Connector to spacecraft at cable: Cannon D -type / male

Note: For interface specification see Section 5.2.5.4.10.4 and Section 5.2.5.4.15.

2.2.2 Harnes Length

RFSX-1318//R

Cable(s) shall be provided to connect to the spacecraft per X-Band SCOE. The cables characteristics shall be as follows:

- *Cable 1 length: 20 meter (use under ambient conditions, only)*
- *Cable 2 length: 10 meter (use under ambient conditions, only)*
- *Cable 3 length: 13 meter (used for TB/TV)*
- *RF cable: flexible coax cable*
- *Connectors: SMA / male (both ends)*
- *Bypass interface cable length shall be 30 meter*
- *A second set bypass interface cables with length 5 meter*

RFSX-461//R

The cables for the RF harness as well as for the bypass harness shall be designed for ambient conditions, except cable 3 used for the TB/TV.

Note: If optical fibre link is used to match the required bypass harness distance, sufficient spare glass fibres shall be provided. Assuming each signal line (i.e. 8 * data + clock for the nominal and further 8 * data + clock for the redundant path) is routed on a separate fibre, 18 (2 *(8 +1)) fibres are in use during operation. In this case additional 5 spare fibres would be considered sufficient.

2.2.3 Special Test Interfaces

For support of the SCOE equipment acceptance and for troubleshooting during AIT, the X-Band SCOE shall meet the following requirements:

RFSX-465/ /T

Observation points shall be provided in the X-Band Data Processing unit for observation of the following protocol data:

CADU´s (scrambled)	input data
CADU´s (de scrambled)	intermediate processing state
Transfer Frames (VCDU´s)	intermediate processing state
Source Packets	output data

RFSX-479/ /T

Observation points shall include a serial to parallel conversion (shift register) of > 16 bit length for display and representation of relevant data structures.

RFSX-480/ /R

The electrical characteristics shall comply with standard levels for the direct connection of commercial logic analysers.

3 OPERATIONAL AND CONTROLLER REQUIREMENTS

3.1 Controller

RFSX-794/ /T

The X-Band SCOE Controller shall include the following functions:

- *LAN for CCS communication handling*
- *Local command processing*
- *MMI for local operations and display*
- *Equipment controller for handling and coordination of all processes*

RFSX-795/ /T

The SCOE shall interface via Local Area Network with the CCS to facilitate command and telemetry functions.

Note: The CCS issues commands to the X-Band SCOE controllers in the form of "Command and Control" (C&C) messages as defined in [AD-105] §3. The requirements applicable are given within §5 of this document.

RFSX-797/ /T

The system shall provide automatic and manual (on request) services for a self-test. These services shall check the areas from software to hardware and interfaces including the TM and/or TC chain operation.

RFSX-798/ /T

The X-Band SCOE controller shall provide system monitoring information to the CCS using TM source packets according to [AD-105] § 2.3.3:

- *TM packets generated shall have an APID identifying the X-Band SCOE as defined in [AD-105] Annex 2*
- *The X-Band SCOE controllers shall generate periodical system information (X-Band SCOE Housekeeping containing RF equipment and measurement devices read-out values). The packet generation rate shall be local and remote commandable between 1 and 10 seconds.*
- *Housekeeping TM packets delivery shall be independent from the command mode local/remote. Packets shall be sent to the CCS while the communication links to CCS are established.*

RFSX-799/ /T

The X-Band SCOE controller shall as a minimum provide the following functions for controlling and monitoring of the RF equipment:

- *Control of RF measurement and operational equipment*
- *Connection of test equipment to RF path within the RF interface unit*
- *Setting / configuration of the RF test equipment (e.g. spectrum analyser, power meter, frequency counter, attenuator settings, switch positions, ...)*
- *Read out of parameters (RF measurement equipment)*
- *Switch control of the RF switching unit*

RFSX-800/ /T

Error messages to the CCS shall be generated if error reports from the digital section of the SCOE are received (i.e. Reed Solomon error detection, Transfer Frame header errors and others depending on the actual design implementation).

RFSX-801/ /T

Each of the basic equipment functions listed above shall also be available for direct access from the CCS via command from / messages to the CCS while the X-Band SCOE is remotely controlled by the CCS.

RFSX-802/ /T

Total RF power shall be determined including correction factors for the RF interface hardware as defined above.

RFSX-803/ /T

There shall be an automated procedure to determine the phase noise of the unmodulated carrier. The software shall include filtering of disturbance from mains harmonics and pass/fail evaluation of the measured spectrum.

RFSX-804/ /T

The spectrum measured in the RF test equipment shall be down loaded to the controller and shall be further analysed with regard to the signal bandwidth and the envelope shape of the signal spectrum.

3.2 Operational Requirements

RFSX-807/ /T

Local and remote mode shall be available as well as manual operating mode

- *"manual mode" means the front end and measurement devices are operated manually from their control front panels*
- *"local mode" means operation of the SCOE by the X-Band SCOE controller local console with the front end and measurement devices remote control mode*
- *"remote mode" means operating the X-Band SCOE controller by the CCS via C&C commands*

RFSX-808/ /T

The X-Band SCOE shall nominally be operated under remote control from the CCS. In remote mode local commanding shall be disabled with the exception of the switch back to local mode, power on/off and reset.

RFSX-809/ /T

In local mode all equipment of the X-Band SCOE shall be operated from local console's GUI.

RFSX-810/ /T

Switching between local mode and remote mode shall be possible without affecting the operation conditions.

RFSX-811/ /T

It shall be possible to interactively define, modify, store and load /select dedicated profiles of the X-Band SCOE equipment and measurement device pre-settings established to execute the measurement procedures.

RFSX-812/ /T

The operation status of the X-Band SCOE shall be displayed on the local console GUI and - while enabled - in parallel be reported to the CCS according to requirement [RFSX-798].

RFSX-813/ /T

Actual equipment configuration (i.e. all configurable parameters) shall be visible at the local GUI and - while enabled - in parallel be reported to the CCS according to requirement [RFSX-798].

RFSX-814/ /T

Errors shall be reported at the local console GUI and - while connection established - in parallel be reported to the CCS according to [AD-105] §3.8 "unsolicited error event message".

RFSX-815/ /T

The X-Band SCOE shall support manual operation of measurement equipment (e.g. spectrum analyser) including plotting/recording of test data without changing to remote control mode and without any changes of the settings selected on the relevant test equipment.

RFSX-816/ /T

Measurement data plots (e.g. from the spectrum analyser considering any pre-setting) shall be available on file (file type: BMP, TIF or PDF (recommended)). Labelling of spectrum analyser plots shall be possible and shall be stored/available in the plot file.

RFSX-817/ /T

All results and plots from the measurement routines shall be stored an files supporting a unique naming convention identifying the generation date and time and the type of measurement (e.g. yyyy-mm-dd_hh-mm_ASA_plot)

RFSX-818/ /T

Result files shall be remote accessible via the EGSE LAN. Access via FTP shall be supported.

RFSX-819/ /T

At any time it shall be possible to initiate a hardcopy of the spectrum analyser screen without interfering the spectrum analyser settings.

RFSX-820/ /T

On the X-Band SCOE local console GUI the status of all SCOE units shall be continuously displayed by means of the cyclical equipment read-outs. Such status display shall be independent from the command mode local / remote.

The status information to be provided shall be as a minimum:

- *TM status*
- *TM data (e.g DL carrier lock; DL sub-carrier lock; DL data lock)*
- *last measurement results*
- *Measurement Routine status*

RFSX-821/ /T

The operation status of the SCOE shall be reported to the CCS by means of cyclic EGSE Internal HK TM Source Packets according to [AD-105]. The HK TM packet generation shall be selectable, i.e. enabled / disabled on individual packet level by command from the CCS [AD-105]. HK TM packets to the CCS shall provide at least the following information:

- *SCOE mode*
    - *Controller status*
    - *Link status*
- *RF equipment settings*

- *RF I/F unit switch and attenuator status*
- *Bypass I/F status (if available)*
- *Receiver status (e.g. lock status, ...)*
- *Status indication and signal quality indictaion detected by trellis decoding*
- *Unit status*

- *Digital section status (if available)*
  - *Frames lost and data correction counter due to losses detected by RS*
  - *Front end unit / frame synchroniser status*
  - *Mass memory unit status (e.g. free disk space, ...)*
  - *Data distribution status*

RFSX-822/ /T

The equipment read-outs (constituted by constant settings and variable measurement values as well as measurement results, measurement execution status etc.) form SCOE internal HK TM parameters shall be cyclically forwarded to the CCS within a HK TM packet [RFSX-798].

RFSX-824/ /T

It shall be possible to continue SCOE operation during test result plotting.

RFSX-825/ /T

It shall be possible to print out any information visible to the local screen.

Note: a printer shall NOT be provided with the X-Band SCOE for the project.

RFSX-828/ /R

The X-Band SCOE controller shall as a minimum provide the following functions for control and monitoring of the digital data processing:

- *mass memory unit operation control*
- *download of virtual channel assignment list*
- *download of packet Id to virtual channel assignment table*
- *Packet selection for distribution to the Instrument EGSEs for further processing*
- *select / de-select Reed Solomon error detection mode*

RFSX-829/ /R

The X-Band SCOE controller shall provide as a minimum the following software for automated equipment configuration and testing:

- *The SCOE controller shall be able to define and store test configurations / RF equipment setup characteristics under a unique configuration name.*
- *The X-Band SCOE controller shall be able to establish a pre-defined test configuration / RF equipment setup characteristics by recalling the configuration name*
- *Software shall be provided to support automated calibration of the RF interface hardware (RF Interface unit, Bypass interface and RF harness) down to the RF test equipment and the X-Band receiver by use of the calibration signal source defined above.*

RFSX-1296/ /T

The X-Band SCOE shall record in real-time the incoming X-Band data stream onto the mass memory unit.

RFSX-831/ /T,R

While operating the X-Band SCOE via bypass link (nominal or redundant) it shall be possible to operate the RF path simultaneously down to and including the X-Band receiver (i.e. switching, attenuator settings, RF power / spectrum measurements, receiver operation up to receiver in lock status). Vice versa, while operating the RF path, any setting / commanding of the bypass links shall not affect the data transmission via the RF path (i.e. the receiver shall NOT go out lock).

4 DESIGN, IMPLEMENTATION AND VERIFICATION

RFSX-835/ /R

The X-Band SCOE equipment shall be provided rack-mounted.

Note: This is also valid for Option "digital SCOE only".

RFSX-836/ /R

A Mains Isolation Transformer Unit (MITU) shall be used to power the X-Band SCOE.

The connected X-Band SCOE equipment in X-Band rack specifies the power demand to be satisfied by the MITU (estimate: < 3kVA).

Note: For each rack (X-Band / S-Band) a dedicated MITU shall be available.

MITU shall be procured from the manufacturer Trafo Schneider (URL: http://www.trafo-schneider.de).

RFSX-838/ /R

The equipment shall be integrated in housings according to chapter §5.5.5.2.

The cabinet shall include an AC control chassis, featuring the following characteristics:

- *Mains input including ON/OFF switch on front panel*

RFSX-841/ /R

The full function and performance test shall include the quantifiable functions and parameters of the product (performance, accuracy, etc.) in all operational modes specified.

RFSX-842/ /R

Acceptance test shall be carried out at end of the delivered cable.

RFSX-843/ /R

The product functional performance test shall include the following:

- *All command functions*
- *All telemetry functions and parameters*
- *All operational modes and*
- *All transitions applicable*

RFSX-844/ /R

Performance parameters derived from requirements given in the sections above shall be measured under all relevant boundary conditions.

5 GENERAL DESIGN AND INTERFACE REQUIREMENTS

Applicability Log Information

Created by:	Peter.Karl
Source Module Path:	/Sentinel-2/L-2_Support/GDIR
Source Module Issue:	3.0
Source Filter:	C_RFS_X == Y
Source Filter Applied:	true
Source Current View:	Standard view
Date(mm/dd/yyyy):	03/03/10 15:33:58

5.1 System Definitions and Assumptions

5.2 General Requirements

5.2.1 General Design Requirements

5.2.2 Mechanical Design and Interface Requirements

5.2.3 Thermal Design and Interface Requirements

5.2.4 Optical Design and Interface Requirements

5.2.5 Electrical Design and Interface Requirements

5.2.5.1 General Requirements

RFSX-908/GDIR-487/R

All interfaces shall be referenced by a specific Interface Code. The tables below lists all the standard interfaces:

Interface Code	Interface Designation	Current	GDIR Sub-Chapter
AN1	Analogue TM Acquisition -5V to +5V		x.2.5.4.5
AN2	Analogue TM Acquisition 0V to +5V		x.2.5.4.5
AN3	Analogue TM Acquisition -10V to +10V		x.2.5.4.5
AN4	Thermocouple Acquisition		x.2.5.4.5
ANF	Temperature Acquisition Type 3 : Fenwall		x.2.5.4.6
ANout	RW torque control		x.2.5.4.29
ANP	Temperature Acquisition Type 2: PT-1000		x.2.5.4.6
ANY	Temperature Acquisition Type 1 : YSI		x.2.5.4.6
BAV	Battery VoltageInterface		x.2.5.4.19
BCH	Battery Charge Interface		x.2.5.4.21
BCU	Battery Current Interface		x.2.5.4.22
BLD	Digital Bi-Level TM Acquisition		x.2.5.4.9
BS	Battery Simulation Interface		x.2.5.2.6.2
BUV	Bus Voltage Interface		x.2.5.4.20
CSM MTR CTL	CSM stepper motor interface		x.2.5.4.27
EHP	Extended High Power On/Off Command		x.2.5.4.7.2
EQSOL	Equipment Switch OFF Line		x.2.5.4.24
FCL-A	Foldback Current Limiter Power Class A:	1A	x.2.5.2.2.5.2
FCL-B	Foldback Current Limiter Power Class B:	2A	x.2.5.2.2.5.2
FCV	Flow Control Valve Command Interface		x.2.5.4.12.2
HSDL	High Speed Data Link		x.2.5.4.14
ISD	Input Serial Data		x.2.5.4.16.2
LBR	Measurement Data Interface		x.2.5.4.17
LCL-A	Latching Current Limiter Power Class A:	1A	x.2.5.2.2.5.2
LCL-B	Latching Current Limiter Power Class B:	2.5 A	x.2.5.2.2.5.2
LCL-C	Latching Current Limiter Power Class C:	5A	x.2.5.2.2.5.2
LCL-D	Latching Current Limiter Power Class D:	8A	x.2.5.2.2.5.2
LCL-E	Latching Current Limiter Power Class E:	10A	x.2.5.2.2.5.2
LCL-F	Latching Current Limiter Power Class F:	16A	x.2.5.2.2.5.2
LVC	Latch Valve Command Interface		x.2.5.4.12.1.1
LVDS	Low Voltage Differential Signals		x.2.5.4.15
LVS	Latch Valve Status Interface		x.2.5.4.12.1.2

Table 5.2-1: Interface Codes Table 1

Interface Code	Interface Designation	Current	GDIR SubChapter
MBC	Main Bus Conditioning Interface		x.2.5.4.23
MIL	MIL-STD-1553B Interface		x.2.5.4.1
MTQ	Magnetorquer interface		x.2.5.4.32
OSD	Output Serial Data		x.2.5.4.16.1
PBA	Battery Power Interface		x.2.5.2.1.2
POS	Position Sensor Interface		x.2.5.4.35
PPS	Pulse Per Second Interface		x.2.5.4.4.2
10 PPS	10 Pulse Per Second Interface		x.2.5.4.4.2
PSA	Solar Array Power Interface		x.2.5.2.2.1
PTA	Pressure Transducer Acquisition Interface		x.2.5.4.12.4.1
PTS	Pressure Transducer Supply Interface		x.2.5.4.12.4.2
PYR	Pyro Interface		x.2.5.4.11
RDI	Release Device Interface		x.2.5.4.26
RLS	Receiver Lock Status IF		x.2.5.4.10.2
RSA	Relay Status Acquisition		x.2.5.4.8
SADM MTR CTL	SADM stepper motor interface		x.2.5.4.28
SAS	Solar Array Simulation Interface		x.2.5.2.5.1
SBDL	Standard Balanced Digital Link		x.2.5.4.2
SECPWR15V	Secondary Power 15V		x.2.5.4.33.2
SECPWR5V	Secondary Power 5V		x.2.5.4.33.1
SHP (SHP26)	Standard High Power On/Off Command		x.2.5.4.7.1
SHP14	Standard High Power On/Off Command		x.2.5.4.7.3
SMD/TK	Shape Memory Device Interface		x.2.5.4.11
Speed	RW speed signal		x.2.5.4.30
SPW	Space Wire		x.2.5.4.13
STC	S-band Digital TC Channel Interface		x.2.5.4.10.1
STM	S-Band Telemetry		x.2.5.4.10.3
SUV	System Undervoltage Interface		x.2.5.4.25
SYNC	Synchronization Clock Interface		x.2.5.4.4.1
TDR	RW torque direction		x.2.5.4.31
TSW	Thermal Heater Switch	1A	x.2.5.2.2.5.2
USL	UART Serial Link Interface		x.2.5.4.3
XTM	X-Band Digital TM Channel IF		x.2.5.4.10.4

Table 5.2-2: Interface Codes Table 2

5.2.5.2 Power Requirements

5.2.5.3 Standard Signals

5.2.5.4 Standard Interfaces

5.2.5.4.1 MIL-STD-1553 Interfaces (MIL)

5.2.5.4.2 Standard Balanced Digital Link (SBDL)

5.2.5.4.3 UART RS-422 Serial Link (USL)

5.2.5.4.4 Timing Pulses

5.2.5.4.5 Analog Acquisition (AN)

5.2.5.4.6 Analog Temperature Acquisitions (ANY, ANP, ANF)

5.2.5.4.7 High Power On/Off Commands (SHP, EHP)

5.2.5.4.8 Relay Status Acquisitions (RSA)

5.2.5.4.9 Digital Bi-Level TM Acquisitions (BLD)

5.2.5.4.10 Communication System Interfaces

5.2.5.4.10.1 S-Band Digital TC Channel Interface (STC)

5.2.5.4.10.2 S-Band Receiver Lock Status Interface (RLS)

5.2.5.4.10.3 S-Band Digital TM Channel Interface (STM)

5.2.5.4.10.4 X-Band Digital TM Channel Interface (XTM)

RFSX-927/GDIR-735/R

The X-Band Digital TM Channel shall consist of one clock signal and eight parallel data lines as shown in Figure below. (For these signals the following abbreviations shall be used):

- *MM1D0 to MM1D7 (Mass Memory 1 Data)*
- *MM2D0 to MM2D7 (Mass Memory 2 Data)*
- *MM3D0 to MM3D7 (Mass Memory 3 Data)*
- *MM4D0 to MM4D7 (Mass Memory 4 Data)*
- *MM1C to MM4C (Mass Memory 1 to 4 Clock)*

where MMxD0 is the MSBit and MMxD7 is the LSBit

RFSX-1340/GDIR-12997/T

Each of the two X-Band Digital TM Channels shall consist of one clock signal and eight parallel data lines.

For these signals the following abbreviations shall be used:

- *MM1D0 to MM1D7 (Mass Memory 1 Data)*
- *MM2D0 to MM2D7 (Mass Memory 2 Data)*
- *MM1C and MM2C (Mass Memory 1 and Mass Memory 2 Clock)*

Note: MMxD0 is the MSBit and MMxD7 is the LSBit

RFSX-1341/GDIR-12998/T,A,R

The interface shall comply with the following characteristics

I/F characteristics	I/F requirement	I/F verification method
Data format	NRZ-L	T
Clock frequency	150MHz/8 = 18,75MHz	T
Clock stability (EOL)	±50ppm	T, A
Duty cycle	50%±3% of period	T
Jitter	< 1%	T
Setup/hold time (T_{Setup}/T_{Hold})	> 15nsec	T
Cable type	TSP 100 Ohm	R

Figure 5.2-1: X-Band to MMFU interface characteristics

RFSX-929/GDIR-738/T

The timing of the X-Band Digital Data Channel shall comply with the following:

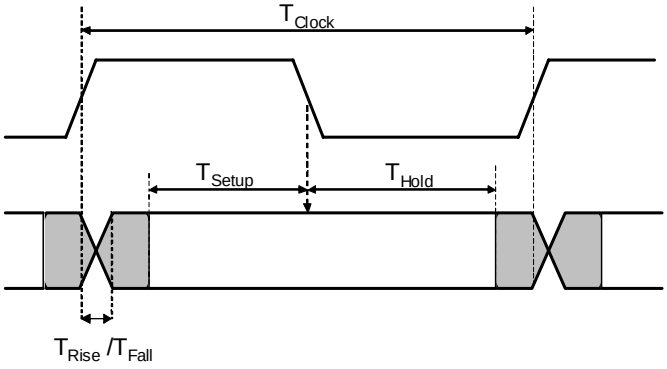

Figure 5.2-2: X-Band timing diagram

5.2.5.4.11 Release Initiator Interfaces

5.2.5.4.12 Propulsion Interfaces

5.2.5.4.13 SpaceWire (SPW)

5.2.5.4.14 High Speed Data Link (HSDL)

5.2.5.4.15 Low Voltage Differential Signals (LVDS)

RFSX-935/GDIR-813/R

The LVDS interface is dedicated to serial digital data links or synchronisation signals. The link is based on the LVDS Standard ANSI/TIA/EIA-644-A [ND-231], see Figure below.

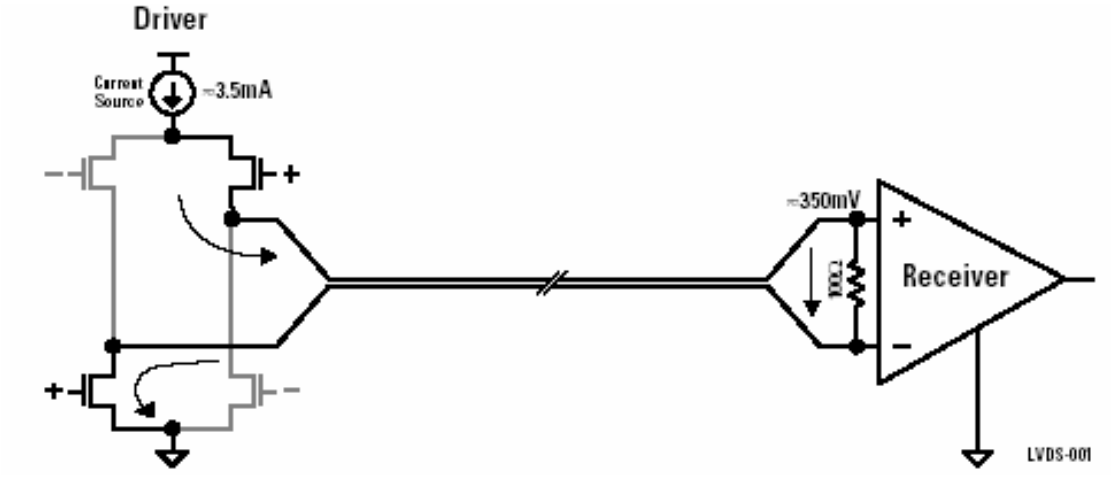

Figure 5.2-3: LVDS

V_{OD} Output differential voltage: the amplitude result of (DO+) - (DO-).

V_{OS} Offset voltage: the common-mode voltage of the LVDS output.

Note: The typical output voltage swing is 350mV at better than 200Mbps into a 100 ohm load, across a distance of about 10 meters.

RFSX-937/GDIR-815/T,A,R

Low Voltage Digital Signal interface:

The (sub-)contractor shall design his side of the interface to be compliant to the characteristics as defined in Interface Datasheet "LVDS", Table below

Each sub-requirement/parameter shall be verified by the method defined in column “Ver.Meth”.

INTERFACE DATASHEET				Page 1 / 1
Sub Req	I/F-Desig: **Low Voltage Differential Signal (LVDS)**	IF-Code: **LVDS**	***Ver. Meth***	***Note***
	Source Circuit Specification			
-1	Circuit type	LVDS driver	R	
-2	Transmission type	Differential (complementary outputs)	R	
-3	Signal Transfer	DC coupled, referenced to signal ground	R	
-6	Output Voltage High	< 1.65 V (True/Compl. line with ref. to Signal-Gnd)	T	(1)
-7	Output Voltage Low	> 0.9 V (True/Compl. line with ref. to Signal-Gnd)	T	(1)
-8	Differential output volt. low	-0.45 V to -0.25 V (True with ref. to Compl. Line)	T	(1)
-9	Differential output volt. high	+0.25 V to +0.45 V (True with ref. to Compl. Line)	T	(1)
-10	Output offset voltage	1.125 V to 1.45 V	A/T	(1,2)
-11	Rise/Fall Times (20 -80%)	2 ns max.	T	(1)
-12	Differential Skew	2 ns max.	T	
-13	Short Circuit Output Current	9 mA max.	A	(4)
-14	Fault voltage emission	-0.3 V to + 4.0 V	A	(4)
-15	Fault voltage tolerance	-0.3 V to + 4.0 V	A	(4)
	Receiver Circuit Specification			
-16	Circuit type	LVDS receiver	R	
-17	Termination	Differential: 100 Ohm +/- 1% resistor across inputs	R	
-18	Transfer	DC coupled	R	
-19	Input voltage range	0 V to 2.4 V	A/T	(2)
-20	Differential input low threshold	-0.1 V (detect low level for signals below -0.1 V)	T*,A	(3)
-21	Different. input high threshold	+0.1 V (detect high level for signals above +0.1 V)	T*,A	(3)
-22	Threshold hysteresis	25 mV min.	A/T	(2)
-23	Common mode voltage range	-1 V to +1 V centered around +1.2 V	A/T	(2)
-24	Fail-safe	unconnected receiver shall detect “Logic 1”	A	
-25	Fault voltage emission	-0.3 V to + 4.0 V	A	(4)
-26	Fault voltage tolerance	-0.3 V to + 4.0 V	A	(4)
	Harness Specification			
-27	Wiring type	Twisted Shielded Balanced 100 Ohm	R	
-28	Shielding baseline	Shield at backshell on source and receiver side	R	(5)
	Notes: (1) into load 100 Ohm +/- 1% (2) alternative verification methods (3) Test with nominal levels, Analysis for worst case characteristics (4) each terminal with ref. to ground (5) for Spacewire links the shielding shall be as given in ECSS-E-50-12A			

Table 5.2-3: LVDS interface data sheet

RFSX-939/GDIR-13024/R

Both sides, driver and receiver shall be supplied by the same voltage (either Vdd = 3,3V or 5V). To be agreed with prime contractor.

RFSX-940/GDIR-13025/T

All receivers shall provide a high input impedance when off (cold sparing).

RFSX-1236/GDIR-13026/R

A separate ground pin shall be available to have the possibility to connect the isolated inner shield to the unit signal ground for each interface.

Note: A dedicated pin will be provided at the C/B interface to have the possibility to connect the isolated inner shield.

For compliance to the parameters defined by the Interface Datasheet "LVDS", driver and receiver circuit devices shall comply to LVDS Standard ANSI/TIA/EIA-644-A [ND-231]. Use of the following circuit devices is recommended:

(a) Source circuit: UT54LVDS031 or UT54LVDS031-LV

(b) Receiver circuit: UT54LVDS032 or UT54LVDS032-LV

5.3 Environment Design Requirements

5.4 Satellite, Instrument & Unit Level Environment Test Requirements

5.5 GSE Design and Interface Requirements

5.5.1 General GSE Requirements

RFSX-948/GDIR-1271/R

GSE shall be designed for the execution of assembly, integration, verification, transportation, launch preparation and launch support and maintenance of satellite items and spares.

Note: As a reminder the satellite includes both the platform and the instruments.

RFSX-949/GDIR-1274/R

GSE and AIV tools shall comply with requirements and safety standard imposed by the facility in which it has to operate. E.g. GSEs supplied for use in Europe or at the launch site shall be certified to comply with the safety requirements applicable to the spacecraft prime contractor. GSE shall be delivered with a CE markings and associated Declaration of Conformity certificates.Specific MGSE load certificates are also required.

RFSX-950/GDIR-12766/R

No GSE fault shall propagate through the interface with flight or other hardware.

5.5.2 GSE SUPPORT REQUIREMENTS

5.5.2.1 GSE Lifetime

RFSX-1342/GDIR-12759/R

GSE shall be designed for a minimum lifetime of 7 years (after acceptance).

RFSX-954/GDIR-2141/A

The EGSE shall generally be designed for continuous operation. Test periods of up to 20 days shall be supported without the need for interruptions due to resource limitations such as disk space or storage medium exchange or routine maintenance activities.

RFSX-956/GDIR-2144/A

The EGSE shall be designed to withstand at least 10 cycles of packing, transport, storage, unpacking and preparation for use.

5.5.2.2 Safety / Design Margin

5.5.2.2.1 General Safety Requirements

RFSX-959/GDIR-12778/T

Safety devices in the GSE shall be tested w.r.t. function and performance.

5.5.2.2.2 Ground Safety Design Criteria

RFSX-961/GDIR-2147/R

No material shall be used which may constitute a risk to the health of personnel.

RFSX-962/GDIR-2149/R

GSE shall in no way be able to endanger the spacecraft system and / or operating personnel. Fail-safe design shall be built in to ensure, that any single point failure in the GSE does not propagate and cause damage to the on-board equipment.

RFSX-963/GDIR-2150/R

The GSE elements shall be designed for tolerance to failures in interfacing equipment (i. e. the onboard equipment or other GSE elements).

RFSX-964/GDIR-1367/A

Safety critical functions which are identified in the safety analysis shall be fail safe in the event of one credible failure, including facility outages.

RFSX-965/GDIR-1492/R

Physical access for safety critical operations or maintenance functions shall be provided. Protrusions which create a hazard such as hoses, wave guides, cables, brackets etc, which cannot be eliminated by design, shall be made to be removable during service or maintenance functions.

RFSX-966/GDIR-1493/R

Moving parts such as fans, belt drives, turbine wheels and similar components that could cause personnel injury or equipment damage due to inadvertent contact or entrapment of floating objects shall be provided with guards or other protective devices.

RFSX-967/GDIR-1495/R

Personnel shall be protected from equipment which can generate high or low temperatures, greater than 45°C (113°F) or less than 0°C (32°F). This equipment shall be shielded, insulated, isolated and/or oriented away from personnel, and labelled to warn them of the danger.

RFSX-968/GDIR-1504/I

All controls and indicators shall be clearly marked or labelled to indicate system function.

RFSX-969/GDIR-1505/I

Emergency controls (electrical or mechanical) used for shutdown, safing, alarm or corrective action shall be clearly marked, visible and readily accessible to operating personnel.

RFSX-970/GDIR-1507/I

Gross weight and centre of gravity shall be conspicuously identified on all equipment required to be lifted or moved by hoists, cranes, forklifts and similar handling equipment.

RFSX-971/GDIR-1510/R

Wheeled equipment shall have self-contained or foot operated wheel locking devices.

RFSX-972/GDIR-1512/I

All connectors (e.g. electrical, hydraulic, pneumatic) shall have tethered caps, plugs or covers to protect against contamination or damage when unmated.

RFSX-973/GDIR-1515/I

All temperature gauges, pressure gauges, electrical meters and similar readout devices shall be colour banded to indicate system operating, marginal and hazardous range limits.

RFSX-974/GDIR-1516/R

All temperature gauges, pressure gauges, electrical meters and similar readout devices shall indicate normal system operating range within the centre 50 percent of the total range of the read-out device.

5.5.2.2.3 Electrical and Electronic Safety Criteria

RFSX-976/GDIR-1520/I

All GSE shall meet the requirements for product liability in the "Product Assurance and Safety Requirements for Subcontractors" [AD-1] .

RFSX-978/GDIR-1522/I

All racks, chassis and compartments which contain exposed terminals and similar components shall be clearly marked or placarded to indicate the highest operating voltage potential present, when this exceeds 28V.

RFSX-979/GDIR-1525/R

Power circuits and safety critical control circuits shall not be routed through the same connector in order to minimise the introduction of voltage transients into signal wiring.

RFSX-980/GDIR-1526/I

Non-bypassable interlocks shall be used to prevent possible shock whenever a voltage in excess of 500 volts is exposed upon opening an access door, cover or plate.

RFSX-981/GDIR-1527/T

All equipment shall automatically revert to a safe configuration when an input power loss occurs and shall include features that prevent hazardous situations occurring to flight hardware and personnel.

RFSX-982/GDIR-1528/I

GSE shall be provided with a power-kill switch accommodated in accessible places to allow rapid power kill in case of contingencies.

RFSX-983/GDIR-1529/R

All cells/batteries shall be designed for electrolyte containment, using hermetically sealed cases.

5.5.2.2.4 Grounding and Bonding Safety Criteria

RFSX-985/GDIR-1532/R

Power lines on GSE shall provide a ground conductor, unless the unit is isolated twice.

RFSX-986/GDIR-1533/I

Each GSE item shall be provided with at least one grounding bolt clearly marked.

5.5.2.2.5 Cable and Wiring Safety Criteria

RFSX-989/GDIR-1536/I

All electrical cables and wires shall be marked to clearly indicate the correct mating connection or termination point to preclude phase reversal or cross-connection.

RFSX-990/GDIR-1537/I

All electrical cables and wiring shall be clamped and supported to remain clear of sharp edges and moving parts.

5.5.2.2.6 Connector and Switch Safety Criteria

RFSX-992/GDIR-1539/R

Only female connectors shall be used as sources of power.

RFSX-993/GDIR-1540/I

All switches shall be clearly marked or labelled to indicate the system function for each switch position.

RFSX-994/GDIR-1541/R

Self-latching function switches such as push-button switch indicators which may be operated without indicating the switch position during a power off phase shall not be used in safety critical circuits.

5.5.2.2.7 Overload Protection

RFSX-996/GDIR-1544/R

Circuit breakers shall provide a visual indication when tripped.

RFSX-997/GDIR-1545/I

Electrical fuse and switch boxes shall be marked on the outside or inside cover to show the voltage present, rated fuse capacity, and equipment that the circuit controls.

RFSX-998/GDIR-1546/R

Overload protection devices shall be installed in each ungrounded conductor in three (3) phase power systems and shall be designed so that all three (3) devices trip simultaneously.

5.5.2.2.8 Handling and Transport Safety Criteria

5.5.2.2.9 Handling Transportation and Storage Protective Equipment

5.5.2.2.10 Fault Tolerance Design

5.5.2.2.11 Operational Safety

RFSX-1003/GDIR-1577/R

Safe operation limits shall be specified in the operational handbooks for the system and its associated GSE, and for all lower levels of integration and its associated GSE.

RFSX-1004/GDIR-1578/I

Labelling, colour codes, switch conventions, and the procedures and communications language shall be standardised, and the standard declared.

5.5.2.3 Cleanliness

RFSX-1006/GDIR-1788/I

All Ground Support Equipment to be used in clean rooms shall be compatible with the materials and cleanliness requirements for that clean room class, and their external surfaces shall be cleaned before delivery and cleanable at the time of use according the standard ISO 14644 part 1- part 8 [ND-261].

RFSX-1007/GDIR-1792/R

Contractors shall develop detailed methods and procedures for attaining the cleanliness levels required for the product both during use and storage.

RFSX-1008/GDIR-1793/R

Any moving parts shall be designed such that lubrication is either unnecessary or can be accomplished by the use of dry lubricants.

NOTE: If it is essential that conventional oil or grease is used, there shall be adequate provision of bellows, seals etc. to prevent contamination.

RFSX-1009/GDIR-1794/I

Ground support equipment designed for use in clean rooms shall be delivered cleaned with Iso Propyl Alcohol / Water (50/50).

5.5.2.4 General Test Requirements

5.5.2.5 Parts, Materials and Processes

5.5.2.5.1 Electrical Parts

RFSX-1013/GDIR-1740/R

All EEE parts used in GSE shall comply with the design life requirements of the related GSE.

5.5.2.5.2 Materials and Mechanical Parts

5.5.2.5.3 Corrosion and Corrosion Protection

5.5.2.5.4 Dissimilar Metals

5.5.2.5.5 Coating Material

5.5.2.5.6 Moisture and Fungus Resistance

5.5.2.5.7 Wooden Material

RFSX-1020/GDIR-1765/R

All MGSE container or wooden equipment shall be in accordance with the Import Regulation valid for wooden packing materials as defined by:

•International Plant Protection Convention, (IPPC) and its International Standard for Phytosanitary Measures, Publication Number 15 [ND-260]

5.5.2.5.8 Materials and Mechanical Parts Restrictions

5.5.2.5.9 Design Lifetime and Warranty

RFSX-1023/GDIR-1780/R

All AIV Tools shall be designed for an operational lifetime commensurable to the expected maximum launch delay. Maintenance requirements and frequency shall be minimized and such operation shall be executable in an easy way.

5.5.2.6 Maintenance, Reliability and Availability

RFSX-1025/GDIR-1784/R

The contractor shall be responsible to establish a maintenance plan to be applied to all GSE utilized in the frame of S/C programme.

RFSX-1026/GDIR-1785/R

It shall be possible to localise any failure in the GSE, which would require replacement/repair, during assembly and test including processing at the launch site. Any standard equipment necessary for this shall be identified. Non-standard equipment shall be supplied as part of the GSE.

RFSX-1027/GDIR-1786/R

GSE spares and repair parts shall be of the same (or better) design standard than the item they replace.

RFSX-1028/GDIR-2165/R

The GSE shall be manufactured and assembled to the usual standards of ground based electronic instrumentation and engineering practice of spacecraft testing. Judgement and acceptance of GSE shall be based on design margin applied, possible failure modes and their effect, and soundness of the design.

RFSX-1029/GDIR-2166/R

The EGSE shall be designed for a minimum downtime including routine maintenance in order not to jeopardize the overall satellite AIV program schedule.

For EGSE, a maximum reliability shall be attained by a combination of the following services to be provided by EGSE suppliers:

- *24 hours response service for "first aid" trouble shooting support.*
- *spare parts, maintenance, and repair service which guarantees a down time of not more than 48 hours.*

5.5.2.7 Interchangeability & Replaceability

RFSX-1031/GDIR-2168/R

GSE sub-assemblies, parts and components bearing the same part number (i.e. configuration item (CI))shall be both physically and functionally interchangeable.

5.5.2.8 Identification (Name Plate) and Marking

RFSX-1033/GDIR-1796/I

Nameplates shall be provided for component identification and shall contain the following information:

1 Manufacture /Supplier

2 Part Number

3 Serial Number

4 Configuration Item (CI) Number

5 Nomenclature of the Item

6 CE Conformity

Table 5.5-1: Information to be displayed on the nameplate

RFSX-1034/GDIR-12746/I

Each container shall in addition to the above be marked with:

1 Project Name

2 Owner of the Item

3 Weight

4 Safe Working Load

5 Date of Manufacturing

6 Date of Proof Test

8 Proof Load

8 Date of Retest

9 Retest Load

10 Retest Cycle

11 Item COG

12 Bonding point identification

13 Hoisting point identification

14 Spezial safety instructions

15 Content identification / serial number

16 Reusable container marking

Table 5.5-2: Information to be displayed on the Container

RFSX-1035/GDIR-1846/I

Nameplates shall be provided for each GSE item or for each sub-assembly where periodic dismantling of the main assembly is foreseen.

RFSX-1036/GDIR-1847/R

The locations of nameplates shall be defined on the assembly drawing.

RFSX-1037/GDIR-1848/I

All electrical cables shall be identified by means of a wire colour code or numbering system.

RFSX-1038/GDIR-1849/I

All accessible electrical cable harness bundles shall be readily identifiable as power or signal lines.

RFSX-1039/GDIR-1850/I

Connections shall be permanently marked with corresponding numbers, for ready identification and the avoidance of mismatching.

RFSX-1040/GDIR-1851/I

All electrical power connections at which the voltage between two pins or between any pins and ground exceeds 28V, shall be marked clearly with the voltage and with 'AC' or 'DC' as applicable.

RFSX-1041/GDIR-1855/I

All markings shall be in English wording and in metric units.

RFSX-1042/GDIR-1858/I

Any GSE printed circuit boards and similar electronic assemblies shall be uniquely identified by markings containing the following information

a) Manufacturer source

b) Part number

c) Serial number

d) Modification status

RFSX-1043/GDIR-2260/R

The identification labels of EGSE drawers shall be located such that removal of the drawers is not necessary in order to ascertain their part number. All Printed Circuit Boards (PCB) and other removable items shall be clearly marked with their part number. All part numbers shall include their relevant change / revision index.

Instruction plates shall be securely fastened to enclosures instrument panels and shall be placed in positions where they can easily be read.

Precautionary markings shall be provided as necessary to warn personnel of hazardous conditions and precautions to be observed.

RFSX-1044/GDIR-2261/R

A numbering system shall be used for identification of cables, plugs and connectors of all EGSE components. These ID numbers shall appear on all relevant diagrams, drawings and associated parts lists and manuals. Labeling the cable itself is outlined in the figure below.

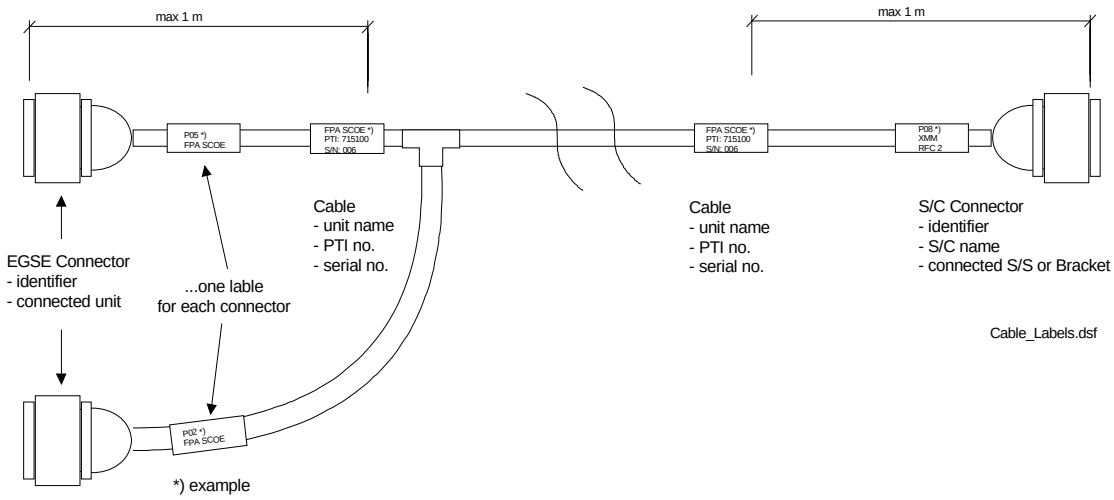

Figure 5.5-1: Harness Identification - Example

5.5.3 Mechanical Ground Support Equipment

5.5.3.1 MGSE for Satellite AIT

5.5.3.2 MGSE for Transport

RFSX-1049/GDIR-2173/R

The centre of gravity of transportation containers shall be as low as possible and the wheels shall be attached at the utmost points of the edges to prevent tilting during movement.

RFSX-1050/GDIR-2174/I

All GSE items shall be provided with re-useable containers to comply with the transport and storage environments given herein.

RFSX-1051/GDIR-2182/I

GSE containers shall be equipped with protected clamps or countersunk butterfly nuts for closing and opening.

RFSX-1052/GDIR-2183/I

GSE containers for racks shall be equipped with ramps including guidances for safe rack loading and unloading.

RFSX-1053/GDIR-2184/I

EGSE containers maximum height (outside dimension) shall be 2.25 m.

5.5.4 Fluid Ground Support Equipment (Propellant Servicing Equipment)

5.5.5 EGSE Support Requirements

5.5.5.1 Communication Requirements

This chapter establishes requirements for all FEE which shall be operated by the **CCS** in any EGSE configuration. The term “Front End Equipment” herewith refers to all EGSE items (i.e. Front Ends, SCOEs, Instrument EGSEs, e.t.c) connected to the CCS and operated through the **CCS** via LAN.

5.5.5.1.1 Function Requirements

5.5.5.1.1.1 Command and Control

RFSX-1060/GDIR-1967/T

The FEE shall execute standard functions called by keyword as defined in the EGSE ICD [AD-105].

Below the keywords are listed representing C&C messages from the CCS identifying mandatory and optional standard functions by the FEE. Functions defined by these keywords shall only be used according to the syntax defined in the EGSE ICD [AD-105], §3.

Keyword		\AD-105**, § 3**
TRANSFER	mandatory	1
RESET	mandatory	2
RESTART	optional	3
START / STOP HALT / CONTINUE	optional	4
APPLY	optional	5
SET	optional	6
REPORT / REPLY	mandatory	7
ERROR	mandatory	8
MESSAGE	mandatory	8
TEST	mandatory	9
GETTM	mandatory	10

Table 5.5-3: Standard functions by FEE

Specific requirements in case of remote commanding by the CCS are given in the section below.

RFSX-1062/GDIR-2018/T

Specific functions executed in the FEE may be defined in addition to the standard functions. Syntax and structure of the C&C messages calling such specific function shall be in accordance to the C&C message definition in the EGSE ICD [AD-105], § 2.3.5. Keywords and command syntax shall be described in detail in the equipment ICD and users manual.

RFSX-1063/GDIR-2019/T

The first two bytes of the C&C message and the HK TM source packet primary header as defined by the EGSE ICD [AD-105], § 2.3.5, shall be configurable by the user.

RFSX-1064/GDIR-2020/T

C&C message and command keywords and arguments shall NOT be case-sensitive.

RFSX-1065/GDIR-2021/T

All functions executed on the FEE shall be called either from the local MMI or by remote command from the CCS.

RFSX-1066/GDIR-2022/R

A complete description of command and control functions available on a FEE shall be defined in the related equipment Interface Control Document and user manual.

5.5.5.1.1.2 Requirements for Communication with CCS

RFSX-1068/GDIR-2024/T

The application protocol shall be implemented as specified in the EGSE ICD [AD-105], chapter 2.2, with the FEE providing server services and the CCS acting as client to all sockets established.

RFSX-1069/GDIR-2025/T

By each FEE two TCP/IP stream sockets shall be established for communication to the CCS. One socket (the receive-link or TC-link) for receiving messages from the CCS and performing the

corresponding handshake, if any. The other socket (the send-link or TM-link) for all messages autonomously sent by the FEE to the CCS (ref. EGSE ICD [AD-105], § 2.2)

RFSX-1070/GDIR-2026/T

*If a command from the **CCS** obtained via the receive-link requests data transmission then this transmission shall be performed using the send-link.*

RFSX-1071/GDIR-2027/T

During startup of the application software system at the FEE the network communication services shall be provided automatically without any manual intervention needed.

RFSX-1072/GDIR-10898/T

The FEE shall provide link server services as long as the FEE application software is running. Neither nominal disconnect by the CCS or the FEE itself nor non-nominal link abort shall require the FEE application software to be re-started. This requires the FEE application software to permanently listen to both ports - also the socket bound to the send-link - in order to detect nominal link disconnect by the remote partner as well as non-nominal link abort and to properly reset the ports upon such event.

RFSX-1073/GDIR-2028/T

*After mains power on or after reset, the FEE shall assume a **local / off-line** operation mode with following characteristics:*

- *remote operation mode inactive (i.e. socket disconnected & off-line - ref EGSE ICD [AD-105], § 2.2.4)*
- *commanding from the FEE local console enabled*
- *all stimulus to the instrument inactive*
- *remote interface to CCS ready to receive socket connection request*

RFSX-1074/GDIR-2029/T

The FEE shall accept and execute command messages (called C&C) from the CCS embedded into command source packets as defined in above reference.

RFSX-1075/GDIR-2030/T

The FEE shall accept a „Transfer remote“ C&C command from the CCS via LAN if the logical link was previously established by a connection request. This command shall bring the FEE into the following configuration:

- *remote operation active (ref. EGSE ICD [AD-105], § 2.2.4)*
- *commanding from the FEE local console disabled, except "switch to local mode"*
- *no change to processes running at the time of switching from local to remote mode*

RFSX-1076/GDIR-2031/T

The FEE shall accept an off-line command from the FEE local console or a „Transfer local“ C&C command from the CCS via LAN. This command shall bring the FEE into the following configuration:

- *remote operation inactive (ref. EGSE ICD [AD-105], § 2.2.4) / logical link is not disconnected*
- *commanding from the FEE local console enabled*
- *if enabled FEE internal HKTM packets generation and transmission to the CCS continues*
- *no change to processes running at the time of switching to remote to local mode*
- *the SCOE shall assume a operation safe mode not causing any hazard to the instrument*

- *remote interface to CCS ready to receive commands*

RFSX-1077/GDIR-2032/T

The FEE shall issue status and error messages to the CCS in the form of C&C messages as defined in above reference. Keywords and message syntax shall be described in detail in the equipment ICD and user manual.

RFSX-1078/GDIR-2033/R

The detailed definition of command and status messages shall be defined based on the actual design implementation of the FEE. As a minimum, messages related to the FEE elements served by the controller shall be processed in accordance to the requirements defined above.

RFSX-1079/GDIR-2034/T

Message, Error, Warning C&C shall be sent to the CCS on FEE status change, only. Such C&C shall be sent only once upon detection of the relevant status. Cyclic repetition of the same error / warning C&C shall be prohibited. E.g. one single error / warning C&C shall be sent upon error situation detection. A message C&C chall be sent if the relevant status returns to nominal.

RFSX-1080/GDIR-2035/R

Error / Warning indications shall be reported to the CCS in the form of binary TM Source packets according to the EGSE ICD [AD-105], § 2.3.3. Such packets shall be generated asynchronous upon event without previously being enabled from the CCS.

The "Event Packet" shall be used to report Errors and Warnings as defined in the EGSE ICD [AD-105], § 2.3.3. 2.

The following Service type 5 sub-types shall be used - sub-types shall be outside value range used for on-board events:

- *Sub-type 241 (i.e. 5,241) = Warning*
- *Sub-type 242 (i.e. 5,242) = Error*
- *Sub-type 253 (i.e. 5,253) = back to normal*

Event packets shall be sent only once upon detection of the relevant error/warning status. Cyclic repetition of the same event shall be prohibited. Reporting a status change back to nominal conditions after a preceding error event can be done using the "back-to-normal" event. The "back-to-normal" event, however, is NOT mandatory.

An ASCII C&C message equivalent to the local console log message may be sent to the CCS in addition being displayed on the CCS log message window.

PUS event packets allow to make use of the standard TM packet / event capture and processing capabilities of the CCS required anyhow for spacecraft TM processing. Capturing and processing (including string parsing) of ASCII based C&C messages usually is not a standard CCS feature.

Different event service 5 sub-types have been selected to clearly distinguish between O/B events and EGSE events.

For cyclic reporting binary HK TM packet shall be used; see requirement below.

RFSX-1081/GDIR-2036/T

For cyclical report of FEE house-keeping data to the CCS specific EGSE Internal HK TM Source Packet(s) shall be provided by the FEE conforming to above reference.

RFSX-1082/GDIR-2037/T

Packet Structure and parameter details shall be described in detail in the equipment ICD and users manual as outlined in EGSE ICD [AD-105], § 2.3.3 - Packet Data Field.

RFSX-1083/GDIR-2038/I

Detailed description of the HK TM Packets and their contents, i.e. each individual measurement / parameter, shall be delivered in electronic form (e.g. Excel Spreadsheet or MS Access DB).

Note: a template - either Excel or Access - will be provided by Astrium and populated by the supplier.

RFSX-1085/GDIR-2040/T

The FEE shall accept a reset command via FEE local console or LAN in on-line mode and via FEE local console in off-line mode. The reset shall bring the complete FEE into the default setting corresponding to the initial status, including disconnect of logical link to the CCS.

RFSX-1086/GDIR-2041/T

Switching between local and remote operation shall be possible in any operation mode without affecting the operation conditions.

RFSX-1087/GDIR-2042/T

Upon switching from local to remote, the FEE shall communicate its operation status to the CCS.

Due to manual intervention during local operation, the CCS software may find the FEE in an operation status when switched back to remote other then has been commanded before. The implementation of this requirement shall avoid unnecessary error messages.

RFSX-1089/GDIR-2044/T

It shall be possible to initiate a self-test mode either locally on the FEE console or from the CCS via the LAN interface depending on the control status.

Self-test may be executed only, if the FEE application software is in "offline" mode, i.e. no processing with the on-board system / instrument.

RFSX-1091/GDIR-2046/T

The detailed results of the self-test shall be available at the CCS and at the local console as an OK / not OK message including error reporting (type of error, diagnostic message) for investigation if the self test was not OK.

RFSX-1092/GDIR-2047/T

Self-tests shall be possible with the EGSE connected and disconnected to the on-board equipment.

Special attention shall be paid to the interfaces connecting the EGSE with the on-board equipment. The self-test shall prove that those interfaces are in a well defined status such that no hazard is caused to the instrument or other on-board equipment.

5.5.5.1.1.3 Log Files Management

RFSX-1095/GDIR-2050/T

During operations in local mode as well as in remote mode the following information shall be recorded in ASCII log files:

- *Instructions, commands, and messages received from the CCS*
- *keyboard entries during local operation*
- *all events, messages, errors etc. occuring during operations (sent to the CCS in remote mode)*
- *(Note: on the local log file error situation might be reported cyclically in contrary to requirement above, but the log file shall NOT contain cyclic acquired equipment telemetry and measurement data)*

•*operator messages to the local display generated during local mode operation*

RFSX-1096/GDIR-2051/T

Log files management

a) Log files shall be created upon application software startup on the FEE controller local disk on a folder dedicated to log files, only.

b) Unambiguous file names shall be provided indicating the test by name (if applicable) and the creation time.

c) The size of a log file shall be limited to a reasonable file size. File size criteria shall be number of lines and/or number of bytes (e.g. <500 lines / <1Mbyte). If this size is reached the current log file shall automatically be closed and new file shall be opened.

d) Log files size criteria shall be configurable by the user.

e) New log file shall be forced to be opened at the beginning of a new day (i.e. time = 00:00).

f) Log files closed shall be accessible by the operator.

g) Log files shall not be automatically deleted or overwritten.

h) Each Log file entry shall be one single line of ASCII text. The log entry line shall be structured by columns with an identifiable column separator (preferred TAB).

i) A "CLOSELOG" command shall be provided to allow the user to force closing the actual log file by local as well as remote command. This command shall cause the actual log file being closed and new log file opened without data loss

j) Log file naming shall be according to the following rules:

<date>_<time>[_<identifier>].<extension>

<date> ::= yyyy-mm-dd / the date field may be omitted if the log files are maintained by sub-folder per day. In this case the <date> nomenclature applies to the sub-folder naming.

<time> ::= hh-mm-ss / time of log file creation

<identifier> ::= any text; optional, e.g. test name. Special characters are NOT allowed except hyphen and underscore. Blank / space character is NOT allowed in a file name.

<extension> ::= LOG

RFSX-1097/GDIR-2052/T

Each entry to a log file shall be preceeded by a time stamp indicating date and time obtained from the controller system time in the format " jjjj.mm.dd hh:mm:ss".

RFSX-1098/GDIR-2053/T

All events subject to log file entry shall be able to be visualised on-line (i.e. at time of occurence) in a display window on the controller local console. Filters shall be able to be applied to allow the operator to only display selected entry types (i.e. Error, Warning, Message, e.t.c.) or all entries.

RFSX-1099/GDIR-2054/T

It shall be possible to browse through the log files directory by means of standard (i.e. operating system utility) file manager and to retrieve a log file corresponding to time and date of a test and to display / print the selected log file contents.

RFSX-1100/GDIR-2055/T

The log files shall be accessible from any LAN connected computer (e.g. the CCS or the global archiving) via FTP.

5.5.5.1.1.4 HK TM Archive Files Management

RFSX-1102/GDIR-2057/T

In case HK TM Packet generation has been started either locally or by remote command from CCS and the TM link to the CCS is not established, these HK TM Packets shall be recorded locally by the FEE controller in a telemetry archive file in the form of binary EGSE internal HK TM Source packets as generated for transfer to the CCS (see EGSE ICD [AD-105], § 2.3.3). -> Re-direction of the HK TM packets datastream to file, if the socket is not established.

Upon link re-establishment the re-direction shall be cancelled and new HK TM Packets routed to the CCS again. Dump of the archive files contents to the CCS shall NOT be done.

While the TM link is established from the CCS such local archiving is not required as all HK TM packets are transferred to the CCS and are subject to central archiving by the CCS.

RFSX-1104/GDIR-2059/T

Archive files management

a) Archive files shall be created on the FEE controller local disk on a folder dedicated to archive files, only.

b) Unambiguous file names shall be provided indicating the test by name (if applicable) and the creation time.

c) The size of an archive file shall be limited to a reasonable file size. File size criteria shall be number of packets and/or number of bytes (e.g. <500 packets / <1Mbyte). If this size is reached the current archive file shall automatically be closed and new file shall be opened.

d) Archive files size criteria shall be configurable by the user.

e) New archive file shall be forced to be opened at the beginning of a new day (i.e. time = 00:00).

f) Archive files shall not be automatically deleted or overwritten.

g) Archive files closed shall be accessible by the operator

h) A "CLOSEARCHIVE" command shall be provided to allow the user to force closing the actual archive file by local as well as remote command. This command shall cause the actual archive file being closed and new archive file opened without data loss

i) Archive file naming shall be according to the following rules:

<date>_<time>[_<identifier>].<extension>

<date> ::= yyyy-mm-dd / the date field may be omitted if the archive files are maintained by sub-folder per day. In this case the <date> nomenclature applies to the sub-folder naming.

<time> ::= hh-mm-ss / time of archive file creation

<identifier> ::= any text; optional. Special characters are NOT allowed except the hyphen and the underscore. Blank / space character is NOT allowed in a file name.

<extension> ::= BIN

RFSX-1105/GDIR-2060/T

It must be possible to browse through the archive files directory by means of standard (i.e. operating system utility, for PC: Windows Explorer) file manager and to retrieve an archive file corresponding to time and date of a test and to display / print the selected file contents.

For visualisation (i.e. display and print) of binary information such as archived HK TM packets commercial off-the-shelf tools (e.g. "Hex-Editor" by the operating system; UltraEdit-32 are considered sufficient. Dedicated application is **NOT** mandatory. Interpreting specific data structure, such as the "TM Source

Packet", is **NOT** required.

RFSX-1107/GDIR-2062/T

The archive files shall be accessible from any LAN connected computer (e.g. the CCS or the global archiving) via FTP.

5.5.5.1.2 Interface Requirements

The only interface used for FEE´s to communicate to the CCS is the Ethernet network. The topology of such network is driven by the FEE´s grounding needs to avoid ground loops. As the CCS is constituted of commercial computer equipment and not necessarily operated through an isolation transformer two different approaches to fulfil the grounding requirements are considered as shown in the Figure 5.5-2 and Figure 5.5-3 below.

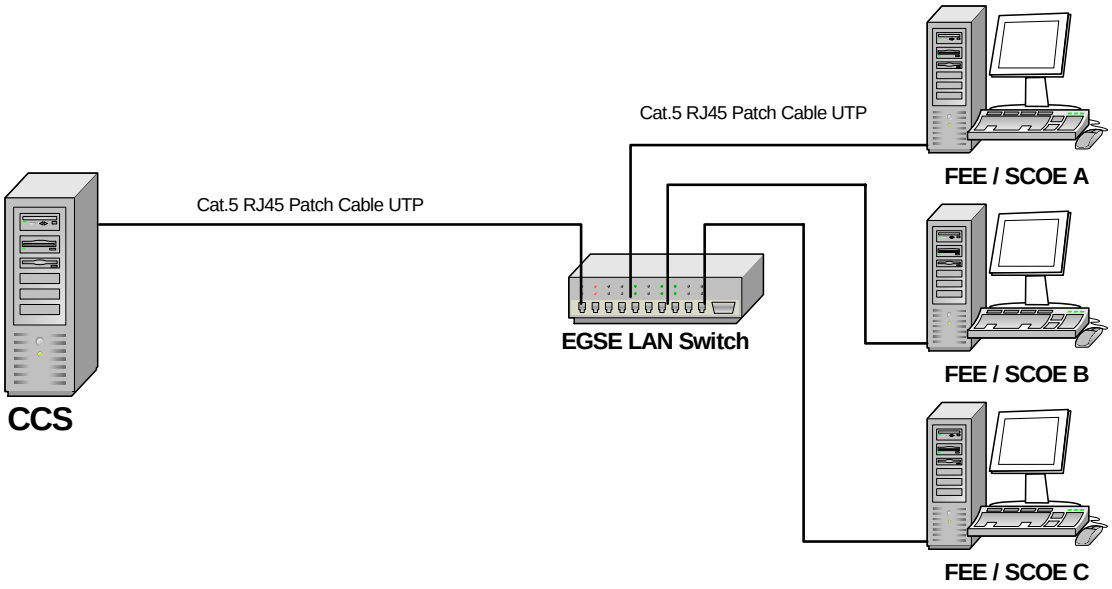

Figure 5.5-2: EGSE LAN Topology using unshielded Cable

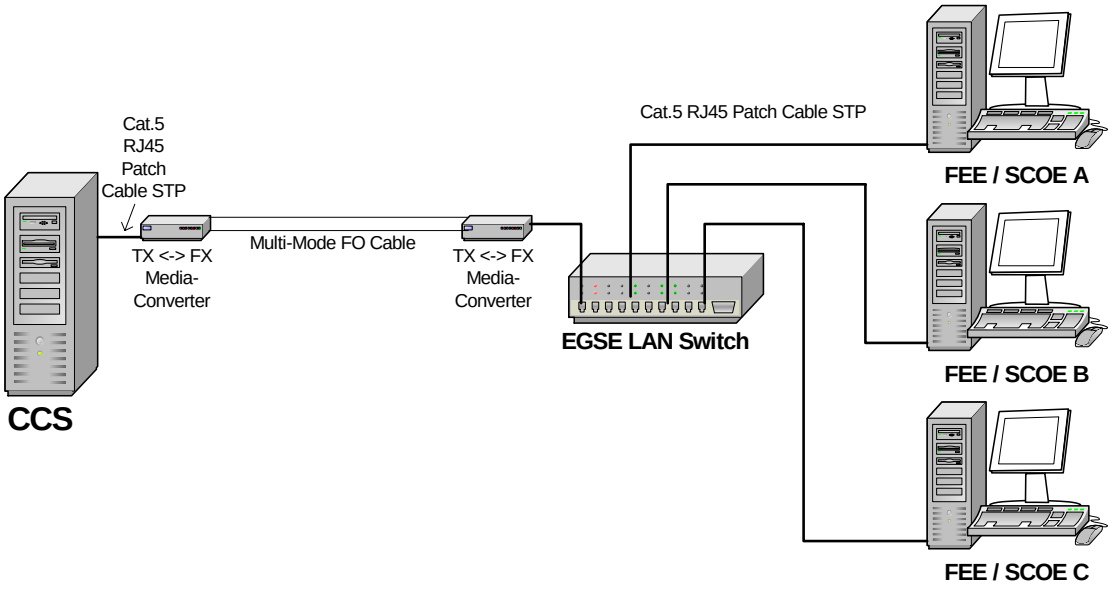

Figure 5.5-3: EGSE LAN Topology using Fibre Optics

RFSX-1112/GDIR-2067/I

The communication between Front End Equipment (FEE) and the CCS shall be performed by means of a Local Area Network (LAN) as follows (ref. EGSE ICD [AD-105], § 2):

- *the physical network is referenced / named "**EGSE LAN"***
- *Ethernet according to IEEE 802.3*
- *10/100/1000-Base-T RJ45; Category 6 shielded twisted pair (STP) or unshielded twisted pair (UTP).*
- *TCP/IP stream socket peer-to-peer connections*

Gigabit LAN (1000-Base-T) may be used where necessary to cope with the data rates.

- *Additional physical LAN segments are used in the EGSE overall configuration. The CCS will be required to interconnect CCS components (i.e. server, workstations, peripherals) via CCS dedicated LAN. A third LAN the CCS will be connected to will be the site / corporate LAN connecting to the users office environment. This will be subject to the detailed CCS equipment specification.*

RFSX-1113/GDIR-2068/R

According to the EGSE ICD [AD-105], § 2.1, Ethernet adapter supporting 100BaseT shall be provided with galvanic isolated line drivers in order to ensure no ground loops induced via the network cabling.

RFSX-1114/GDIR-2069/I

In order to allow easy exchange of a specific type of FEE (e.g. TM/TC FE or S-Band SCOE) between different EGSE setups / configurations / benches one single alias node name shall be assigned to one type of FEE (e.g. considering all EGSE configurations within the project a total amount of 3 to 4 TM/TC FE´s are required. Each individual TM/TC FE unit shall have assigned the alias name "tmtc-fe").

In order to allow various test benches being interconnected via the EGSE LAN for (test result) data exchange reasons each FEE is required to have assigned an individual IP Address within the EGSE LAN IP Address range.

Proposed EGSE LAN IP Addressing - (this is a configuration example) see Table 5.5-4 below:

sub-net: 192.168.200.0, sub-net mask: 255.255.252.0, host-id range:1..1022 (i.e.: 3rd byte:: 0..3 + 4th byte: 0..255)

Node-Name	IP-Address 3rd byte = x	IP-Address 4th byte = x	Description
	200		Test Bench A
	201		Test Bench B
	202		Test Bench C
	203		Test Bench D
ccs-server		1	CCS
tmtc-fe		11	TM/TC FE Controller
sband-fe		12	S-Band SCOE Controller
lps-fe		13	Launch Power Supply (LPS) SCOE Controller
sas-fe		14	Solar Array Simulator (SAS) SCOE Controller
…			etc.
pwr-fe		199	Power FE Controller

Table 5.5-4: EGSE LAN IP adresses

RFSX-1116/GDIR-2128/T

IP Addresses in the EGSE LAN shall be fix assigned. No dynamic address allocation shall be used (i.e. no DHCP).

RFSX-1117/GDIR-2129/T

All IP addresses and socket / port numbers shall be configurable by the user. A step-by-step procedure describing IP address and port number settings shall be provided in the equipment users manual.

RFSX-1118/GDIR-2130/T

Time synchronisation of EGSE computers shall be achieved via the EGSE LAN by means of UNIX standard Network Time Protocol (NTP) with the CCS acting as the time server.

The CCS system clock itself will be required to be synchronised via external precise time reference. This may be a time reference available on the corporate LAN or a project dedicated time reference acting as NTP server on the LAN. This will be subject to the detailed CCS equipment specification.

RFSX-1119/GDIR-2131/T

The FE controller shall support remote desktop service allowing the local desktop environment to be accessed from a remote computer in a mirroring mode, i.e. getting a mirror of the local screen via the LAN and getting keyboard and mouse access simultaneously to the local user.

A tool common across Windows and Linux platforms supporting such mirroring is "VNC" (URL: <http://www.realvnc.com/download.html) requiring the VNC Server process being installed on the FE controller.

Note: WinXP "Remote Desktop" utility is not suitable for this purpose as it causes a remote user login thereby cancelling the actually running applications and logging off the actual user.

RFSX-1121/GDIR-10921/T

Off-line activities on the FEE and remote access to the FEE shall run at lower task/thread priority levels than the on-line application thus preventing the on-line application to get overloaded.

5.5.5.2 Implementation Requirements

This section provides general design, implementation, manufacturing and environmental requirements. These requirements are applicable for the implementation, as well as for selection of commercial equipment. Justification shall be given in the case of deviation from the guidelines below.

5.5.5.2.1 General

RFSX-1125/GDIR-2138/R

Design, manufacture and assembly shall be consistent with the ISO metric standard and shall satisfy EU standards.

RFSX-1126/GDIR-2139/R

For communication of stand-alone COTS FEE controller to the FEE equipment an Ethernet network interface shall be used. No specific hardware shall be required to be installed on the FEE controller to operate the FEE equipment through the FEE application Software. Thus, the FEE application Software shall be easy portable on different / new hardware.

a) a second LAN adapter shall be used not to interfere the FEE internal communication with the EGSE LAN communication.

b) in particular, no IEEE488/HPIB-Bus controller shall be required on a PC PCI-Bus, instead an external LAN - HPIB Gateway (e.g. Agilent E5810A) shall be used.

5.5.5.2.2 Ergonomy

RFSX-1128/GDIR-2196/T

The maximum force necessary to operate a control or mechanism by hand shall be 120 N.

RFSX-1129/GDIR-2197/I

EGSE design shall foresee adequate space and accessibility for the operating personnel for nominal and non-nominal tasks.

RFSX-1130/GDIR-2198/I

It shall be possible to slide a drawer to its full forward position without disconnecting a cable.

RFSX-1131/GDIR-2199/I

Panel which need frequent operator access shall be at an ergonomic height.

RFSX-1132/GDIR-2200/I

All adjustment during operation shall be carried out from the front panels.

RFSX-1133/GDIR-2201/I

All permanent connections shall be at the rear side.

RFSX-1134/GDIR-2202/I

The side walls shall be extended to protect the front panel elements from a crash during rack movement.

RFSX-1135/GDIR-2203/I

Critical front panel switches (as power ON / OFF, Remote/Local, Self-test ...) shall be protected against inadvertent activation.

RFSX-1136/GDIR-2204/I

Red lamps at front panels shall be reserved for alarm, no-go or failure indications.

RFSX-1137/GDIR-2205/I

Screens / Monitors for MMI application and local control shall be of type TFT screen - at least 19". In order to reduce volume and weight of the equipment, use of CRT monitors is prohibited.

RFSX-1138/GDIR-2206/I

TFT screens shall be operated via digital DVI interface rather than analog VGA, wherever possible.

5.5.5.2.3 Mechanical & Thermal Design

RFSX-1140/GDIR-2208/R

EGSE shall be housed in standard 19" racks or consoles to the extent practical; overall height not exceeding 2 m.

Requirement above does not apply to COTS computer equipment

RFSX-1142/GDIR-2210/R

The racks and drawers shall be of a modular concept, allowing easy access for maintenance, trouble shooting and replacement.

RFSX-1143/GDIR-2211/R

The drawers shall be mounted on telescopic slides or angle bars and shall have locking handles or screw fastening at the front.

RFSX-1144/GDIR-2212/R

EGSE racks - and other GSE items with a mass > 40 kg - shall be mounted on self-steering wheels (castors) for transport over short distances within a facility. Minimum diameter for these wheels shall be 80 mm.

RFSX-1145/GDIR-2213/R

Racks front wheels shall be steerable. It is not recommended to have steerable wheels at the rear side of the rack, if the wheels are sticking out from the rack's shape while turning.

RFSX-1146/GDIR-2214/R

EGSE racks shall be equipped with crane hoisting rings.

RFSX-1147/GDIR-2215/R

EGSE racks shall be compatible with lifting by standard forklifts.

RFSX-1148/GDIR-2216/R

EGSE racks shall be either firmly supported on the floor or have devices to block the castors.

RFSX-1149/GDIR-2218/R

The equipment shall contain adequate cooling capabilities (air in/outlets and fans), to avoid overheating in the operating environment.

RFSX-1150/GDIR-2219/R

Air in/outlets shall be on the bottom and top of the rack. Air outlets at the top of the rack shall NOT blow in horizontal direction.

RFSX-1151/GDIR-2220/R

Wherever possible, fans shall be on/off regulated by temperature sensors in order to keep the noise level as less as possible.

RFSX-1152/GDIR-2221/R

Electrical connections within the equipment shall be secured to prevent breakage or changes in the electrical characteristics of outputs as a result of vibration, acceleration or shocks encountered under the specified environment.

RFSX-1153/GDIR-2222/R

External connectors must be equipped with locking devices.

RFSX-1154/GDIR-2223/R

The access to all connectors shall be such that any individual connector can be mated or demated without the need to disconnect any other connector.

5.5.5.2.4 Electrical & EMC

RFSX-1156/GDIR-2225/R

EGSE racks shall interface facility mains power shall be as follows:

One single connection via single phase or three phase power plug depending on the rack total power consumption

- *Voltage:* *230V(±10%), 16 A max., AC single phase*
- *400V(±10 %), 25 A max., AC three phase*
- *Frequency:* *50 Hz ±10 %*
- *Connector Type:* *230V EN 60309 CEE 16A or*

  SchuKo-Plug (EN 60083 - CEE 7/7) or
- *400V EN 60309 CEE 16A or 32 A*

COTS items mounted inside rack or desktop operated shall provide power cords with Schuko-Plug according to EN 60083 - CEE 7/7.

RFSX-1157/GDIR-10922/I

EGSE be provided in a rack and shall fulfil the following needs w.r.t. mains supply:

- *The unit shall be equipped with Mains Power I/F according IEC 38 Table: 230V /400V.*
- *The Mains Power I/F shall be performed galvanically isolated. An isolation transformer according to EN 61558 class II is required.*

RFSX-1158/GDIR-2226/R

The following interfaces shall be galvanically isolated:

- *all signal interfaces towards the spacecraft shall be driven from earth free power supplies,*
- *the signal ground / return lines shall have no permanent internal connection to drawer/ rack structure but shall be available at a user defined interface for controlled grounding*
- *LAN I/F card shall be galvanically isolated from drawer/ rack structure*

RFSX-1160/GDIR-2228/T

The EGSE grounding shall be supported according to the schematics outlined in Figure below. For each EGSE Item of EGSE a Grounding Diagram as defined in RFSX-1162 shall be provided.

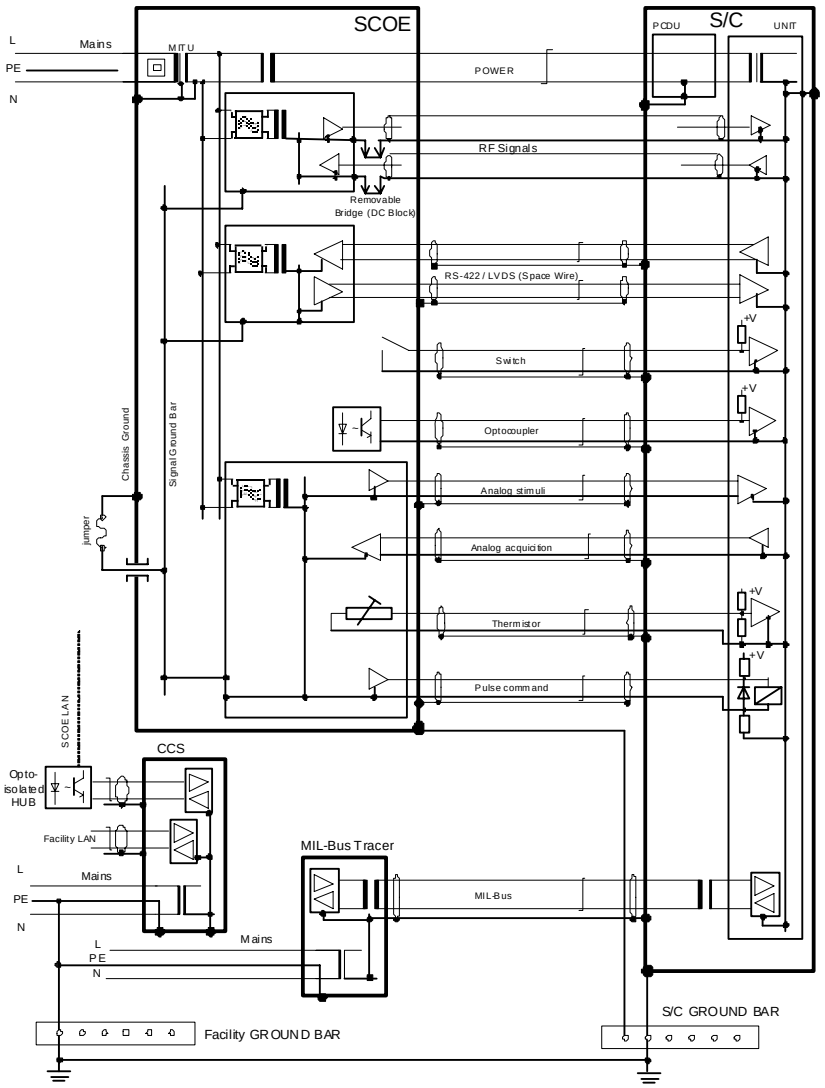

Figure 5.5-4: EGSE Grounding Schematics

RFSX-1161/GDIR-964/R

EGSE signal and power circuits interfacing with flight hardware shall simulate the original flight interfaces w.r.t. Impedance, power and signal characteristics, timing, grounding and isolation and test harness design.

RFSX-1162/GDIR-965/R

A detailed EGSE grounding diagram including all isolations, grounding / return connections, redundancy and cross-strapping shall be provided in the EICD.

This requirement is applicable for delivered EGSE as well as EGSE used by Equipment suppliers for their Equipment level tests.

RFSX-1163/GDIR-2230/R

EGSE items (e.g. controller PC and peripheral devices) which from practical reasons cannot be installed in racks, shall be grounded via the equipment rack these items belong to. i.e. the mains power supply for these EGSE items shall be the isolated mains from the associated rack.

In case such external device is linked to the rack-mounted equipment through galvanic isolated signal interface (e.g. LAN), it may be supplied from non-isolated facility mains.

RFSX-1164/GDIR-2231/R

Electrical circuit ground shall be insulated from equipment chassis ground wherever possible. In cases where this is excluded due to technical / physical reasons (e.g. for RF equipment) an additional separation transformer or DC-block or other shall be provided to exclude ground loops involving the on-board equipment.

The following rules shall apply:

- *Electrical circuit ground shall be connected to Star-Point once.*
- *Interfaces as part of those circuits shall not establish a second connection to Star-Point.*
- *Shielding shall never lead signal currents; except RF I/Fs equipped by COAX-cables.*

Electronics, which drive COAX-I/Fs, shall be supplied by galvanical isolated power supplies.

RFSX-1165/GDIR-2232/R

The equipment circuit ground shall be accessible through a grounding stud at the equipment front or rear panel. The grounding stud shall provide a M8 screw thread and a 13 mm hex-nut to connect external grounding cable.

RFSX-1166/GDIR-2233/R

Signal deterioration due to resistive, inductive and capacitive behaviour of the interconnection lines or coax cables shall be such that all relevant applicable signal specifications are met.

RFSX-1167/GDIR-2234/T

The isolation resistance between loads, which are not connected together and between shields and centre conductor and shield to shield shall be at least 10 MOhm under 500V DC in both polarities.

RFSX-1168/GDIR-2235/R

Shields shall be routed continuously through any connectors on separate pins.

RFSX-1169/GDIR-2236/R

Connector shells and outer overall cable shields shall be connected to the drawer/ crate/ rack structure. They shall not be connected to signal ground or return lines.

RFSX-1170/GDIR-2237/R

For EGSE connecting to the spacecraft / flight equipment shields shall be connected to ground at one side only (see Figure 5.5-4). Deviations from this baseline shall be subject to customer approval.

RFSX-1171/GDIR-2238/R

The design concerning hazardous voltages shall conform with EN61010.

RFSX-1172/GDIR-2239/R

Test points shall be provided to allow easy isolation and identification of failed items without dismounting or disconnecting other equipment. The test-points shall ease the use of measurement probes (e.g. banana jacks or BNC test points or similar conventional methods).

RFSX-1173/GDIR-2240/T,R

Test points shall be short circuit protected, to the extend practical or they shall be secured by other means.

RFSX-1175/GDIR-2242/T

Bonding of adjacent structure parts and equipment within MGSE and EGSE racks shall be accomplished by metallic contacts providing an ohmic resistance of less than 50 mOhm.

RFSX-1176/GDIR-2243/T

All signal input/output interfaces (video, RF,…) shall withstand permanent operation by short-circuit or open-circuit without degradation.

RFSX-1177/GDIR-2244/R

All data and signal interface drivers shall survive a short circuit to driver ground, receiver ground or structure without permanent degradation.

5.5.5.2.5 Software Design & Development

The main software constituents for the various EGSE elements are shown in the graphic below.

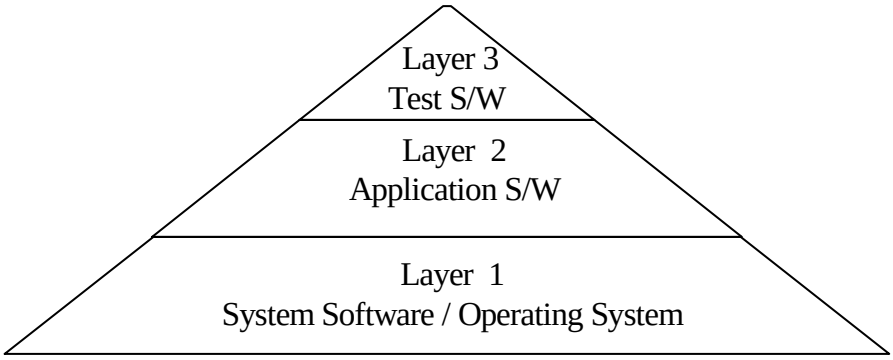

Figure 5.5-5: Software Layers

The responsibility for the software deliverance is strictly correlated with the layers as follows:

Layer 3 Test software produced by the Test / AIV team as part of the test and AIV preparation tasks.

All software that is specifically developed by the EGSE user to perform particular tests during the different phases of the test and AIV program, e.g.: electrical Integration, Function and Performance tests, Software Verification, Compatibility testing.

Below an overview is given of the test software to be prepared for the various stages of the test and AIV program. Software in this context includes also the simulation and configuration data sets to be defined and prepared by the checkout team.

CCS: local data base (TM, TC and EGSE parameter definitions), synoptic display definitions, automated procedures (control files, test sequences)

FEE: configuration files

Simulators: simulation models

Layer 2 Application software is produced and delivered by the EGSE element suppliers according to the user requirements.

Layer 1 System Software is commercial software delivered by the EGSE element suppliers as there is the Operating System (e.g. Linux, Windows) and COTS tools as for example Editors, Interpreter, Compiler, Graphical Systems, Database Management Systems, Communication Software.

RFSX-1182/GDIR-2249/R

Configuration control shall be applied to all three software layers.

RFSX-1183/GDIR-2250/R

All three software layers installed on any EGSE computer shall be strictly separated from each other by appropriate disk and folder organisation.

•Layer 1 and layer 2 software shall be installed on a dedicated physical disk, the system disk, where appropriate, or at least on a dedicated logical disk partition.

•For storing Layer 3 software, configuration files and the test data logs, a root / home path shall be provided. It's further sub-folder organisation shall be definable by the user.

•No layer 1 and layer 2 items shall be contained in the layer 3 path.

RFSX-1184/GDIR-2251/T

Layer 2 software shall be easily portable to different hardware of similar type running the same layer 1 - at least the operating system - software. To achieve this:

•All layer 2 software shall be located on the system disk / partition on a dedicated root / home path.

•Layer 2 software shall NOT be subject to hardware bound license keys

•By copying the contents of the a.m. root / home path layer 2 software shall be portable to another computer.

If required, a copy of drivers and DLL-files shall be provided within this layer 2 directory and a procedure/manual shall be provided if such files have to be installed on operating system level. A "ReadMe.Txt" file might be sufficient.

RFSX-1185/GDIR-2252/R

Backup shall be provided in terms of appropriate backup tool (operating system capability or COTS tool) and backup storage media (DVD Writer recommended). By means of this utility a bootable system disk image backup shall be created in order be able to restore the complete system environment as a whole in one go in case of a disk crash.

RFSX-1186/GDIR-2253/I

A bootable system disk image backup reflecting the layer 1 and layer 2 software delivery status shall be created and delivered by the EGSE unit supplier upon equipment delivery.

RFSX-1187/GDIR-2254/I

All layer 1 and layer 2 software shall be deliverable items. For COTS items the installation media shall be delivered or a CD/DVD shall be created and delivered in case of installation files without media delivery by the tool supplier.

5.5.5.3 Verification Requirements

The verification process is that part of the subcontractor's task, which demonstrates conformance to applicable requirements. A satisfactory completion of the verification process is the basis for a contractual acceptance of the product by the customer.

Requirements in this specification indicated by the identification and numbering scheme explained in section 1 shall be subjected to formal verification close out.

As far as the equipment or S/W is a rebuilt from lower level test equipment (e.g. unit tester), the formal verification of the corresponding functions may be achieved by demonstration of successful use in lower level integration and testing.

RFSX-1190/GDIR-2265/R

Adequate test equipment and simulators shall be made available to support the equipment verification process. This test equipment is not deliverable and may therefore be recruited from the suppliers laboratory inventory.

Of particular importance are the simulation of the communication interface with the CCS (Core EGSE) and the simulation of the interfaces with the on-board systems. These shall be fully representative on all protocol layers including the physical interface. Software test stubs used for such tests are deliverable in source code to the customer.

RFSX-1191/GDIR-2266/R

The subcontractor shall establish a verification program that assures that:

- *The product (H/W and S/W) is in compliance with the specified requirements.*
- *The design is qualified.*
- *The product (H/W and S/W) is in agreement with the qualified design, free from workmanship defects and acceptable for use.*

Qualification is defined as the proof that a design fulfils the requirements with adequate margin.

For re-used software modules / components acceptance test reports / qualification test reports may be used to demonstrate compliance with the requirements stated. The sub-contractor shall not be required to re-run acceptance / qualification tests for existing, re-used software.

In case reference is made to already performed and existing acceptance / qualification in the frame of other space programs, requirements tracing of the relevant requirements to the existing test procedures and test result has to be provided as well as the existing test procedures and test reports themselves.

RFSX-1193/GDIR-2268/I

The verification process activities shall be incrementally performed at different levels and in different stages applying a coherent bottom-up concept and utilizing a suitable combination of different verification methods. The verification process flow shall be basically subdivided into the following steps:

- *Identification and classification of all the requirements to be verified*
- *Selection of verification criteria (methods/levels/stages) against identified requirements*
- *Establishing the planning for the associated verification activities*
- *Obtain customer concurrence*
- *Performance of verification tasks and verification control*
- *Completion of verification control and evidence for verification close-out*
- *Customer review and final approval.*

All above tasks shall be executed in accordance to .

RFSX-1194/GDIR-2269/I

All specific support test equipment must be compliant with the intended purpose, within its useful life and calibration.

The test tolerances quoted in the specifications shall be applied to the nominal test values specified. The tolerance of test parameters specifies the maximum allowable range within which the specified test level (input level) may vary and does not take into account instrument accuracy.

All instruments and measurement equipment used in conducting the tests shall have an accuracy of better than one third of the tolerance for the variable to be measured unless otherwise specified.

Note: This is to be recorded in as-run-test procedure/test report

RFSX-1195/GDIR-2270/R

For tests performed using automated test equipment running scripts, batch files or generally S/W the test procedures and -reports shall provide the relevant test-step information in the S/W source code or in the print-out/protocol of each test S/W item.

Test Report shall include configuration control information (compilation date, check-sum, version/revision-number, etc.) for each test S/W item used for the reported test.

RFSX-1196/GDIR-2271/T

The specified item shall undergo a incremental test program, starting at module level up to system level. Objectives of these tests shall be at least:

- *Function*
- *Performance*
- *Interface*
- *Failure Tolerance*

RFSX-1197/GDIR-2272/T

Details of the tests, test planning, test requirements and test procedures shall be defined/specified by the subcontractor in accordance with the verification method given in this specification and shall be approved by the customer in advance.

RFSX-1198/GDIR-2273/T

Module level testing shall include testing of tolerance against erroneous input data and signals. This shall include as a minimum:

- *User input error*
- *Corrupted input data from external sources*

RFSX-1199/GDIR-2274/T

The product functional performance test shall include at least:

- *all interfaces*
- *all system functions*
- *all system command functions*
- *all telecommand and telemetry functions*
- *all I/F board functions*
- *all operational modes and*
- *all transitions applicable.*

under the specified performance loads.

RFSX-1200/GDIR-2275/T

The objective of the functional performance test shall not only be the verification of the user requirements but also the verification of the correct and consistent system behavior.

RFSX-1201/GDIR-2276/T

The functional performance test shall include testing of the quantifiable functions and parameters of the product (performance, accuracy, etc.) in all operational modes specified

5.5.6 EGSE Specific Requirements

5.5.6.1 General EGSE Requirements

RFSX-1343/GDIR-2282/R

The design of EGSE interfaces to flight equipment shall not allow propagation of EGSE failures to the flight hardware.

RFSX-1205/GDIR-2283/A

For all EGSE S/C interfaces a FMEA/FMECA (denpending on the project specific PA requierements) shall be provided.

Requirement/Section Cross Reference

EADS astrium

EC / GS2 Common Units
Routing Sheet

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