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Information Documentaire / Document Information

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GENERAL DESIGN, CONTROL AND INTERFACE SPECIFICATION (GDCIS) - ELECTRICAL PART applicable for REPEATER & TCR UNITS - PLATFORM ISS EXPRESS-1000H

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Approval evidence is kept within the documentation management system

CHANGE RECORDS

ISSUE	DATE	§ CHANGE RECORDS	AUTHOR
01	22/10/2008	First issue, based on the following documents: • SPACEBUS GDCIS – Electrical part applicable for Units of the repeater and the TCR-RF (ref S000330, iss 03, 21/02/2006) • ELECTRICAL DESIGN, CONSTRUCTION AND INTERFACE SPECIFICATION FOR REPEATER UNITSPLATFORM NPO PM - MSS-767 (ref AM11-ASPI-SP-0015, iss 04, 26/03/2003) • AMOS5 Payload GDIR (attachment D1 to AMOS5 contract) • AMOS5 TCR GDIR (attachment D2 to AMOS5 contract)	JM. LEROUX
02	27/03/2009	Second issue, modifications detailed below: • Reference number added for all [X1000H-SPECIFIC] requirements • Redundant requirements deleted • §2.1 Aplicable Document AD11 added • §4.4.5 Correction of derating requirement [X1000H-SPECIFIC-019] • §5.4 Precision added in operational requirement [X1000H-SPECIFIC-025] • §6.3.4.3 Comment added for fault voltage tolerance requirement applicable to DR TM source, matrix organization: [SB4-SAT-AD1-P4-REQ-308 c], req. B4. • §7.2.1.2.2 correction of Long Term transient shape (Conducted Susceptibility)	JM. LEROUX

TABLE OF CONTENTS

TABLE OF ILLUSTRATIONS

1. SCOPE

This document establishes the general electrical design and interface requirements for equipments included in EXPRESS-1000H Payload & TCR subsystems to be met to ensure their specified performance during assembly, integration, testing, storage, transportation, launch and orbital operations.

This document is applicable for the units of the repeater and TCR (excluding TCR horn and antennae).

Specific requirements are defined in particular unit specification documents.

In case of conflict between this specification document and the particular unit specification document, the terms of the particular unit specification document shall apply.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

In case of conflict between any specification document and this applicable document, the specification document shall have precedence.

Any discrepancy shall be notified to the attention of Contractor for clarification and resolution.

Ref.	Title	Reference
AD11	Instructions for preparing IDS's and ICD's	REF-ASPI-CN-88-E

2.2 Reference Documents

The following documents listed hereinafter are for reference and information only. They have been used as basis for some requirements defined in the present specification.

In case of conflict between any unit specification document and this reference document, the specification document shall have precedence.

- [SB-GDCIS] SPACEBUS GDCIS – Electrical part applicable for Units of the repeater and the TCR-RF (ref S000330, iss 03, 21/02/2006)
- The procurement of the AMOS-5 Payload, Attachment D1
  PAYLOAD GENERAL DESIGN & INTERFACE REQUIREMENTS
  Issue 1
- The procurement of the AMOS-5 Payload, Attachment D2
  TCR GENERAL DESIGN & INTERFACE REQUIREMENTS
  Issue 1
- ELECTRICAL DESIGN, CONSTRUCTION AND INTERFACE SPECIFICATION FOR REPEATER UNITS
  PLATFORM NPO PM - MSS-767
  ref AM11-ASPI-SP-0015, iss 04, 26/03/2003
- Reduced "SNIFF" RE and "SNORT" RS EMC Procedure
  Reference SDR-ASPI-TP-0058 Issue 1 Dated 27/11/2000
- US, DOD military standard on "Electromagnetic Interference Characteristics, Measurement"
  Reference MIL-STD-462

- US, DOD military standard on "Electromagnetic Compatibility Requirements for Space Systems"
  Reference MIL-STD-1541A (USAF) December 1987

- MIL STD 883C - Class 3

2.3 ACRONYMS, SYMBOLS AND ABBREVIATIONS

A/D	Analog/numeric conversion
ABM	Apogee Boost Motor
AC	Alternating current
ADPM	Antenna Deployment and Pointing Mechanism
AN	TM Analog
AOCS	Attitude and Orbit Control Subsystem
AOCSP	Attitude and Orbit Control System PCB
AOCSP_NG	Attitude and Orbit Control System PCB_ New Generation
APM	Antenna Pointing Mode
AWG	American Wire Gauge
BAPTA	Bearing and Power Transfer Assembly
BBC	Bus Brick Connection
BCRB	Battery Connection Relay Box
CM	Common Mode
CRM	Central Reconfiguration Module
DB	TM Digital bi-level
DC	Direct current
DC/DC	Direct current/Direct current
DM	Differential Mode
DOCON	DOwn CONverter
DR	TM Digital Relay
DS16	TM Digital Serial 16 bit
DSPG	Distributed Single Point Grounding
EED	Electro-Explosive Devices
EGRN	Electrical Ground Reference Network
EGRP	Electrical Ground Reference Point
EGSE	Electrical Ground Support Equipment
EMC	Electro-Magnetic Compatibility
EPC	Electrical Power Conditioning
EPS	Electrical Power Subsystem
ESD	Electro-Static Discharges
HLC	High Level Command

HPC	High Priority Command
ICD	Interface Control Drawing
IDS	Interface Data Sheet
ITO	Iridium Tantale Oxyd
IRES	Infra-Red Earth Sensor
LLC	Low Level Command
LMU	Li-Ion Battery Management Unit
LNA	Low Noise Amplifier
LPC	Low Priority Command
LSB	Least Significant Bit
MLC	Memory Load Command
MLI	Multi Layer Insulator
MSB	Most Significant Bit
NRZ	Non Return to Zero
NRZ-L	Non Return to Zero Level
OBDH	On Board Data Handling
OBP	On Board Processor
OSR	Optical Surface Radiator
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PCU	Power Conditioning Unit
PFDIU	PlatForm Distribution and Interface Unit
PLDIU	Payload Distribution and Interface Unit
PROP	PROPulsion electronic (Chemical/Plasmic) PCB
PPS	Plasmic Propulsion Subsystem
PPU	Power Processing Unit
PYPGP	Pyrotechnic Pcb with GP relays
RA	Rotary Actuator
RUBI	Remote User Brick Interface
RF	Radio Frequency
RX	Receiver
S/C	Spacecraft
S/W	Software
S4DSAP	SB4000 Deployment of Solar Array PCB
SA	Solar Array
SADM	Solar Array Drive Mechanism
SADP	Solar Array and Deployment PCB
SBDL	Standard Balanced Digital Signal

SDIU	Satellite Distribution and Interface Unit
SDMP	Stepper and Deployment Motor PCB
SLI	Single Layer Insulator
SMU	Satellite Management Unit
SPF	Single Point Failure
SSM	Second Surface Mirror
STR	Star Tracker
TC	Telecommand
TCR	Telemetry, Command and Ranging
TH	Thermistor
TLM	Telemetry
TM	Telemetry
TOM	Thruster Orientation Mechanism
TTC	Tracking, Telemetry and Command
TWT	Travelling Wave Tube
TWTA	Travelling Wave Tube Amplifier
TX	Transmitter
UPCON	UP CONverter
UPS	Unified Propulsion Subsystem
w.r.t.	with respect to

3. GENERAL SPECIFICATIONS

3.1 Engineering specifications

Reference **[CU-GDCEL-REQ-001]**

The metric standard (SI - International system) shall be used for design, manufacturing and testing of systems or subassemblies.

In Reference *

Reference **[CU-GDCEL-REQ-002]**

All requirements in this document shall be applicable in all environmental conditions (mechanical, thermal, radiation,)

In Reference *

3.2 Lifetime

Reference **[X1000H-SPECIFIC_001] replaces [CU-GDCEL-REQ-003]**

Units and subsystems shall be designed for:

- 15,25 years in orbit including IOT
- 2,75 years for integration and tests at S/C level, transportation to the launch site and launch campaign, and total storage period (either at the subsystem level or at the satellite level) in appropriate conditions

In Reference *

3.3 Delivery

Reference **[CU-GDCEL-REQ-004]**

All unit/subsystem shall be delivered in POWER OFF status.

In Reference *

3.4 Redundancy rules

Reference **[CU-GDCEL-REQ-005]**

When redundancy is implemented in the design, any single failure leading to total or partial loss of the unit operational capability or mission shall be forbidden.

In Reference *

Reference **[CU-GDCEL-REQ-006]**

When nominal and redundant ways are designed on the same board or device, the two functions shall be separated physically in order to avoid any risk of failure propagation.

In Reference *

Reference **[CU-GDCEL-REQ-007]**

Nominal and redundant ways shall use separated connectors.

In Reference *

3.5 Single point failure

Reference **[CU-GDCEL-REQ-008]**

All units, with nominal power consumption higher than 20W, shall always be able to switch-off in any case of failure (except in case of OFF command interface failure).

In Reference *

3.6 Test points

Reference **[CU-GDCEL-REQ-009]**

The test points shall be clearly identified in the unit ICD/IDS.

In Reference *

Reference **[CU-GDCEL-REQ-010]**

Test points on multi-pin connectors shall be designed to withstand, without causing damage to the unit, the highest voltage on that connector unit as well as short circuits

In Reference *

Reference **[CU-GDCEL-REQ-011]**

Unit test connectors shall be provided with electrically conductive covers

In Reference *

Reference **[CU-GDCEL-REQ-012]**

Input test points shall be connected to a referenced voltage point

In Reference *

4. ELECTRICAL ARCHITECTURE REQUIREMENTS

4.1 Grounding and isolation requirements

4.1.1 Grounding concept

The spacecraft structure constitutes a low impedance reference named Electrical Ground Reference Network (EGRN).

Reference **[CU-GDCEL-REQ-013]**

All metallic sub-chassis, chassis and enclosures of each unit, including all connectors' shells and other fittings, shall be considered electrically as extensions of the EGRN.

 # In Reference *

The Electrical Ground Network Network includes the following items :

- Aluminium panels (honeycomb and skins),
- All grounding strap (metallizations) and their rivets,
- All baseplate supporting equipment.

The EGRN shall not be used as an intentional current return path for primary or secondary power line users.

The grounding and bonding concept is a “returns by wires” concept with a Distributed Single Point Grounding (DSPG) configuration. The emission and susceptibility can be therefore accurately controlled and kept within a wide requirements range.

The basic philosophy for grounding is illustrated in Figure 8.

Reference **[X1000H-SPECIFIC_002]**

Connections between two separated networks shall not use single-ended at both end interfaces. One end (receiver side in general) shall be based on differential type.

Unit secondary reference point shall be grounded using one of the solutions of the following figure.

The grounding of unit secondary reference point shall not result in flowing electrical current in the structure.

 # In Reference *

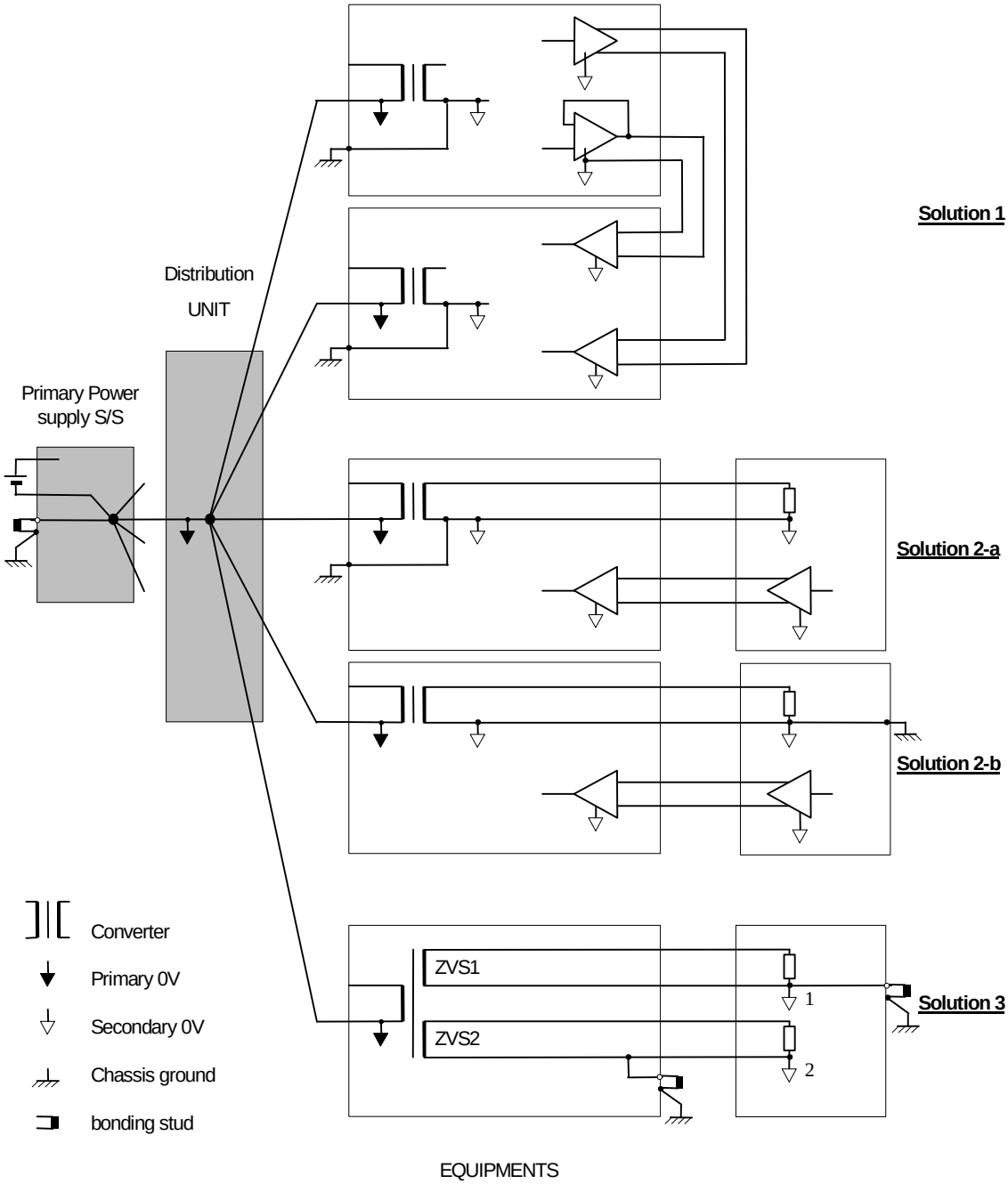


Figure 1 : Basic philosophy for Distributed Single Grounding Concept

4.1.2 Grounding Solutions

Reference **[CU-GDCEL-REQ-014]**

One of the solutions listed below shall be used for units grounding

Solution 1

The unit secondary reference point is insulated from the secondary reference point of other units (implying the use of insulated or differential interfaces between the units). In this case, the equipment shall be grounded internally to its own housing in order to ensure a low impedance ground path.

Solution 2

The unit secondary reference point is common to several units.

In this case :

- the unit assembly shall be grounded at only one point.

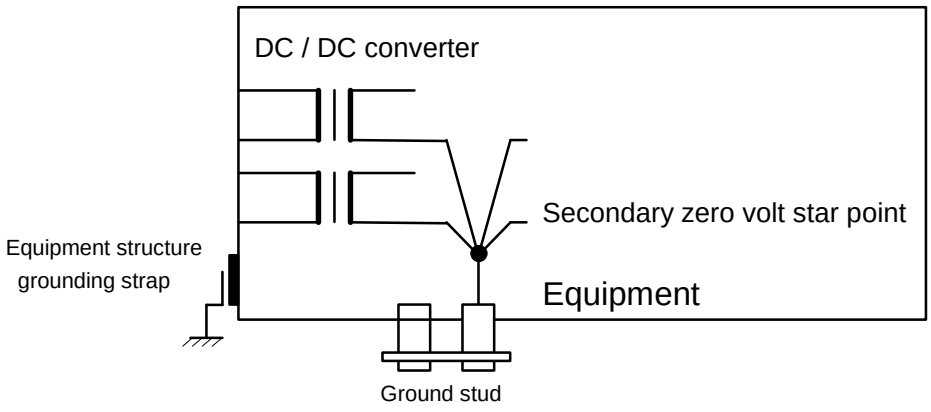
Solution 3

Unit shall provide dedicated bounding studs so that each unit secondary reference point can be grounded externally to the equipment housing. One of the grounding stud shall be insulated from the equipment structure and connected to the unit secondary reference point; the other one shall be connected directly to the chassis ground (See the following figure).
It shall be possible to ground the unit secondary reference point by placing a bar (removable strap) between the two bounding studs.

This requirement is not mandatory for RF equipment which have an internal link.

It must be noted that the above-mentioned bounding studs is different from the bounding strap used to connect the unit case to the mechanical structure

The bar shall be supplied by the equipment manufacturer.



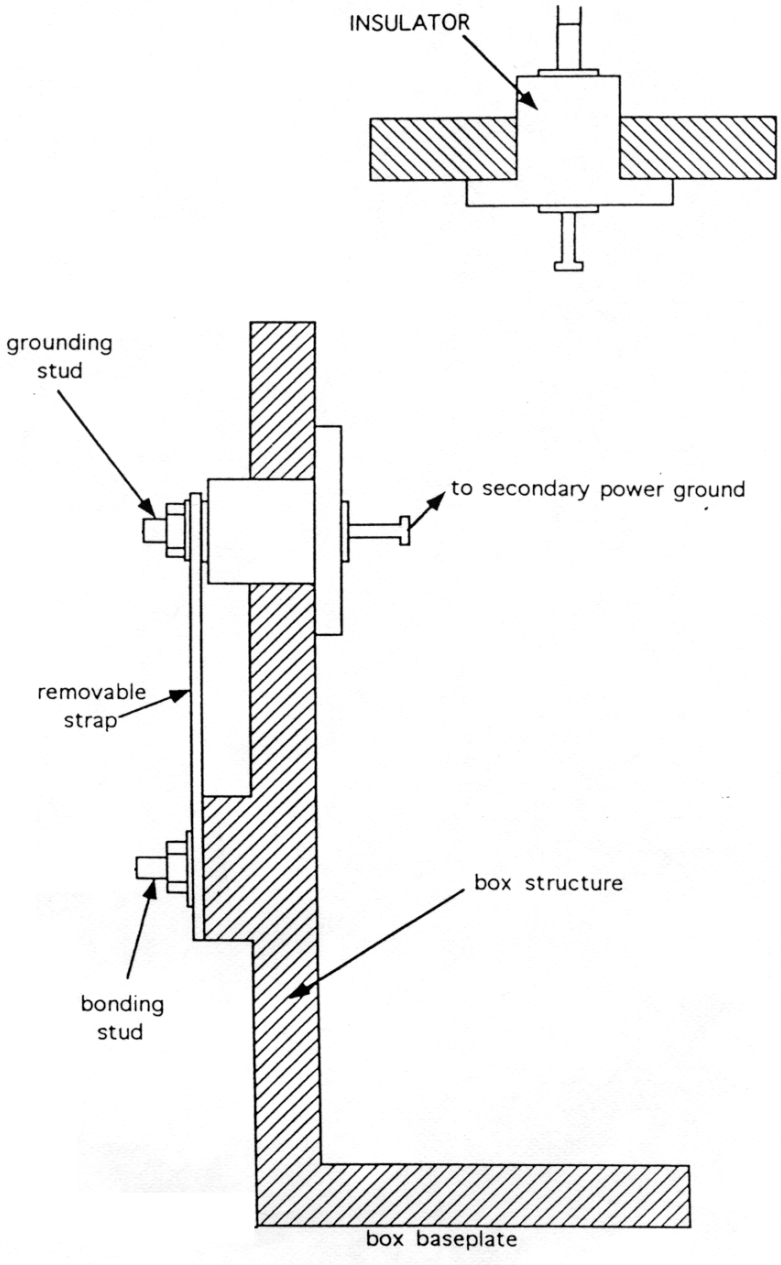


Figure 2 : Grounding of a unit secondary reference point via a bonding stud

*# In Reference *

4.1.3 Grounding and isolation diagram

Reference **[CU-GDCEL-REQ-016]**

An overall zero volt and grounding diagram shall be provided in the IDS for establishing functional and electromagnetic compatibility.

 # In Reference *

Reference **[CU-GDCEL-REQ-015]**

This diagram shall indicate any AC or DC loop, the type of isolation/insulation used, and any impedance coupling between zero volt and structure and shall be established for all Equipment and Subsystems containing electrical/electronic circuits.

 # In Reference *

Reference **[X1000H-SPECIFIC_003]**

Any deviation with this general concept shall be reported to the Prime Contractor.

The grounding and isolation diagram will be used to verify the correct implementation of the Distributed Single Point Grounding (DSPG).

The following data shall be at least found in the grounding and isolation diagram:

- primary power grounding,
- secondary power grounding,
- signal grounding,
- interface circuit grounding,
- electronic box grounding,
- isolation between different grounds or references,
- principal interface circuit diagram,
- cable types used between units (TP, TSP, coaxial lines, triaxial lines,...),
- redundancy and cross-strapping.

 # In Reference *

4.1.4 Power lines grounding

Reference **[X1000H-SPECIFIC_004]**

Users of primary power shall isolate the power wires from the structure and shall be compliant with insulation requirements.

 # In Reference *

4.1.4.1 Grounding of secondary power bus 0V

Secondary power line returns shall be referenced to the electrical ground reference (structure) at only one location point.

- if the secondary power output only supplies one unit (local secondary power or non-distributed secondary 0V), the secondary power return line shall be grounded to the EGRN at each unit level.
- if several units are supplied from the same DC/DC converter secondary transformer winding (distributed secondary power ground), the distribution shall be a star point system for power lines and return.

The return of all the secondary power bus lines shall be grounded to the EGRN according to a system plan. The basis of this plan shall be a single grounding point located preferably at the DC/DC converter secondary power source.

Possible exception for secondary 0V mechanical grounding could be accepted:

- for EPC or for sensitive analog equipments which use multiple direct grounding points.
- for secondary power supplying matrix telecommand outputs or matrix status acquisitions. In this case, the secondary 0V is isolated from the mechanical ground plane by series resistors.

Reference **[CU-GDCEL-REQ-017]**

The grounding connection impedance between the unit electrical 0V ground and its housing shall be lower than 2.5 mΩ measured under 1 Adc current and inductance shall not exceed 100 nH.

 # In Reference *

Reference **[CU-GDCEL-REQ-018]**

The high voltages necessary for the TWT's shall be considered as secondary power and shall be referenced at the EPC (via EPC structural part) and at the TWT side (via the TWT structural part).

 # In Reference *

Reference **[X1000H-SPECIFIC_005]**

Each pair of the EPC/TWT shall be interconnected by a dedicated ground strap.

 # In Reference *

Reference **[CU-GDCEL-REQ-019]**

The grounding path shall be designed and sized to withstand a current equal to 1.5 times the worst case fault current as limited by the unit primary power bus protection device. The following current shall be considered :

- either a primary current due a short-circuit between the primary power supply positive line and the unit secondary reference point/mechanical ground.
- or a secondary current due to a short-circuit between a secondary power line and the secondary reference point/mechanical ground.

 # In Reference *

Reference **[CU-GDCEL-REQ-020]**

All transformer screens shall be grounded to chassis.

In Reference *

4.1.5 Primary and secondary power lines insulation

Reference **[CU-GDCEL-REQ-021]** AD-AV4-AD01_Part4-5.8.2-001/a

The primary power lines shall be transformer insulated from all secondary power.

In Reference *

Nota: During measurement rating on components must be withstood. Derating may be exceeded.

	Insulation	**Isolation resistor with stray capacitance in parallel**
[CU-GDCEL-REQ-022]	Between unit primary power + (positive) input lines and structure with measurement 100 Vdc	**(>1 MΩ) // (< 50 nF)**
[CU-GDCEL-REQ-023]	Between unit primary power - (negative) input lines and structure with measurement 50 Vdc	**(>1 MΩ) // (< 600nF)**
[CU-GDCEL-REQ-024]	Between primary power leads and secondary power leads with measurement 100 Vdc both polarities	**(>1 MΩ) // (< 50 nF)**

Reference **[X1000H-SPECIFIC**-006**]**

The primary power and command buses, telemetry lines, control lines going to EGSE (if any) and the structure shall be isolated from each other.

However one exception is allowed for voltage and bi-level telemetry which may be referenced to the structure.

In Reference *

~~#Reference **[X1000H-SPECIFIC]**~~

~~Repeater and TCR units (including RDIU and CCU) shall be operational with one connection of the primary bus to the structure.~~

~~#In Reference *~~

4.1.6 High voltage units

Reference **[CU-GDCEL-REQ-025]**

Isolation between the highest voltage inside the equipment and thermistor, relay coil, relay contact or heater leads shall be guaranteed with 6 dB margin.

In Reference *

Reference [X1000H-SPECIFIC_007]

The isolation between these elements and the mechanical ground shall be greater than 1 MΩ and is defined at component level.

In Reference *

4.1.7 Signal Interface Isolation

Signal interfaces must provide appropriate isolation to avoid ground loops or low impedance ground loops between two separated units.

Connections between two separated networks shall therefore not use single-ended interface at both ends excepted for coaxial lines or RF signals lines.

One end (receiver side in general) shall be based on differential type.

Signal interface shall use a return by wire concept. Any signal line shall usually have its own return line.

Several lines should however share a single return line in the following cases:

- the impedance of the return line is low enough to prevent noise immunity loss of the relevant interfaces.
- the different return currents are never present at the same time.

Signal emitter leads are referenced to secondary ground or primary ground.

Single ended receivers are only allowed for thermistors and relay contact telemetry's.

Signal receiver leads are fully differential and separated from primary returns.

Signal receiver leads are fully differential and separated from secondary returns.

Signal receiver leads are fully differential and separated from telecommand returns.

Nominal and redundant receiver returns are separated.

4.2 Bonding requirements

4.2.1 General purpose

Bonding is the establishment of a low impedance path between two metal surfaces or different structural parts.

Bonding is requested for all mechanical structure elements, equipment housing, cables:

- to prevent hazard from high potentials,
- to prevent build up and accumulation of electrostatic charges,
- to avoid differential charge build up that could result in an electrostatic discharge,

- to reduce electromagnetic interferences due to electric field or other forms of mutual coupling,
- to protect from high voltage arcing,
- to provide an Electrical Ground Reference Network (EGRN) used as an equipotential surface reference plane (important for RF unit).

All metallic sub-chassis, chassis and enclosures of each unit, including all connectors shells and other fittings, shall be considered electrically as extensions of the EGRN.

Structure of electrical unit shall be bonded to the EGRN preferably by a direct, low resistance and low impedance bond.

The bonding requirements are such that all satellite equipment primary and secondary structures supporting or containing electrical assemblies shall be bonded by one of the following methods, in order of preferences :

- Direct inherent bond by welding, brazing, soldering etc…,
- Direct semi-permanent bond, where clean metal areas are mated with a fastening methods that exerts sufficient pressure to withstand deforming stresses, shocks and vibrations,
- Riveting joints where at least 3 rivets are driven tight per joint,
- Clamped metallic fittings, normally permanent and immovable after installation
- Lock devices (bolts, nuts, studs, lock-washers),
- Indirect bond bonded to each of the members using a strap of solid flat metal.

Reference **[CU-GDCEL-REQ-026]**

To avoid surfaces discharge, each electrically conductive area larger than 5 cm² shall be connected to a referenced voltage.

 # In Reference *

Reference **[X1000H-SPECIFIC**_008**]**

Each active equipment shall be connected to the structure. The resistance between the unit and structure shall be less than 20 mΩ.

 # In Reference *

4.2.2 Bonding characteristics at unit level

	Bonding connection	Electrical continuity
[CU-GDCEL-REQ-027]	between two adjacent parts of a metal case including the resistance between any point of the case and any point of the cover or bonding point (possibly after vibration tests)	**≤ 5 mΩ under 1Adc current**
[CU-GDCEL-REQ-028]	between connector shell and unit structure	**≤ 2.5 mΩ under 1Adc current**
[CU-GDCEL-REQ-029]	between connector back-shell and connector body	**≤ 5 mΩ under 1Adc current**

4.3 Paints and coatings characteristics

Reference **[CU-GDCEL-REQ-030]**

Coatings (including paintings) on non conductive surface (not applicable on coating inside units)

Coatings applied on a dielectric or non-conductive surface shall be grounded to the ground reference network on the edges.

The coating surface resistivity applied on non conductive materials shall be less than 1 E9 Ω / square.

In Reference *

Reference **[CU-GDCEL-REQ-031]**

Coatings (including paints) on conductive surface (not applicable on coating inside units)

The coating resistivity applied on a conductive surface shall be less than 1 E9 Ω.m, assuming a depth e ≤ 100 µm.

In Reference *

4.4 Electrical connector requirements

4.4.1 Connector types

Reference **[X1000H-SPECIFIC_009]**

Connectors at interfaces shall be clearly identified in the ICD/IDS.

In Reference *

Reference **[CU-GDCEL-REQ-032]**

All connectors shall be selected according to AD11.

In Reference *

Reference **[CU-GDCEL-REQ-033]**

MDM and very high density (ex.:AMP104) connectors shall not be used.

 # In Reference *

Reference **[X1000H-SPECIFIC_010]**

The housing of connectors shall be electrically connected to the unit structure.

 # In Reference *

Reference **[X1000H-SPECIFIC_011]**

Unit or structure mounted connectors shall be of pin type, except those connectors dedicated to power generation and distribution outputs (“hot”) and for test purposes, which shall be socket type.

The connectors type shall be in accordance with the type of associated cable conductors.

Pin and socket connectors shall be mechanically locked together, to prevent inadvertent disconnection.

 # In Reference *

Reference **[CU-GDCEL-REQ-034]**

All connectors, not dedicated to power generation and distribution outputs, shall be pin type.

 # In Reference *

4.4.2 Connector characteristics

4.4.2.1 Connectors mating and demating requirements

Reference **[CU-GDCEL-REQ-035]**

Mating and demating of each connector shall be less than 20 before unit delivery

 # In Reference *

Reference **[X1000H-SPECIFIC_012]**

For test purposes, flight connectors shall be protected against multiple mating/demating operations by connector savers. Such connector savers shall have one flight type connector (same part number and same quality level) on one side. These connectors shall be delivered with the subsystem/unit by the contractor.

 # In Reference *

Reference **[X1000H-SPECIFIC_013]**

Connector near another

When multi-pin connectors are close to one another, they shall be configured such that mating with a wrong connector is not possible (inversion of two adjacent connector receptacles) or the contact assignments shall be chosen such that mating with a wrong connector will not cause damage to the unit itself or to any other elements of the system.

No degradation shall be considered during worst-case analysis.

 # In Reference *

4.4.2.2 Connector mounting requirements

Reference **[X1000H-SPECIFIC_014]**

Connectors shall be mounted in easily accessible positions on one face.

In Reference *

Reference **[CU-GDCEL-REQ-036]**

The connectors shall be placed in such a way that connection and disconnection on one connector shall be made without any specific tool and without disconnecting the other connectors.

In Reference *

~~#Reference [X1000H-SPECIFIC]~~

~~Sufficient spacing shall be kept between two connectors to let the harness responsible to use metallic covers to ensure the electromagnetic compatibility (5 mm shall be kept between two covers).~~

~~#In Reference *~~

Reference **[CU-GDCEL-REQ-037]**

At least, 6mm shall be kept between two adjacent connectors.

In Reference *

Reference **[CU-GDCEL-REQ-038]**

The connectors shall be mounted according to manufacturer connector requirements.

In Reference *

4.4.2.3 Connector identification

Hardware and materials used for identification shall comply with the requirements of this document.
The identification shall be visible when the unit is mounted. The identification shall be legible from 0.5 m distance with unaided eye.

Reference **[CU-GDCEL-REQ-039]**

Each unit or bracket shall be permanently marked by visible connector identification closely adjacent to the corresponding connector.

In Reference *

4.4.3 Connector savers

Reference **[CU-GDCEL-REQ-040]**

Saver connectors shall be used during unit integration to lower number of mating and demating.

In Reference *

4.4.4 Pins characteristics

Reference **[CU-GDCEL-REQ-041]**

Lines which have a common return shall be placed on adjacent contacts to facilitate cable twisting and/or shielding (except for matrix concept).

 # In Reference *

Reference **[X1000H-SPECIFIC-015]**

For power connectors, power and return lines shall be separated by at least one unassigned connector contact to reduce short circuit risk.

 # In Reference *

Reference **[X1000H-SPECIFIC-016]**

An adequate number of spare pins (5%) shall be made available on each connector.

 # In Reference *

Reference **[CU-GDCEL-REQ-042]**

The connected contacts on each connector shall never be inferior to two third of its maximum capacity.

 # In Reference *

4.4.5 Derating requirements

Reference **[X1000H-SPECIFIC-017]**

Connectors derating requirements shall be compliant to ESA standard.

 # In Reference *

Reference **[X1000H-SPECIFIC-018]**

Maximum applied voltage

Derate to 50% of specified voltage (pin to pin and pin to case).

 # In Reference *

Reference **[X1000H-SPECIFIC-019]**

Maximum temperature

30°C below the specified maximum ~~operating~~ rated temperature.

 # In Reference *

Reference **[X1000H-SPECIFIC-020]**

Maximum current per contact

50% of rated current specified in the procurement specifications and additionally, as specified for the wire and cable attached to them.

 # In Reference *

#Reference [X1000H-SPECIFIC]

For power connectors, power and return lines shall be separated by at least one unassigned connector contact to reduce short circuit risk.

#In Reference *

4.5 Links

4.5.1 Harness Definition Responsibility

The subsystem internal harness definition is under system responsibility. Nevertheless, specific requirements may be submitted by the co-contractor.

4.5.2 Design Rules

The following rules shall be applied:

- The use of shields shall occur only when specified in the relevant subsystem specification or when the necessity is proven by analysis
- The design shall not be wire length dependent (the maximum possible length to be taken into account is 15 m as a general requirement. Exception is made with high current links where maximum length could be limited to 5 m).

Any exception to these rules shall be approved by the Prime.

4.5.3 Links Compatibility

The contractor shall demonstrate compatibility on these links, using the specified harness configuration (functional and EMC).

4.5.4 Number of Connector Pins for TM/TC Return Lines and Shielding

Each equipment shall provide as a minimum the number of pins for the return of the different CMD and TLM signals presented in Table 1.

RETURN FOR	NUMBER OF PINS PER CONNECTOR
ON/OFF commands used for relays driving	2 (pin redundancy)
TLM data (DR)	2 for nominal DR 2 for redundant DR
TLM data (Analog, Digital Bi-level)	• 2 (pin redundancy) if all TLM data are referenced to one common ground • nx2 (pin redundancy) if the TLM data are referenced to n different grounds

Table 1: Connector Pins for Return Lines and Shielding

Each connector for telemetry and command signals shall provide two pins, which are connected with the box housing. These two pins could be used for shields grounding if any better solution could not be defined.

4.5.5 Matrix Command and Telemetry Harness Concept

The basis definition of the matrix harness for TM/TC shall be unshielded lines assembled into one bundle in order to limit magnetic loop between the row (hot line) and the column (return line).

Each row or column line coming from the nominal RDIU shall be routed in chain to several equipment before returning back to the redundant RDIU. Each matrix node is thus simultaneously connected to the nominal and the redundant function.

Examples are given at the end of the paragraph, Figure 5 (Commands) & Figure 6 (Telemetries), with a 3 x 3 matrix organization.

The bundle shall be rooted near the ground plane (<1cm).

Care shall be taken when connecting to the matrix nodes several switches with the same common ground reference; those equipment shall share the same column.

Equipment switches shall be connected to the matrix row and column lines through intermediate connectors with a mounting plug.

Nominal and redundant switches shall not be located on the same intermediate connector.

Intermediate connectors shall be mounted on brackets.

The intermediate connector shall be a socket contacts connector and the mounting plug a pin contacts connector.

Very high integrated connector (ex : MDM or AMP 104) shall not be used.

The two following requirements are useless if the short circuit between adjacent pins never occurs :

a) two different rows or columns shall not be set on two adjacent pins on the intermediate connector,
b) two columns of matrix row contacts shall be separated by one matrix column contacts on the intermediate connector (see following figures).

Case 1 :

Taking into account requests a) and b), row and column pins arrangement on the intermediate connector shall be as shown in Figure 3 for a 50 pins connector and Figure 4 for a 78 pins connector.

On a 50 contacts connector, the maximum pins used for :

- row lines is 2 x 4 contacts (nominal + redundant lines) ⇒ 8 pins
- column lines is 2 x 4 contacts (nominal + redundant lines) ⇒ 8 pins
- switch commanded contacts is 32 (16 commands)
- 2 contacts not used

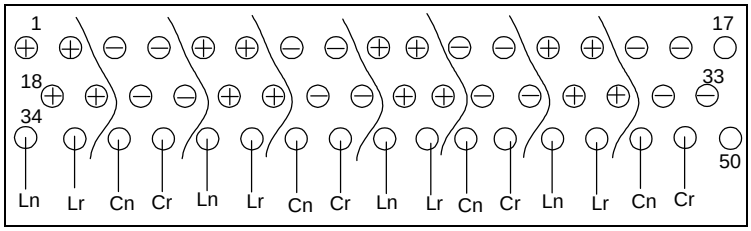


Figure 3: Intermediate 50 pins Connector Arrangement

On a 78 contacts connector, the maximum pins used for :

- row lines is 2 x 5 contacts (nominal + redundant lines) ⇒ 10 pins
- column lines is 2 x 5 contacts (nominal + redundant lines) ⇒ 10 pins
- switch commanded contacts is 50 (25 commands)
- 8 contacts not used

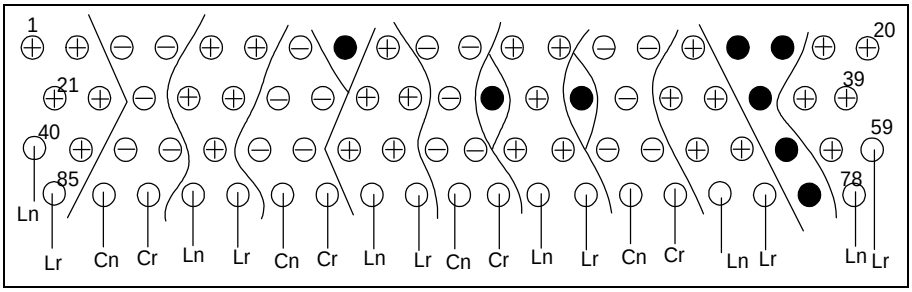


Figure 4: Intermediate 78 pins Connector Arrangement

Case 2 :

Without taking into account requests a) and b), row and column pins arrangement on the intermediate connector shall be made without any constraints.

On a 50 contacts connector, the maximum pins used for :

- column lines is 2 x 4 contacts (nominal + redundant lines) ⇒ 8 pins
- row lines is 2 x 4 contacts (nominal + redundant lines) ⇒ 8 pins
- switch commanded contacts is 32 (16 commands)
- 2 contacts not used

On a 78 contacts connector, the maximum pins used for :

- row or column lines is 2 x 7 contacts (nominal + redundant lines) ⇒ 14 pins
- row or column lines is 2 x 4 contacts (nominal + redundant lines) ⇒ 8 pins
- switch commanded contacts is 56 (28 commands)
- 0 contacts not used

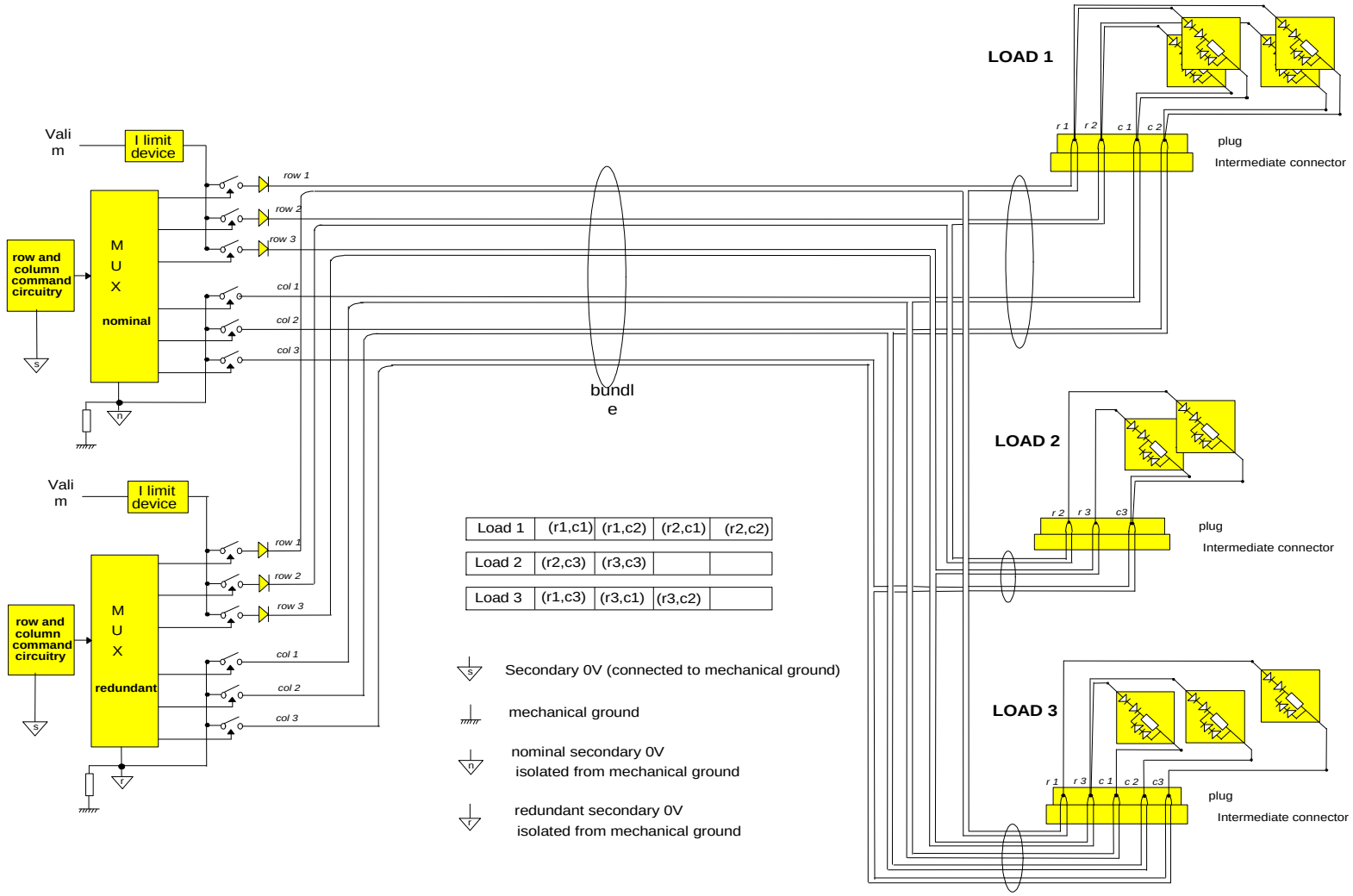


Figure 5: Example of a 3x3 Matrix Commands Harness Concept

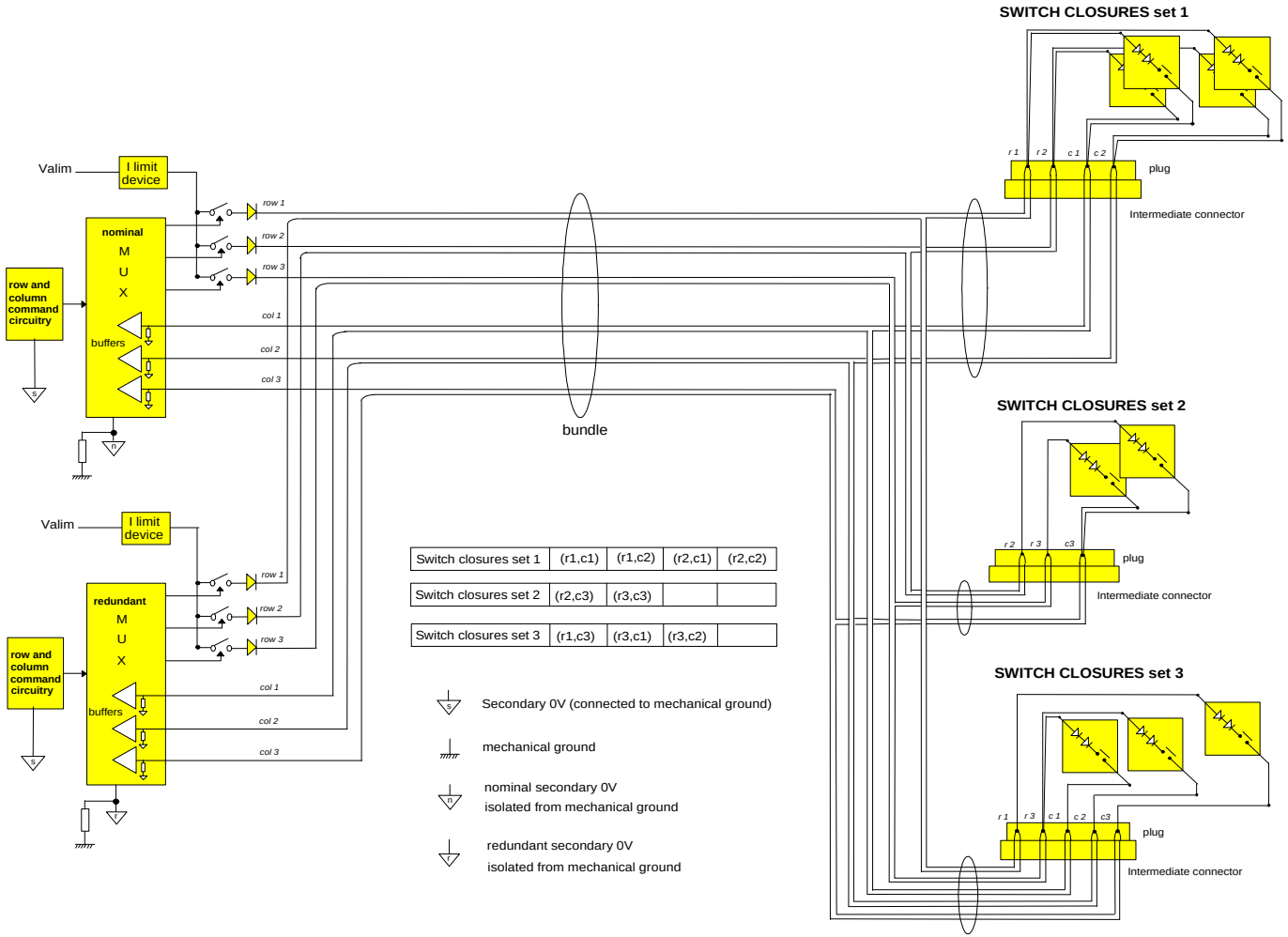


Figure 6: Example of a 3x3 Matrix Telemetries Harness Concept

5. POWER SUBSYSTEM INTERFACES REQUIREMENTS

5.1 Power Bus Definition

The power conditioning subsystem of EXPRESS-1000H platform provides two power buses, which are distributed to the spacecraft users:

- the “100V” power bus shall be used to supply the Payload and TCR RF equipments,
- the “27V” power bus shall be used to supply the RDIU and the CCU.

The 100V and 27V voltage is applied to input power connectors 30 minutes before the satellite lift-off and is not commutated during the satellite in orbit operation.

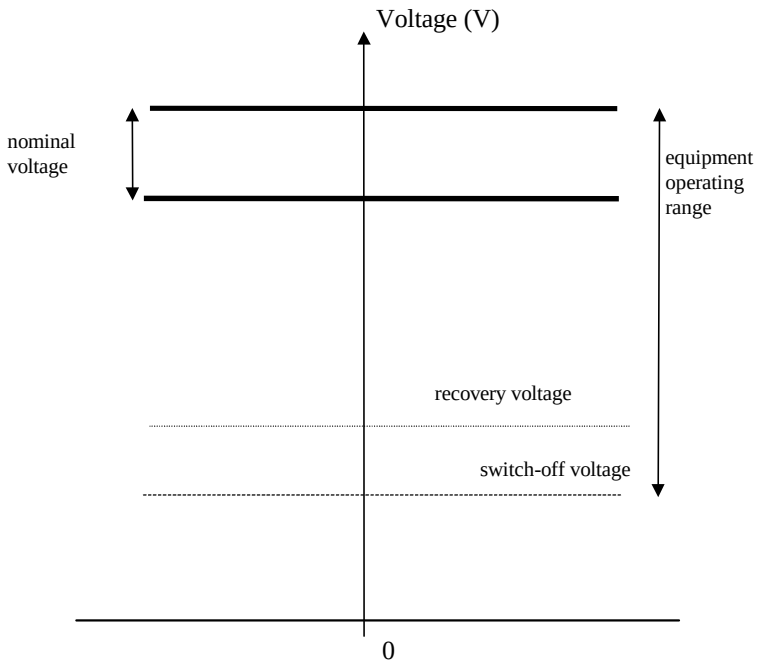


Figure 7: Equipment operating range.

5.2 Power bus nominal voltage

Reference **[X1000H-SPECIFIC_021] replaces [CU-GDCEL-REQ-043]** AD-AV4-AD01_Part4-5.1.1.2-001/a

At the loaded input connector of user, the nominal “100V” bus voltage is defined as follows :

Maximal DC bus voltage : **101V**

Minimal DC bus voltage : **97.5V**

At the loaded input connector of user, the nominal “27V” bus voltage is defined as follows :

Maximal DC bus voltage : **28V**

Minimal DC bus voltage : **25.5V**

*# In Reference **

5.3 Power bus operational voltage

Reference **[X1000H-SPECIFIC_022] replaces [CU-GDCEL-REQ-044]**

The DC/DC of spacecraft equipment shall be able to operate according to the following voltage.

Function	DC MIN VOLTAGE (V)
High Power Payloads Units (> 20W)	**94,0**
Low Power Payloads Units (< 20W)	**94,0**
Beacons	**94,0**
TTC RF (TX , RX and transponders)	**84,5**
RDIU	**22,5**
CCU	**22,5**

Note: beyond the voltage range specified in §5.2, the degradation of equipment technical characteristics is allowed.

*# In Reference **

5.4 Equipment operating requirements

Reference **[CU-GDCEL-REQ-045]**

Status of the units shall not be modified (Switch off, mode, gain step...) if the power bus voltage is under their automatic switch-off voltage level during less than 10 µs.

*# In Reference **

Reference **[X1000H-SPECIFIC_023] replaces [CU-GDCEL-REQ-046]**

Units shall be automatically switched off if the power bus voltage is under their automatic switch-off voltage level during more than 1 second

Function	AUTOMATIC Switch-Off Voltage (V)	AUTOMATIC RECOVERY	RECOVERY VOLTAGE(V)
High Power Payload Units (> 20 W)	In range 92 – 94	NO for TWTA's	(1)
Low Power Payload Units (< 20W)	In range 87 – 94		(1)
RDIU	In range 18 – 21,4		(1)
TTC RF (RX+TX)	In range 0 - 84,5	YES	≤ 84,5
CCU	In range 0 - 22,5	YES	≤ 22,5

(1) When automatic recovery is implemented, maximal recovery voltage shall equal minimal operational voltage defined in §5.3.

The threshold voltage values, at which the units will switch off and automatically switch on (when applicable), shall be indicated in the User's Manual.

*# In Reference **

Reference [X1000H-SPECIFIC-024]

The automatic switch-off shall not occur caused by interferences induced in the “100V” and “27V” power circuits with the levels specified in §7.2 herein for voltage range specified in §5.2.

In Reference *

Reference [X1000H-SPECIFIC-025]

The Payload and TCR equipments (including RDIU and CCU) shall be able to operate after fall of the “27V” bus and “100V” bus supply voltage down to 0V for some time followed by a recovery of the nominal supply voltage, and further switch ON by dedicated command for units which do not recover automatically.

In Reference *

5.5 Distribution requirements

The mean power demand is defined as the maximum average power drawn from its dedicated power lines in the worst conditions.
Specifically, the maximum average is defined as the average during a period of 5 minutes shifted to any point in time where this average will yield a maximum and does not include peak power defined hereafter.

The long peak power demand is defined as the maximum operational average power drawn from the unit dedicated power lines in the worst .
Specifically, the maximum operational average is defined as the average during a period of 50 msec shifted to any point in time where this average will yield a maximum. Operational mode change requires specification of the average power demands per mode and duration.

Reference **[CU-GDCEL-REQ-047]**

The unit input ON/OFF relay contact shall be sized to withstand twice the peak current corresponding to the long peak power demand.

In Reference *

Reference [X1000H-SPECIFIC-026]

The switching elements of power circuits shall be located on the “+” power bus.

In Reference *

5.5.1 Mean power demand

Reference **[CU-GDCEL-REQ-048]**

The mean power demand shall be measured in voltage nominal conditions (see chapter "Power bus nominal voltage") during a period of 5 minutes.

In Reference *

5.5.2 Peak power demand

Reference **[CU-GDCEL-REQ-049]**

The long peak power demand shall be measured in voltage nominal conditions (see chapter "Power bus nominal voltage") at worst functional case of equipment (wheel spin up, telecommand generation, etc)

In Reference *

5.6 Load current limitation

Reference **[CU-GDCEL-REQ-050]**

For High Power Payload Units (> 20 W), the maximum current drawn by the unit from the supply lines in case of failure, shall be limited to 1.5 times the peak current value corresponding to the long peak power demand (except during the unit ON/OFF sequence).

For Low Power Payload Units (< 20W), the maximum current drawn by the unit from the supply lines in case of failure, shall be limited to 2 times the peak current value corresponding to the long peak power demand (except during the unit ON/OFF sequence).

In Reference *

5.7 Fuses

Reference **[X1000H-SPECIFIC_027] replaces [CU-GDCEL-REQ-051]**

The Payload and TCR equipments shall protect the satellite power circuits from the overloads caused by failure of Payload or TCR equipment: protection units shall be implemented inside equipments.

The power circuit protection units shall be installed into switched “+” power bus.

As protection units, fuses (jumpers) or current limiters shall be used. The protection can be a multiple-shot one.

In Reference *

Reference **[X1000H-SPECIFIC_028]**

The protection release shall not affect the operability of other equipment.

In Reference *

Reference **[X1000H-SPECIFIC_029]**

The Payload and TCR equipments shall survive a short circuit occurring on the external power line (e.g. reverse discharge of input filter has to be taken into account).

In Reference *

Reference **[X1000H-SPECIFIC_030]**

The protection elements of power circuits shall not operate due to in-rush currents and transient currents specified in §7.2 herein.

In Reference *

Reference **[X1000H-SPECIFIC_031]**

The following requirements apply to Payload and TCR units (including RDIU and CCU):

- Equipment in any situations (including protection elements release) shall not induce current variation rate over 60 A/µs.
- The recommended value of the protection release current shall not exceed (for nominal including turn-on): 3 times higher than the nominal current for the equipment with power consumption up to 3 A inclusively.
- In case of a short circuit inside the unit, the allowable current shall not exceed 10 times nominal current during the operation of the protection element (not exceeding 20 ms).

In Reference *

5.8 EXPRESS-1000H specific bus characteristics & requirements

The negative 27V and 100V power buses of the satellite electric power subsystem shall be common and directly coupled with the structure in one point at the platform level.
See below Payload & TCR Power Distribution block-diagram:

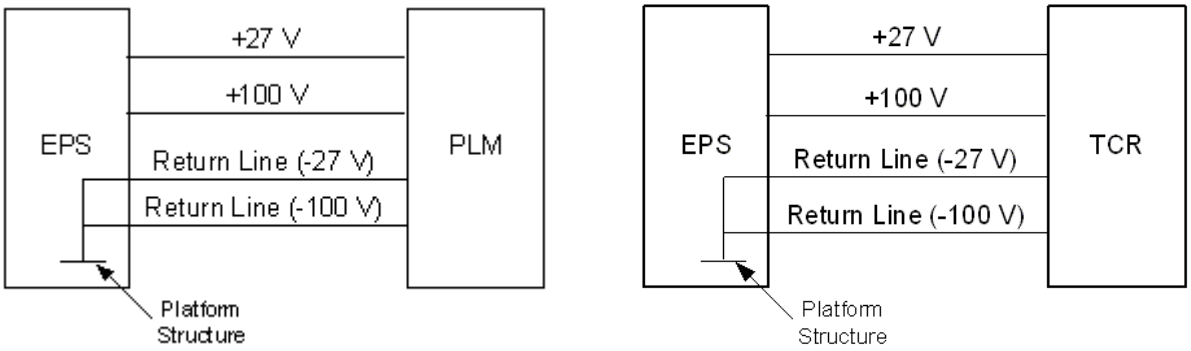


Figure 8: X1000H Power Distribution block-diagram

Reference **[X1000H-SPECIFIC_032]**

Voltage variation rate

27V and 100V buses voltage variation rate at voltage ripple (fall and increase) is less than 1 V/µsec.

Verification of the requirement shall be performed at bus voltage variation rate of 20 V/msec to 10 V/sec.

*# In Reference *

Reference [X1000H-SPECIFIC_033]

Switch-on bus voltage

When PCU is switched ON 100V and 27V buses voltage is increasing monotonically.

As soon as the level of 10V is reached, duration of increase to 99 V and 26.46V is between 5 msec and 100 msec.

Then a transient phase occurs during less than 10 msec; transient voltage during this phase will remain in the following range:

- 100V bus : (100± 11) V (the tolerance is taken into account).
- 27V bus : (27 ± 3,54) V (the tolerance is taken into account).

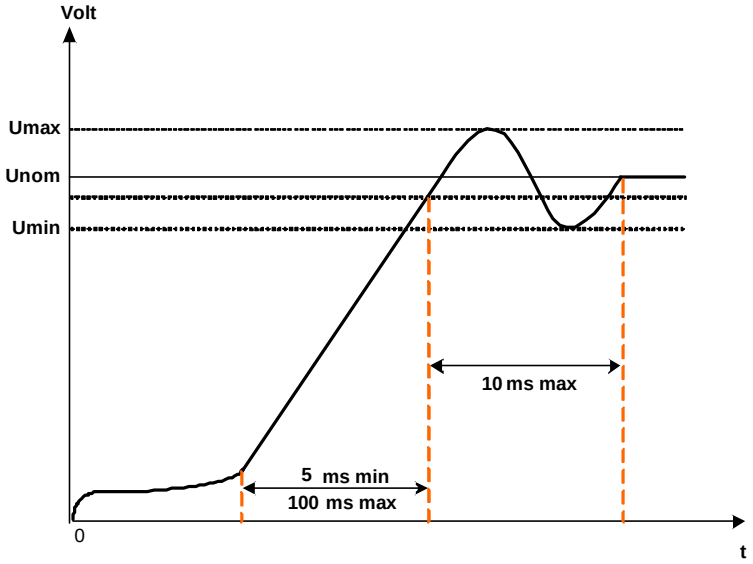


Figure 9 : 100V and 27V buses voltage at switch on (for information only)

In Reference *

Reference [X1000H-SPECIFIC_034]

Switch-off bus voltage

When PCU is OFF 100V and 27V buses output voltage is decreasing monotonically down to 1V during less than 10 sec and more than 0.5 sec.

In Reference *

Reference [X1000H-SPECIFIC_035]

Power bus resistance (impedance)

To specify the requirements to Power bus resistance (impedance) for “27V” bus and “100V” bus, the Chapter 8.5.9 herein is fully applicable.

In Reference *

Reference [X1000H-SPECIFIC_036]

The power buses shall consist of several wires, and the connectors shall use at least two contacts (pins).

In Reference *

Reference **[X1000H-SPECIFIC_037]**

Each equipment power connector shall comprise both positive and negative power buses.

In Reference *

Reference **[X1000H-SPECIFIC_038]**

Power bus isolation

Each power line ("+" and "–" power lines of each equipment) shall maintain a galvanic insulation of at least 1 MΩ for TCR units including CCU, and 2 MΩ for Payload units including RDIU versus structure under all specified environmental condition for 100 V and 27 V buses.

In Reference *

6. SIGNAL LINE INTERFACE REQUIREMENTS

Reference **SB4-SAT-AD1-P4-REQ-442**

[FC Applicability: ALL CF (hardware)**]**

Signal interface shall use a return by wire concept.

*

6.1 Conventions

Time duration :
The time duration is defined at 50% of the measured full amplitude.

Signal rise and fall times :
The rise and fall times of a signal are defined as the time between 10% and 90% of the measured voltage swing.

Measurements :
Measurements are made at the unit (or harness) connector level.

6.2 Command interface

6.2.1 Low Level and High Level Commands (LLC & HLC)

Reference **[X1000H-SPECIFIC_039]**

Matrix commands architecture shall apply to any Payload unit with LLC or HLC command capability (user side, or source side for RDIU).

Single ended commands architecture shall apply to any TCR unit with LLC or HLC command capability (user side, or source side for CCU).

In Reference *

Matrix architecture:

Matrix HLC and LLC commands are generated through matrix row and column drivers. One row pulled up to a positive voltage and one column pulled down to the secondary 0v in order to command only the device at the node of the activated row and column.

The command signal is a differential voltage pulse distributed to the user for :

- relay driving or general logic control application with low level commands
- payload waveguide relay driving with high level commands

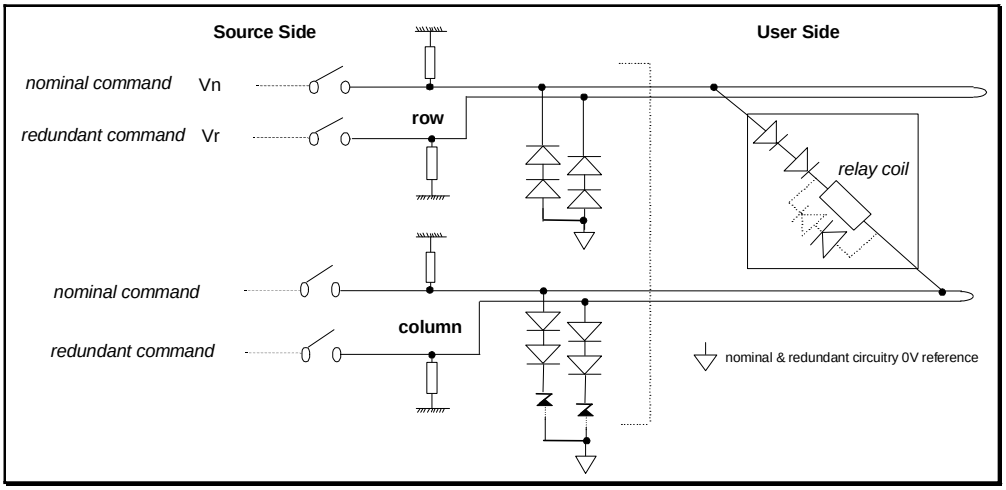
Single ended architecture:
The command signal is a single positive voltage pulse, distributed to the user on a dedicated line for :

- relay driving or general logic control application with low level commands
- payload waveguide relay driving with high level commands

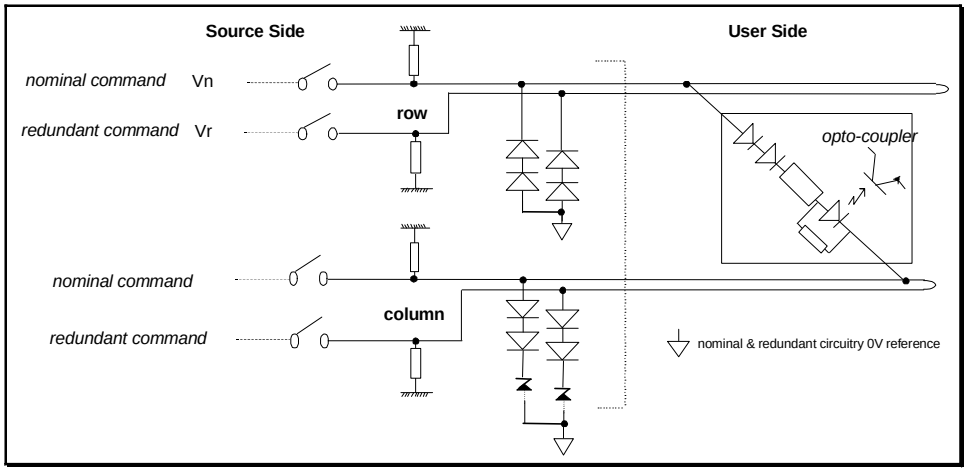
6.2.1.1 Command schematics

6.2.1.1.1 Matrix command schematics

Relay interface

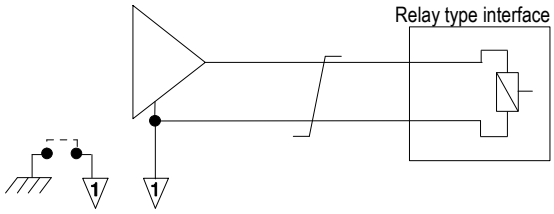


Opto coupler interface

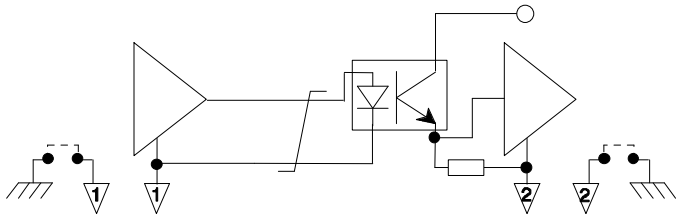


6.2.1.1.2 Single ended command schematics

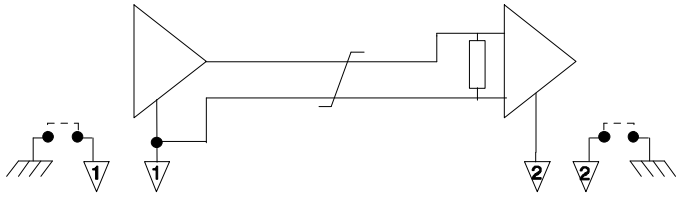
Relay interface



Optocoupler interface



Differential interface



6.2.1.2 Source side requirements

Reference **SB4-SAT-AD1-P4-REQ-182 b**

The command lines (rows and columns) shall be double insulated inside the equipment (except external side of I/O connectors) and no failure propagation shall occur between rows, between columns or between row and column.

*

Reference **SB4-SAT-AD1-P4-REQ-184 a**

matrix command (LLC and HLC) outputs shall be protected by a current limiting device

*

Reference **SB4-SAT-AD1-P4-REQ-192 a**

Row and column switches shall be closed after the pulse during the demagnetisation of the relay coil.

*

Reference **SB4-SAT-AD1-P4-REQ-193 a**

Only one command shall be activated at the same time; simultaneously commands are not allowed.

*

Reference **SB4-SAT-AD1-P4-REQ-194 a**

Only one row and one column shall be activated per command and per matrix.

*

6.2.1.3 User side requirements

Reference **SB4-SAT-AD1-P4-REQ-195 a**

All telecommand users shall provide two diodes in series with the commanded device at any matrix node.

*

Reference **SB4-SAT-AD1-P4-REQ-196 c**

For user interface with relay coil, two serial free wheel diodes shall be implemented in parallel with the relay coil at user side.

When the time constant of relay (L/R) is inferior to 1ms for LLC or 5ms for HLC, the diodes could be non implemented in the receiver interface.

*

Reference **SB4-SAT-AD1-P4-REQ-637**

L/R time constant of the relay/RF switch shall be lower than 15 ms

*

Reference **SB4-SAT-AD1-P4-REQ-201 b**

The user shall not impose any potential or grounding reference on any row or column.

*

6.2.1.4 Failures management

Reference **SB4-SAT-AD1-P4-REQ-202 b**

The user interface design shall permit the unit power on/off without damage when the electrical interfaces are not fully connected.

*

Reference **SB4-SAT-AD1-P4-REQ-235 b**

Unpowered equipments shall not be damaged and degraded in their performances when command signals are applied.

*

Reference **SB4-SAT-AD1-P4-REQ-236 b**

Each input shall be sufficiently decoupled (fault propagation) from each input/ output :

- normal condition (powered equipment, without failure)
- unpowered equipment
- unpowered equipment and with any one failure.

*

Reference **SB4-SAT-AD1-P4-REQ-237 b**

Each command source failure shall not cause the loss of more than 1 command.

*

Reference **SB4-SAT-AD1-P4-REQ-630**

Any short circuit of one row (+ TC at user side) or (-exclusive) one column (- TC at user side) to the structure shall not cause the loss of any TC.

*

6.2.1.5 Command signal characteristics

6.2.1.5.1 Command signal waveform

Signal duration (Td):
Time between crossing points of rise and fall time to 50% of the full amplitude.

Signal rise/fall time (Tr ; Tf):
Maximum between 10% and 90% of the nominal voltage swing.

Delay between 2 signals:
Time between the voltage crossing point at 50% of the full amplitude level.

Closed time Tc:
Command duration with switch closed.
Free wheeling time (Ti):
Duration between end of pulse and switch opening .

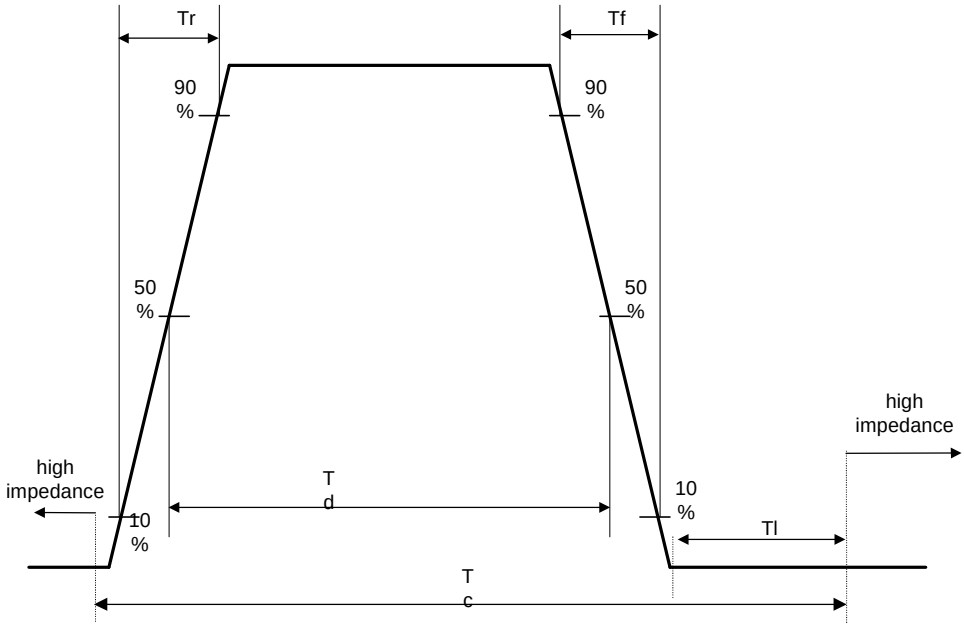


Figure 6.2-1

Figure 10 : Matrix command signal waveform

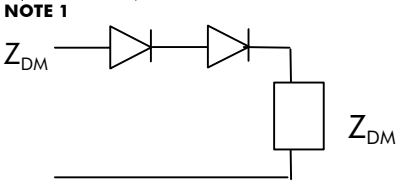
6.2.1.5.2 LLC electrical parameters

Reference **SB4-SAT-AD1-P4-REQ-238 c**

The LLC commands shall comply with these LLC electrical characteristics :

Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
A	***TYPE***			
Req-1	Output type	Differential (Diff) or Single Ended (SE)		Differential for matrix drivers organisation
Req-2	Input type		Differential	
B	**VOLTAGE**			
Req-1	DM low « 0 » voltage	-29V/ +4V (Diff) -2V/ +2V (SE)	-29V / +4V	User shall also comply with Req-H1
Req-2	DM high « 1 » voltage	26 V (+3V / -1V)	26 V (+3V / -4V)	
Req-3	Threshold		$11V \leq V_T \leq 19V$	
Req-4	CM Permanent Fault Voltage Emission	Not allowed	Not allowed	DM = 0
Req-5	DM Permanent Fault Voltage	Not allowed	Not allowed	
Req-6	DM Transient Fault Voltage Emission	-63 V/1 s +33V/80ms	± 2V / 25 ms	
Req-7	DM Transient Fault Voltage Tolerance	-63 V/1 s +33V/80ms	-63 V/1 s +33V/80ms	
C	**CURRENT**			
Req-1	Driving capability	> 180 mA		
Req-2	Load current		2,2 mA ≤ *load* ≤180 mA	Considering the whole DM high level voltage range
Req-3	Overcurrent	≤300 mA		
Req-4	short circuit between 2 outputs	Withstand		
D	**IMPEDANCE (Differential impedance excluding the two serial diodes (see figure NOTE 1))**			
Req-1	Impedance under DM low voltage		R≤ 9kΩ	
Req-2	Impedance during free wheeling time (TI)	<10Ω		Excluding diodes inside matrix source

NOTE 1

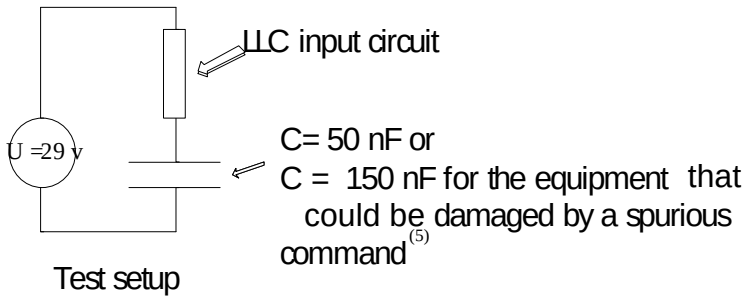


Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
E	***TIME***			
Req-1	Rise Time (Tr)	50 μs ≤ Tr ≤ 500 μs		Matrix output loaded by a user impedance in accordance with Code C and D.
Req-2	Fall Time (Tf)	1 μs ≤ Tf ≤ 600 μs		Matrix output loaded by a user impedance in accordance with Code C and D.
Req-3	« On » duration (Td)	40 ms ≤ Td ≤ 50 ms		
Req-4	Closed duration (Tl)	20 ms ≤ Tl ≤ 30 ms		Matrix requirement
Req-5	Spurious Command		Td ≤ 0,1 ms	Td = time duration
F	***MATRIX COMMAND GROUNDING AND ISOLATION*** (2)			
Req-1	Between matrix ground and Chassis: R equivalent	113 KΩ< R < 2 MΩ	> 10 MΩ	
Req-2	between one row or one column and Chassis: Equivalent Capacitance (In // R equivalent)	C_CM < 1nF	C_CM<500 pF (3)	(3) Around 10 KHz
Req-3	Between matrix ground and Chassis: C equivalent (In // R equivalent)	C_CM < 34 nF(3) (for SMU and PFDIU) C_CM < 50 nF(3) (for PLDIU)		(3) Around 10 KHz
Req-4	between row / column lines and relay or opto-coupler at user side		galvanic isolation	use of relay coil or opto-coupler at user side
G	***SINGLE ENDED COMMAND GROUNDING AND ISOLATION***			
Req-1	Isolation from Secondary Ground	Connected	≥ 1 MΩ//≤ 10 nF	
Req-2	Isolation from Chassis	≥ 1 MΩ//≤ 10 nF	≥ 1 MΩ//≤ 10 nF	
H	***SPECIFIC REQUIREMENT***			
Req-1	Transient low "0" voltage	N/A	The input LLC shall not be activated with the following setup hereafter(4)	U=29V with tr 50 to 500 μs

(2) Primary and users secondary grounds shall be considered connected to chassis for measurements

Note: CM: Common mode / DM: Differential Mode

Test setup(4)



Test setup

(5) 150 nF is only applicable to Payload units.

Table 2: LLC electrical characteristics

*

Reference **SB4-SAT-AD1-P4-REQ-587**

For LLC a single return shall be allowed for a maximum of 4 LLC commands.

*

Reference **SB4-SAT-AD1-P4-REQ-588**

Each return shall be electrical insulated from other return.

*

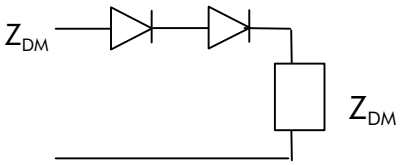
6.2.1.5.3 HLC electrical parameters

Reference **SB4-SAT-AD1-P4-REQ-239 c**

The HLC commands shall comply with these HLC electrical characteristics :

Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
A	***TYPE***			
Req-1	Output type	Differential (Diff) or Single Ended (SE)		for matrix drivers organisation
Req-2	Input type		Differential	
B	***VOLTAGE***			
Req-1	DM low « 0 » voltage	-29 V / +4V (Diff) -2 V / +2V (SE)	-29 V / +4V	User shall also comply with Req-H1
Req-2	DM high « 1 » voltage	26 V (+3V / - 3V)	26 V (+3V/- 5.5V)	
Req-3	Threshold		$11V \leq V_T \leq 20,5V$	
Req-4	CM Permanent Fault Voltage Emission	Not allowed	Not allowed	DM=0
Req-5	DM Transient Fault Voltage Emission	-63 V / 1s +33V/1s	± 2 V / 125 ms	
Req-6	DM Transient Fault Voltage Tolerance	-63 V / 1s +33V/1s	-63 V / 1s +33V/1s	
C	***CURRENT***			
Req-1	Driving capability	> 500 mA		
Req-2	Load current		22 mA ≤ *load* ≤ 500 mA	Considering the whole DM high level voltage range
Req-3	Overcurrent	≤ 1 A		
D	**IMPEDANCE (Differential impedance excluding the two serial diodes (see figure NOTE 1))**			
Req-1	Impedance under DM low voltage		R≤ 9kΩ	
Req-2	Impedance during free wheeling time (TI)	<10Ω		Excluding diodes inside matrix source

NOTE 1

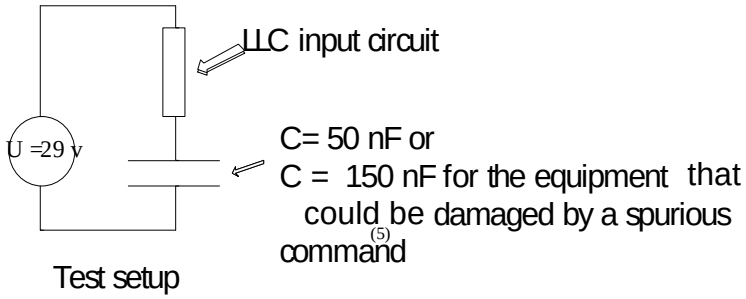


Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
E	***TIME***			
Req-1	Rise Time (Tr)	50 µs ≤ Tr ≤ 500 µs		Matrix output loaded by a user impedance in accordance with Code C and D.
Req-2	Fall Time (Tf)	1 µs ≤ Tf ≤ 600 µs		Matrix output loaded by a user impedance in accordance with Code C and D.
Req-3	« On » duration (Td)	500ms ≤ Td ≤ 530ms		
Req-4	Closed duration (Tl)	110ms ≤ Tl ≤ 140ms		Matrix requirement
Req-5	Spurious Command		Td ≤ 0,1 ms	Td = time duration
F	***MATRIX COMMAND GROUNDING AND ISOLATION*** (2)			
Req-1	Between matrix ground and Chassis: R equivalent	113 KΩ< R < 2 MΩ	> 10 MΩ	
Req-2	between one row or one column and Chassis: Equivalent Capacitance (In // R equivalent)	C_CM < 1nF	C_CM<500 pF (3)	(3) Around 10 KHz
Req-3	Between matrix ground and Chassis: C equivalent (In // R equivalent)	C_CM < 50 nF (3) (for PLDIU)(		(3) Around 10 KHz
Req-4	between row / column lines and relay or opto-coupler at user side		galvanic isolation	use of relay coil or opto-coupler at user side
F	***SINGLE ENDED COMMAND GROUNDING AND ISOLATION***			
Req-1	Isolation from secondary ground	Connected	≥ 1 MΩ//≤ 10 nF	
Req-2	Isolation from chassis	≥ 1 MΩ//≤ 10 nF	≥ 1 MΩ//≤ 10 nF	
H	***SPECIFIC REQUIREMENT***			
Req-1	Transient low "0" voltage	N/A	The input LLC shall not be activated with the following setup hereafter(4)	U=29V with tr 50 to 500 µs

(2) Primary and users secondary grounds shall be considered connected to chassis for measurements

Note: CM: Common mode / DM: Differential Mode

Test setup(4)



Test setup

(5) 150 nF is only applicable to Payload units.

Table 3 : HLC electrical characteristics

*

Reference **SB4-SAT-AD1-P4-REQ-589**

Each return shall be electrical insulated from others returns.

*

Reference **SB4-SAT-AD1-P4-REQ-590**

For HLC a single return shall be allowed for a maximum of 4 HLC commands.

*

6.2.2 SBDL Electrical Characteristics

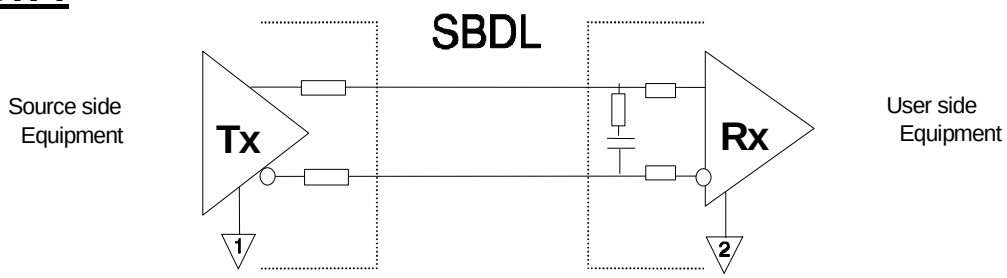
Reference **SB4-SAT-AD1-P4-REQ-626**

The following electrical characteristics shall be applied to a "point to point" connection. The cross strap of two redundant transmitters (MASTER) inside the unit (the same Pcb) is allowed.

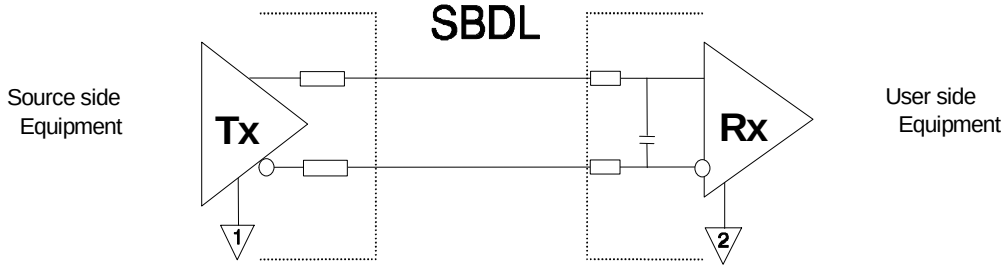
*

SBDL electrical interface is according to one of these schematics (Option1 and Option2):

OPTION 1



OPTION 2



Reference **SB4-SAT-AD1-P4-REQ-241 b**

SBDL serial link differential signals shall be identified as "non-inverted" and "inverted line".

*

Reference **SB4-SAT-AD1-P4-REQ-559**

The status of the signal shall be defined as true (logical « 1 ») when the non-inverted line has a positive voltage level w.r.t. the inverted line, i.e. when the non inverted line is at a high voltage level and the inverted line is at a low voltage level.

*

Reference **SB4-SAT-AD1-P4-REQ-560**

The status of the signal shall be defined as false (logical « 0 ») when the non-inverted line has a negative voltage with respect to the inverted line, i.e. when the non-inverted line is at a low level and the inverted line is at a high level.

*

Reference **SB4-SAT-AD1-P4-REQ-627**

ML16 clock and address receiver internal state shall not change in case of:
- logical "1" state transition to OFF bus state transition
- OFF bus state transition to logical "1" state.

*

Reference **SB4-SAT-AD1-P4-REQ-243 c**

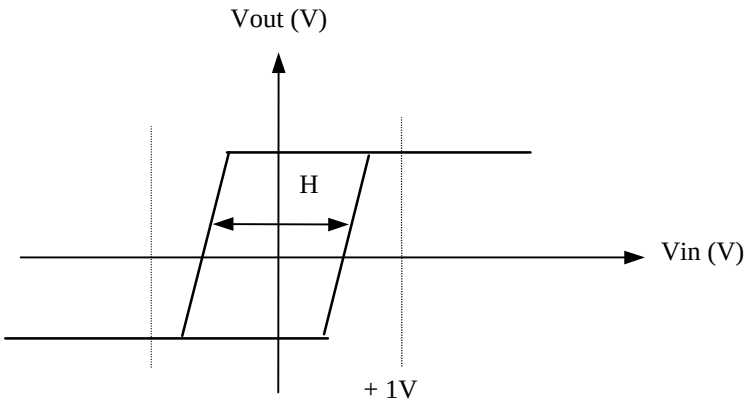
The SBDL interfaces shall comply with the following characteristics:

Code	PARAMETERS	SOURCE SIDE (transmitter)	USER SIDE (receiver)	COMMENT
A	***TYPE***			
Req-1	Output type	Differential driver or balanced driver		Differential driver required for ML16 drivers
Req-2	Input type		Differential	
B	***VOLTAGE***			
Req-1	Low level output voltage (VOL)	0V to 0.5V		D-Req4 (common mode)
Req-2	High level output voltage (VOH)	4 V to 5.5V		D-Req4 (common mode)
Req-3	Low level differential output voltage (logical 0)	-5.5 V to -3.5 V	See (1)	D-Req5
Req-4	High level differential output voltage (logical 1)	3.5 V to 5.5 V	See (1)	D-Req5
Req-5	Logical « 0 » differential threshold		-1V min	
Req-6	Logical « 1 » differential threshold		+1V max	
Req-7	CM Permanent Fault Voltage Emission	-0.5V to +7V		
Req-8	CM Permanent Fault Voltage Emission		-0.5V to +7V	through 2KΩ
Req-9	Overvoltage Tolerance (CM)	-7V to +12V		through 2KΩ
Req-10	Overvoltage Tolerance (CM)		-7V to +12V	
C	***CURRENT***			
Req-1	Current capability	20mA min. 100mA max.		Differential short circuit
D	***IMPEDANCE***			
Req-1	Power on differential Impedance	120Ω ± 10%		Serial resistor required
Req-2	Power off differential Impedance	4 KΩ min.		
Req-3	AC differential Impedance		120 Ω in series with 100 pF to 1nF max.	Option 1
Req-4	AC differential Impedance		2 x 2.2 KΩ min with 10 pF min. in parallel	Option 2 (Max. capacitor value is limited by propagation time)
Req-5	DC in line series resistor		2.2 KΩ min.	the value is related to each receiver input
Req-6	DC differential Impedance		10 KΩ min.	

Code	PARAMETERS	SOURCE SIDE (transmitter)	USER SIDE (receiver)	COMMENT
E	***TIME***			
Req-1	Rise Time (Tr)	10 ns ≤ Tr ≤ 100 ns		Measured on 120 Ω with 50pF in parallel. Only applicable to ML16/DS16
Req-2	Fall Time (Tf)	10 ns ≤ Tf ≤ 100 ns		Measured on 120 Ω with 50pF in parallel Only applicable to ML16/DS16
F	***GROUNDING AND ISOLATION***			
Req-1	from Secondary Ground (0Vs)	Circuit is referenced to 0Vs	Circuit is referenced to 0Vs	
Req-2	from Primary Ground	Isolated (> 1MΩ // 50nF)	Isolated (> 1MΩ // 50nF)	
Req-3	from chassis	Connected	Connected	

Table 4 : SBDL characteristics

(1) Two solutions are acceptable for the receiver :
*use a classical differential receiver with the following characteristics



- The hysteresis H has to be greater than 0.8V
- The high level threshold has to be under 1V and the low level threshold has to be above -1V (differential measure).

* use the differential line receiver **HS-26C(T)32MS** specially designed for such applications.

*

6.2.3 Memory Load Command (ML16)

6.2.3.1 Command Definition

The purpose of the memory load command (or 16-bit serial load command) interface is to transfer a 16-bit data word, in serial form, from a Master toward a Slave.
The interface consists of clock, address and data signals and use SBDL interface. The three signals are sent by the Master (Source side) to the Slave (User side).

The following notation is used:

- ML16_ADDRESS: ML16 address signal
- CLOCK: ML16 and DS16 common clock signal
- ML16_DATA: ML16 data signal

Reference **SB4-SAT-AD1-P4-REQ-548**

Outside the data transfer period, ML Address & ML/DS Clock shall be in logical « 1 » state.

*

Reference **SB4-SAT-AD1-P4-REQ-550**

One dedicated address line shall be provided to each ML16 user.

*

Reference **SB4-SAT-AD1-P4-REQ-551**

One clock signal shall be provided to each user, for telecommand and telemetry.

*

Reference **SB4-SAT-AD1-P4-REQ-552**

The data shall be valid only when the address line is active (level "0").

*

Reference **SB4-SAT-AD1-P4-REQ-553**

For each data transfer, 16 clock pulses shall be generated on the clock line.

*

Reference **SB4-SAT-AD1-P4-REQ-240 b**

The Master shall shift the data on the rising edge.

*

Reference **SB4-SAT-AD1-P4-REQ-628**

The Slave shall acquire the data on the falling edge.

*

Reference **SB4-SAT-AD1-P4-REQ-554**

One data line shall be provided to each ML16 user.

*

Reference **SB4-SAT-AD1-P4-REQ-555**

The data shall be a 16-bit word code.

*

Reference **SB4-SAT-AD1-P4-REQ-557**

The data word shall be clocked out with the MSB first (bit 0)

*

Reference **SB4-SAT-AD1-P4-REQ-242 b**

The ML16 commands shall comply with the SBDL electrical characteristics (See chapter "SBDL Electrical Characteristics")

*

6.2.3.2 Memory Load Command timing

Reference **SB4-SAT-AD1-P4-REQ-561**

The Memory Load Command shall respect the following timing:

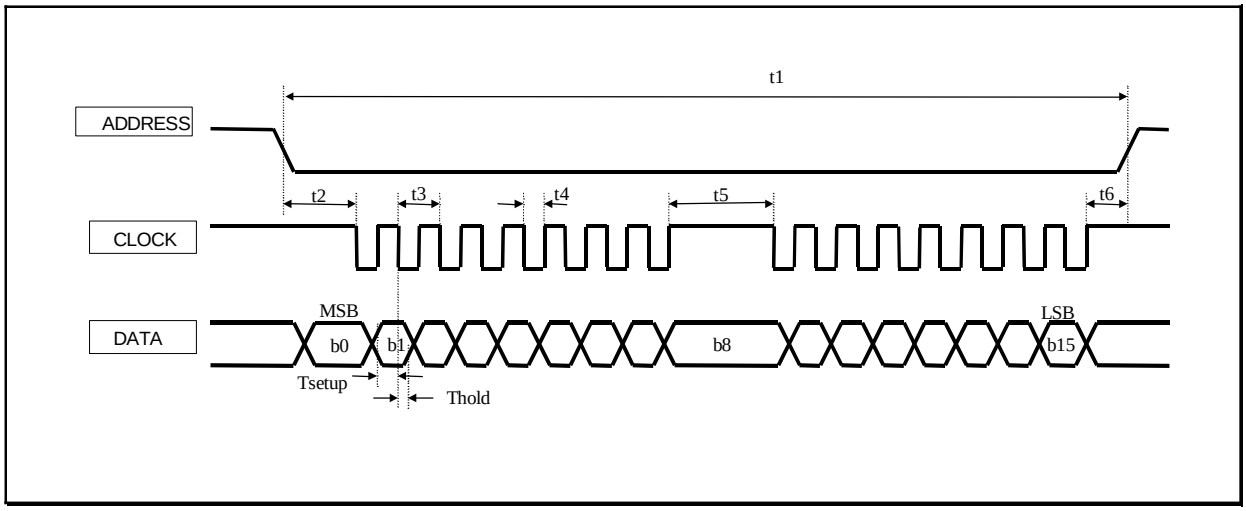


Figure 11 : Memory load command signal waveform diagram

TIMING			
		MASTER	SLAVE
t	Reference time	t=0,954µs ± 5%	t=0,954µs ± 5%
t1	Address active state duration	125t max.	125t max.
t2	Address to clock delay	28t ± t	27t min.
t3	Clock period	4t ± 0.1t	4t ± 0.1t
t4	Active to inactive edge of clock delay (Half Clock period)	2t ± 0.3t	2t ± 0.5t
t5	Middle frame gap	1.8t min. 36t max.	1.5t min. 37t max.
t6	Clock rising to end of address	1.8t min.	1.5t min.
Tcc	Command to command delay	3.8t min.	3.5t min.
Tsetup	Data valid setup time to clock falling edge	1.5t min.	0.5t min.
Thold	Clock falling edge to data change	1.5t min.	0.5t min.

Table 5 : Memory load command timing

*

Reference **SB4-SAT-AD1-P4-REQ-604**

All equipment sequencing constraints differing from the following table shall be approved by the Prime and indicated in the equipment IDS.

		Master	Slave
Command to acquisition delay	Tca	3.8t min	3.5t min
Acquisition to command delay	Tac	3.8t min	3.5t min

*

6.3 Telemetry interface

6.3.1 Telemetry channel types

The telemetry channel types are :

a. Analog Channel (AN)

b. Digital Bi Level Channels (DB)

c. Digital relay channels (DR)

d. Digital Serial Channel 16-bit (DS16)

e. Thermistors Power Supply and Conditioning (TH)

6.3.2 Analog channels

6.3.2.1 Analog channels definition

For ADSP users the analog TM is coded in 12 bits.
For unit including BBC/RUBI device, the analog TM is coded in 10 bits.
The system accuracy of the analog channels is better than ± 1 % of full scale.

6.3.2.2 Analog channels accuracy

Reference **SB4-SAT-AD1-P4-REQ-244 b**

The accuracy of the analog channel signal conditioning in the source shall be as specified in the corresponding subsystem specification but shall be limited to ± 0.5 % of full scale.

*

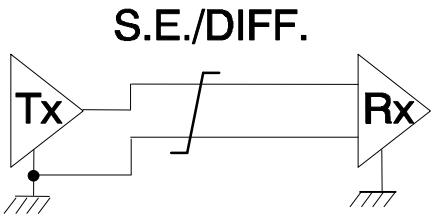
Reference **SB4-SAT-AD1-P4-REQ-613**

The overall A/D conversion accuracy including sampling error, quantization error plus offset shall be less than ± 0.5 % of full scale.

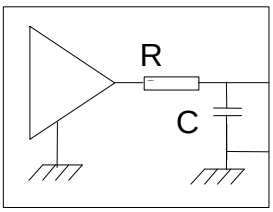
*

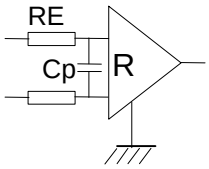
6.3.2.3 Analog channels characteristics

- Standard analog channel:



- Parameter definition:





Reference **SB4-SAT-AD1-P4-REQ-250 c**

The analog telemetry shall comply with these analog electrical characteristics:

Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
A	***TYPE***			
Req-1	Output type	Single ended		
Req-2	Input type		Differential	
B	***VOLTAGE***			
Req-1	Range	0 V / 5.12V		
Req-2	Fault Voltage Emission	± 15 V	± 15 V	
Req-4	Fault Voltage Tolerance	± 17 V	± 17 V	
C	***CURRENT***			
Req-1	Over-current	≤ 15 mA		permanent
D	***IMPEDANCE***			
Req-1	impedance ON	Rs ≤ 5 KΩ in parallel with 100 nF ≤ C ≤ 1 µF (RS x C ≥ 0,1 ms)	≥ 1 MΩ	
Req-2	impedance OFF	RP ≤ 100 kΩ **(2)**	≥ 1 MΩ	
Req-3	Receiver input Capacity		100 pF Max	500 pF for harness
Req-4	DC in line series resistor		Re ≥ 3 KΩ	value related to each receiver input
Req-5	Receiver filter Capacity		Cp ≥ 10nF	
E	***GROUNDING AND ISOLATION***			
Req-1	from secondary ground (0Vs)	Connected	≥ 1 MΩ	

Table 6 : Analogic telemetry characteristics

(2) Rp is the impedance between positive output and the ground when the unit (source side) is OFF.

*

6.3.3 Digital Bi-level channel

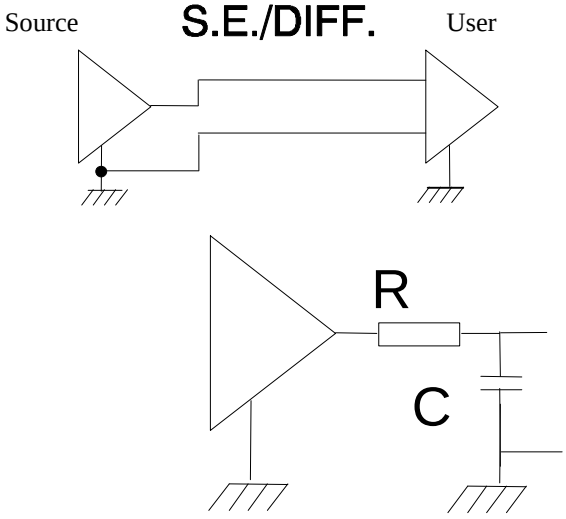
6.3.3.1 Digital Bi-Level channel definition

Reference **SB4-SAT-AD1-P4-REQ-562**

The digital bi-level information shall be presented by the source in the form of a voltage that can assume only two distinct values, an on-level («ONE» level) and an off level («ZERO» level).

*

6.3.3.2 Digital Bi-Level channel characteristics



Reference **SB4-SAT-AD1-P4-REQ-260 c**

The digital bi-level telemetry shall comply with these digital bi-level electrical characteristics :

Code	PARAMETERS	SOURCE SIDE	USER SIDE	COMMENT
A	***TYPE***			
Req-1	Output type	Single ended		
Req-2	Input type		Differential	
Req-3	Transfer	DC COUPLER	DC COUPLER	
B	***VOLTAGE***			
Req-1	Low level output voltage (discrete ''0'')	0V to 0.5V		
Req-2	High level output voltage (discrete ''1'')	+3.5V to +10V		
Req-3	Fault Voltage Emission	± 15 V	± 15 V	
Req-4	Fault Voltage Tolerance	± 17 V	± 17 V	
C	***CURRENT***			
Req-1	Over-current	≤ 10 mA		permanent
D	***IMPEDANCE***			
Req-1	impedance ON	Rs ≤ 5 KΩ in parallel with 100 nF ≤ C ≤ 1 µF (RS x C ≥ 0,1 ms)	≥ 220 kΩ	
Req-2	impedance OFF	RP ≤ 100 kΩ **(2)**	≥ 1 MΩ	
Req-3	Capacitance		100 pF max	500 pF for harness
E	***GROUNDING AND ISOLATION***			
Req-1	from secondary ground (0Vs)	connected	isolated (≥ 1 MΩ)	

Table 7 : Digital bilevel telemetry characteristics

(2) Rp is the impedance between positive output and the ground when the unit (source side) is OFF.

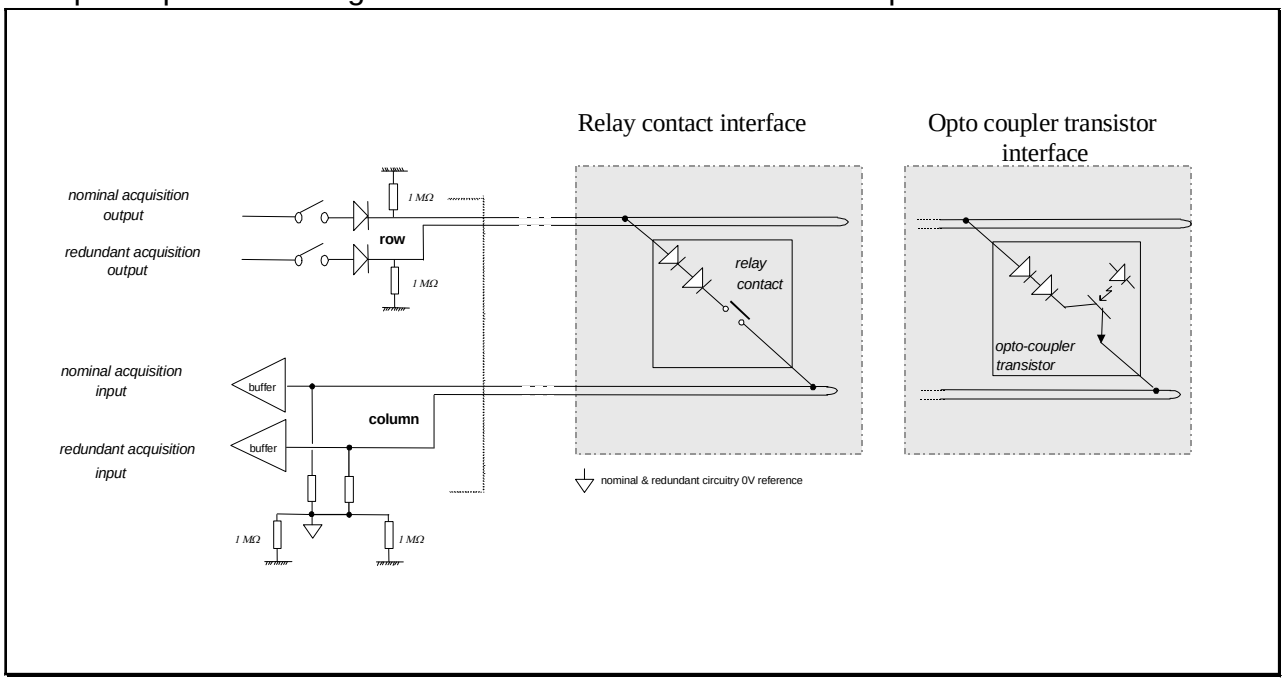
*

6.3.4 Digital switch closure channel telemetry

The Digital relay acquisition also called DR shall be used to transmit a relay or a switch status signal.

6.3.4.1 Matrix switch closure acquisition definition

The matrix switch closure acquisitions are performed through a matrix organisation. One row is pulled up to a positive voltage and the switch closure status is acquired on the column.



6.3.4.1.1 Source side requirements

Source side is related to the switch closure location

Reference **SB4-SAT-AD1-P4-REQ-266 b**

All source shall provide two diodes in series with the switch closure device.

*

Reference **SB4-SAT-AD1-P4-REQ-267 a**

Each row and column line shall be insulated from the mechanical ground inside the source equipment

*

Reference **SB4-SAT-AD1-P4-REQ-268 a**

The source equipment shall provide a galvanic isolation between the switch closure (contact or opto-coupler transistor) lines and the source electrical circuitry

*

Reference **SB4-SAT-AD1-P4-REQ-269 b**

The source equipment shall not impose any potential or grounding reference on any row or column.

*

Reference **SB4-SAT-AD1-P4-REQ-563**

Closed contact shall correspond to the TM "Zero" level with the unit powered or active

*

Reference **SB4-SAT-AD1-P4-REQ-564**

Open contact shall correspond to the TM "One" level with the unit unpowered or inactive

*

6.3.4.1.2 Receiver (or user) side requirements

Receiver side correspond at one hand to the switch closure polarisation outputs and at the other hand to the switch closure acquisition input.

Reference **SB4-SAT-AD1-P4-REQ-272 b**

Each node of the matrix switch closures shall be polarized by a nominal or a redundant separated interrogation command circuits.

*

Reference **SB4-SAT-AD1-P4-REQ-565**

Each set of switch closure status shall be selected by the nominal or the redundant acquisition input circuits

*

Reference **SB4-SAT-AD1-P4-REQ-274 b**

The command lines (rows and columns) shall be double insulated inside the equipment (except external side of I/O connectors) and no failure propagation shall occur between rows, between columns or between row and column.

*

Reference **SB4-SAT-AD1-P4-REQ-275 b**

In case of failure, the concerned row output or the concerned column acquisition input shall be in a high impedance state.

*

Reference **SB4-SAT-AD1-P4-REQ-276 a**

The polarization outputs of the matrix switch closure shall be protected by a current limiting device

*

Reference **SB4-SAT-AD1-P4-REQ-281 a**

The matrix acquisition pulse duration shall be at least 20 ms .

*

Reference **SB4-SAT-AD1-P4-REQ-566**

At least one serial diode shall be inserted on the positive output (row line output).

*

Reference **SB4-SAT-AD1-P4-REQ-282 a**

Only one row shall be selected per interrogation.

*

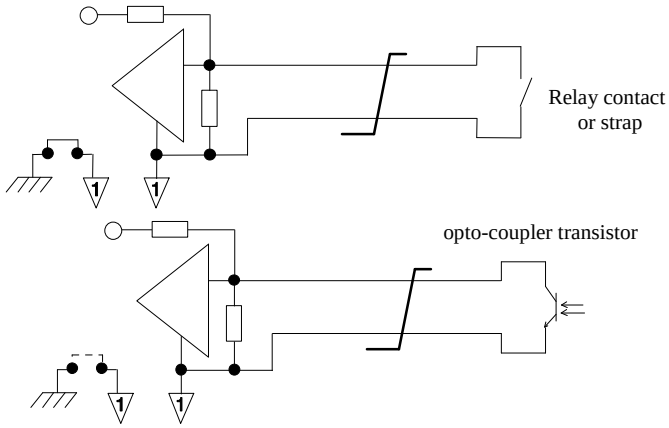
Reference **SB4-SAT-AD1-P4-REQ-283 b**

The matrix acquisition input interfaces shall not overload the source during normal operation (16 status (column lines, worst case) could be acquired simultaneously).

*

6.3.4.2 Single ended switch closure acquisition definition

Direct switch closure acquisition shall be performed via a dedicated circuits referenced to the secondary 0V.
Digital relay channel telemetry schematics (Relay and opto-coupler transistor):



6.3.4.2.1 Source side requirements

Source side is related to the switch closure location.

Reference **SB4-SAT-AD1-P4-REQ-301 a**

Digital switch closure channels shall be completely isolated from any other return inside the source equipment.

*

Reference **SB4-SAT-AD1-P4-REQ-302 a**

The source equipment shall provide a galvanic isolation between the switch closure lines and the source electrical circuitry.

*

Reference **SB4-SAT-AD1-P4-REQ-303 a**

Separated returns for nominal and redundant channels shall be provided.

*

Reference **SB4-SAT-AD1-P4-REQ-567**

Closed contact shall correspond to the TM "Zero" level with the unit powered or active

*

Reference **SB4-SAT-AD1-P4-REQ-568**

Open contact shall correspond to the TM "One" level with the unit unpowered or inactive

*

6.3.4.2.2 Receiver (or user) side requirements

Receiver side correspond to the switch closure acquisition inputs

Reference **SB4-SAT-AD1-P4-REQ-304 b**

Digital relay shall be referenced to the secondary ground inside the user equipment

*

6.3.4.3 Digital relay channel telemetry characteristics

Reference **SB4-SAT-AD1-P4-REQ-308 c**

For matrix organization, the digital relay telemetry shall comply with these digital relay electrical characteristics :

Code	PARAMETERS	SOURCE SIDE DR	USER SIDE PCB	COMMENT
A	***TYPE***			
Req-1	Output type	differential		
Req-2	Input type		differential	for matrix organisation
B	***VOLTAGE***			
Req-1	Row min. voltage	N/A	9V	
Req-2	DM fault voltage emission	Not allowed	±17 V	
Req-3	DM fault voltage tolerance	-17 V	N/A	permanent, ON or OFF
Req-4	DM fault voltage tolerance	±17 V	N/A	permanent OFF only (5 kΩ on user side input)
Req-5	CM fault voltage emission	Not allowed	±17V	
Req-6	Drop voltage («ON state »)	≤ 3,7V at 1mA		- relay : 2 diodes + 1 relay contact - opto : 2 diodes+1 transistor junction
Req-7	CM Fault Voltage Tolerance	±17 V	±17 V	DM = 0
C	***CURRENT***			
Req-1	Contact capability 'ON'	I ≥ 1mA	0,5mA<I<5mA	Permanent, closed contact
Req-2	Contact capability 'OFF' (leakage)	<200µA @ 17V		Permanent, open contact
Req-3	Fault Current emission	N/A	<100mA	

Code	PARAMETERS	SOURCE SIDE DR	USER SIDE PCB	COMMENT
E	***MATRIX DR GROUNDING AND ISOLATION*** [1]			
Req-1	between row / column lines and Chassis	≥ 1 MΩ// <50 pF for switch** <500 pF for all the other equipment**	113 KΩ<R<10 MΩ //< 25 pF	** Only stray capacitance, no physical capacitance shall be added. Note: For Repeater Subsystem only the equivalent capacitance for one MAP equivalent matrix (contribution of all units connected) shall be lower than 33nF.
Req-2	Between matrix ground and Chassis		113 KΩ<R<10 MΩ // 10nF<C_CM<50nF for PLDIU or 10nF<C_CM<34nF for PFDIU	
Req-3	Between switch closure lines and the electrical circuitry	galvanic isolation		use of relay contact or opto-coupler transistor at source side

[1] Primary and users secondary grounds shall be considered connected to chassis for measurements

Table 8 : Digital relay telemetry characteristics (For matrix acquisition)

*

Reference **SB4-SAT-AD1-P4-REQ-632**

For single ended acquisition, the digital relay telemetry shall comply with these digital relay electrical characteristics :

Code	PARAMETERS	SOURCE SIDE DR	USER SIDE PCB	COMMENT
A	***TYPE***			
Req-1	Output type	differential		
Req-2	Input type		Single ended	for single ended acquisition
B	***VOLTAGE***			
Req-1	DM fault voltage emission	Not allowed	±16 V	
Req-2	DM fault voltage tolerance	±16 V	N/A	permanent OFF only
Req-3	Drop voltage («ON state ») for DR ABM / MBSV / Umbilical	≤ 4V / 400mA / 50ms		Only for ABM / MBSV / Umbilical
	Drop voltage («ON state ») for DR BSV/ SMU / PYPGP	≤ 0,5V / 10mA		Only for BSV/ SMU / PYPGP
	Drop voltage («ON state ») for DR TOM/ BAPTA / SADM	≤ 1V / < 1mA		Only for TOM/ BAPTA / SADM
C	***CURRENT***			
Req-1	Contact capability 'OFF' (leakage)	<100µA @ 5V		Permanent, open contact
Req-2	Fault Current emission	N/A	<100mA	

Code	PARAMETERS	SOURCE SIDE DR	USER SIDE PCB	COMMENT
E	***SINGLE COMMAND GROUNDING AND ISOLATION***			
Req-1	From Primary or Secondary Ground	Galvanic isolation		Not applicable to optical switches (BAPTA/SADM)
Req-2	Chassis	Isolated (≥1MΩ)		Not applicable to optical switches (BAPTA/SADM)

Table 9 : Digital relay telemetry characteristics (Single ended acquisition)

*

Reference **SB4-SAT-AD1-P4-REQ-591**

For an equipment all digital relay telemetry return shall be insulated from all other digital relay telemetry return and from grounding

*

6.3.5 Digital serial channels : DS16

6.3.5.1 Telemetry definition

The function of this interface is to transfer in a serial form a 16-bit data word from the Slave to the Master.
The interface consists in clock, sample and data signals, and it uses SBDL interface.
Clock and Sample signals are provided by the Master. Data signal is provided by the Slave.

The following notation is used:
- DS16_SAMPLE: DS16 sample signal
- CLOCK: ML16 and DS16 common clock signal
- DS16_DATA: DS16 data signal

The interface consists of clock, sample and data signals shall use SBDL interface.

Reference **SB4-SAT-AD1-P4-REQ-570**

Outside the data transfer period, DS Sample & ML/DS Clock shall be in logical « 1 » state.

*

Reference **SB4-SAT-AD1-P4-REQ-571**

The data transfer shall be valid only when sample line is active (level "0").

*

Reference **SB4-SAT-AD1-P4-REQ-572**

One dedicated sampling signal line shall be provided to each DS16 user.

*

Reference **SB4-SAT-AD1-P4-REQ-573**

One clock signal shall be provided to each user, for telecommand and telemetry.

*

Reference **SB4-SAT-AD1-P4-REQ-575**

For each data word transfer, 16 clock pulses shall be generated on the clock line.

*

Reference **SB4-SAT-AD1-P4-REQ-309 b**

The Slave shall shift the data on the falling edge.

*

Reference **SB4-SAT-AD1-P4-REQ-629**

The Master shall acquire the data on the falling edge.

*

Reference **SB4-SAT-AD1-P4-REQ-576**

Each DS16 Slave shall provide one data line to its corresponding Master.

*

Reference **SB4-SAT-AD1-P4-REQ-578**

The data shall be clocked out with the MSB first (bit 0).

*

6.3.5.2 Digital serial Electrical characteristics

Reference **SB4-SAT-AD1-P4-REQ-313 b**

The digital serial telemetry shall comply with the SBDL electrical characteristics (See chapter: "SBDL Electrical Characteristics")

*

6.3.5.3 Digital serial telemetry timing

Reference **SB4-SAT-AD1-P4-REQ-580**

The Digital Serial Telemetry shall respect the following timing:

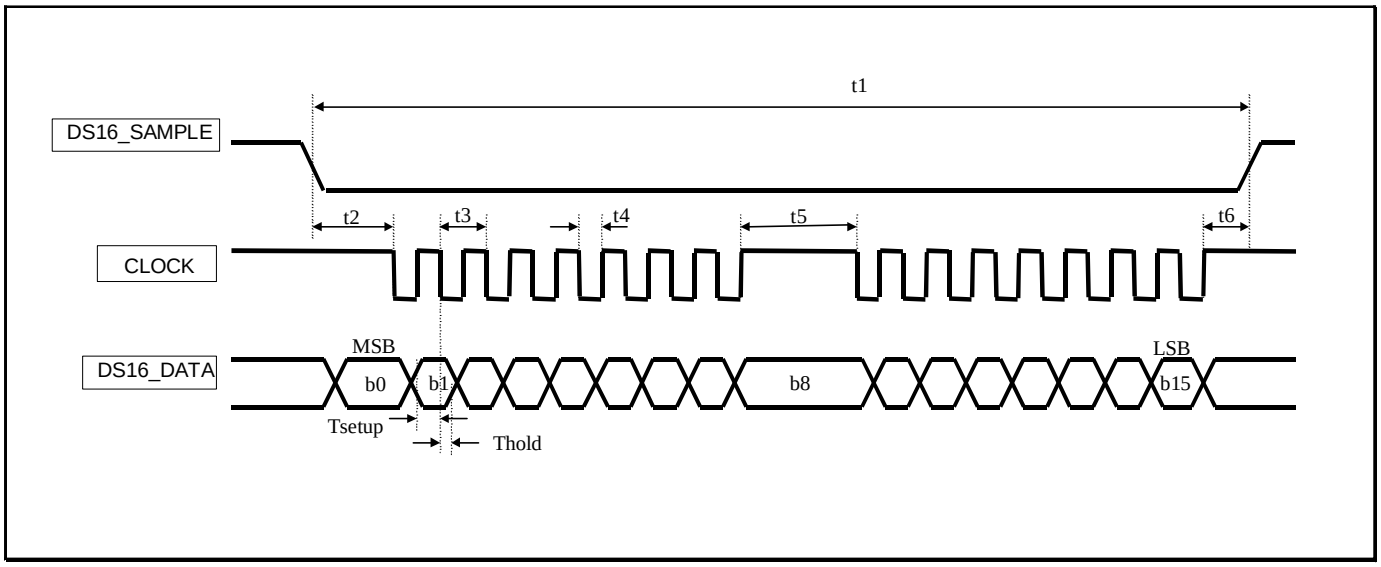


Figure 12 : Digital Serial 16-Bit Telemetry Signal Waveform Diagram

TIMING			
		MASTER	SLAVE
t	Reference time	t=0,954µs ± 5%	t=0,954µs ± 5%
t1	Sample active state duration	125t max.	125t max.
t2	Sample to clock delay	28t ± t	26.5t min.
t3	Clock period	4t ± 0.1t	4t ± 0.1t
t4	Active to inactive edge of clock delay (Half Clock period)	2t ± 0.3t	2t ± 0.5t
t5	Middle frame gap	1.8t min 36t max	1.5t min 37t max
t6	inactive edge clock to transfer end Clock rising to end of sample	1.8t min	1.5t min
Taa	Acquisition to acquisition delay	3.8t min	3.5t min
Tsetup	Data valid setup time to clock falling edge	1.5t min	2.8t min
Thold	Clock falling edge to data change	0t min	0t min

Table 10 : Digital serial telemetry timing

*

#

6.4 CCU / Transceiver interfaces

6.4.1 CCU / Receiver interfaces

Reference **SB4-SAT-AD1-P4-REQ-583**

The interface between receiver and the CCU shall provide (form SBDL signal): Squelch, Clock, Lock Status and Data signals.

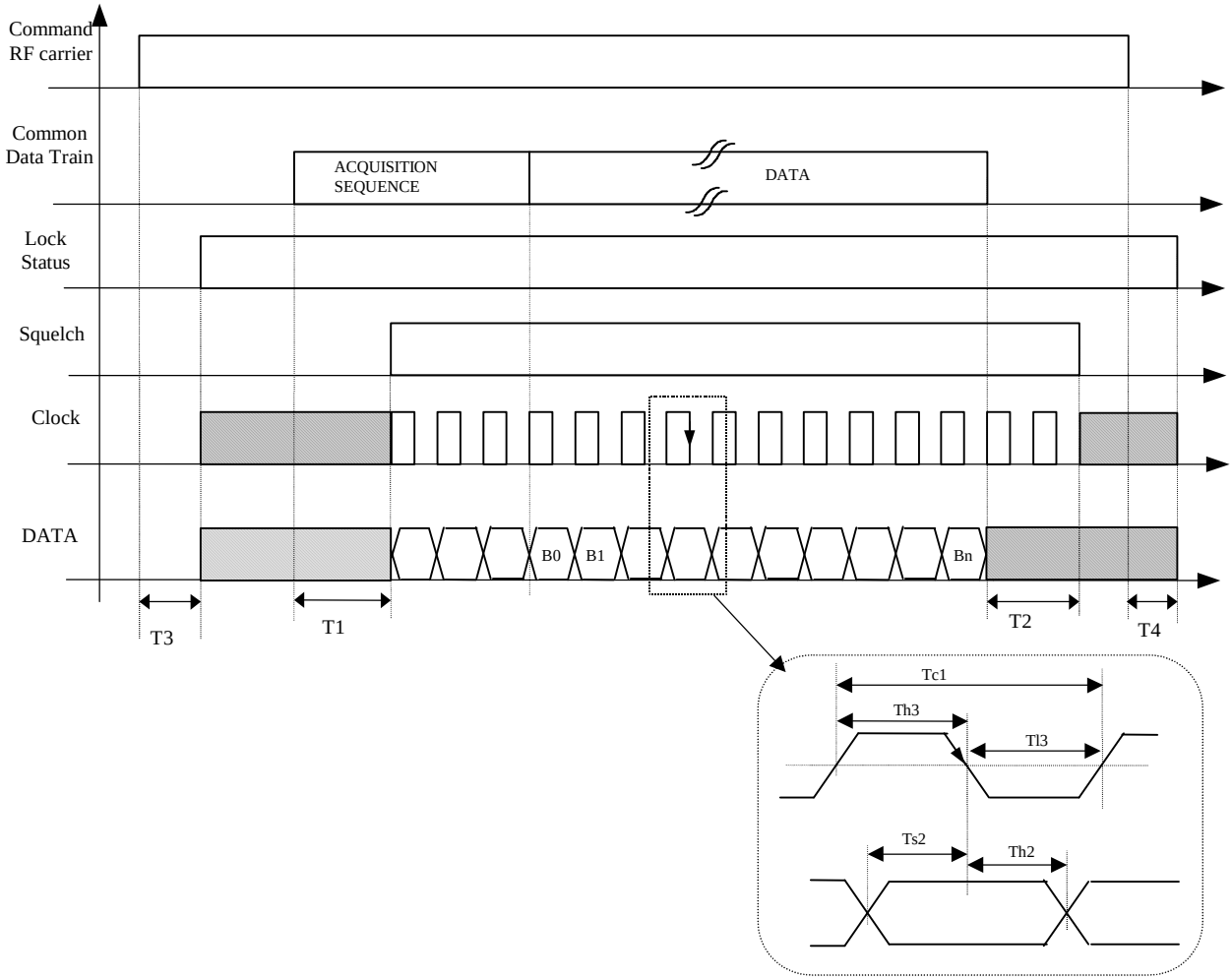


Figure 13 : Signals between receiver and CCU.

T1 : *≤ 168 bits duration*
1 bit duration ≤ T2 ≤ 128 bits duration
T3 & T4 *≤ 100ms*
Tc1 (Bit clock period) = 1 Bit rate +/-5%
Th3 (TC bit clock high level duration at 50% edge) : ≥60µs
Tl3 (TC bit clock low level duration at 50% edge) : ≥60µs
Ts2 (Set-up time from NRZ DATA bit stable to clock falling edge (sampling edge)) : ≥10µs
Th2 (Hold time from clock falling edge to NRZ DATA bit change) : ≥20µs

The above described interface is used to transmit from the receiver to the CCU the following signal : SQUELCH , CLOCK , DATA

*

Reference **SB4-SAT-AD1-P4-REQ-584**

The receiver bit clock shall be running as soon as Lock Status is ‘high’.

*

Reference **SB4-SAT-AD1-P4-REQ-326 b**

Data Validation shall be performed on the falling edge of the clock signal.

*

Reference **SB4-SAT-AD1-P4-REQ-327 a**

The bit clock stability shall be better than +/- 5% as soon as SQUELCH is high and until SQUELCH falls to low.

*

6.4.2 CCU / Transmitter interfaces

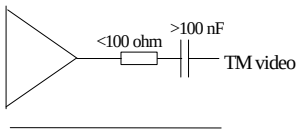
Reference **SB4-SAT-AD1-P4-REQ-330 c**

The TM video signals shall comply with the following characteristics :

Code	PARAMETERS	Transmitter side CCU	Receiver side	COMMENT
A	***TYPE***			
Req-1	Output type	single ended		
Req-2	Input type		differential	
Req-3	Type of Modulation	BPSK	BPSK	
Req-4	Waveform	Filtered quasi sine wave	Filtered quasi sine wave	
B	***VOLTAGE***			
Req-1	output AC voltage	3V ± 5.7% peak to peak		
Req-2	DC Fault Voltage Emission	-1V<U<10V	±17V in series with >2kΩ	
Req-3	DC Fault Voltage Tolerance	±17V in series with >2kΩ	-1V<U<10V	
C	***IMPEDANCE***			
Req-1	output impedance **(1)**	< 100Ω in series with > 100nF		
Req-2	input impedance		>10kΩ// <500pF	
D	***SPECIFIC REQUIREMENT***			
Req-1	TM sub-carrier frequency	65536 Hz	65536 Hz	upgrade : 32768Hz
Req-2	TM sub-carrier frequency stability	$\pm 10^{-4}$		
Req-3	TM bit rate	4096 bit/s or 8192 bit/s	4096 bit/s or 8192 bit/s	
Req-4	Phase plot accuracy	± 2°		Difference between theoretical and real phase
Req-5	group delay variations	< 1μs peak to peak		
Req-6	Amplitude distortion	<1 dB peak to peak		
Req-7	signal to noise ratio	65 dBHz		

Code	PARAMETERS	Transmitter side CCU	Receiver side	COMMENT
Req-8	Spurious and Harmonics	• **<-20dBc** : 0<f<220kHz • **<-60dBc :** f>220kHz 32768Hz +/-8kHz 65536 Hz +/- 8kHz [15kHz ;30kHz] 100kHz +/-1kHz	N/A N/A	With respect to TM sub carrier levels TM signal bandwidth TM signal bandwidth Ranging signals bandwidth Ranging signals bandwidth
Req-9	phase step response accuracy	± 5% **(2)**		
E	***FAIL SAFE PROTECTION***			
Req-1	protection	short circuit proof		
F	***GROUNDING AND ISOLATION***			
Req-1	From secondary ground 0Vs	Grounded	Galvanic isolation	
Req-2	From primary ground	Isolation ≥ 1MΩ	Isolation ≥ 1MΩ	
Req-3	From chassis	Grounded	Isolation ≥ 1MΩ	

(1)



(2) At all times, for more than 25% of a sub-carrier period after a phase reversal, the phase of the modulated sub-carrier shall be within ±5% of a perfect signal.

Table 11 : TM Video Signal Characteristics.

*

6.5 Data Bus interfaces

Two types of Data bus are available on EXPRESS-1000H :
- OBDH - 485
- 1553

Applicable Bus for interface of payload equipments with RDIU is OBDH - 485.
Applicable Bus for interface of RDIU with EXPRESS-1000H platform is 1553.

Reference **[CU-GDCEL-REQ-149]**

The unit shall be able to receive telecommands and transmit telemetries through nominal and redundant OBDH buses in less than 2 seconds after ON command receipt.

*# In Reference *

6.5.1 OBDH – 485

The "Data Bus Network Electrical and Protocol Specification" (SBF.6AV2.AS.SP.338) document defines the requirements to be satisfied by the OBDH-485.

6.5.2 1553 bus interface

The MIL-STD-1553B Bus interface shall comply with MIL-STD-1553B standard.

7. EMC/ESD PERFORMANCE REQUIREMENTS

This chapter defines the EMC/ESD environment to which the payload units will be subjected during the satellite life :

- before the launch during integration, qualification or acceptance tests and launch operations,
- during the launch,
- in-orbit.

Compliance with these requirements shall be demonstrated by the Co-Contractor by tests, analysis and similarity. Qualification reports based on analysis or similarity must also be approved by the Prime Contractor before acceptance.

7.1 Radiated Emissions and Susceptibility Requirements

7.1.1 Radiated Emissions E-Field

Electrical field radiated by payload & TCR active units, fitted with its test harness (manufactured at flight level from EMC point view), from 1MHz to 26GHz shall not exceed the level given in Figure 14, with the notches defined as follows :

- 27dBµV/m in receive frequency range of C-band payload from 5775 to 6725MHz,
- 27dBµV/m in receive frequency range of Ku-band payload from 14000 to14500MHz, from 17300 to 18100MHz,
- 90dBµV/m in transmit frequency range of C-band payload from 3450 to 4200MHz. For the 2nd harmonic frequencies, the radiation level shall not exceed 70dBµV/m,
- 90dBµV/m in transmit frequency range of Ku-band payload from 10950 to 11200MHz, and from 11700 to 12750MHz. For the 2nd harmonic frequencies, the radiation level shall not exceed 70dBµV/m.

Note: All field values are RMS.

RE requirement shall be met at 1 m distance from unit under test.

In the range from 25MHz to 26GHz, the tests shall be performed in both horizontal and vertical polarizations if a linearly-polarized antenna is used.

Upper frequency limit of RE requirement for non-RF equipment shall be limited at 1GHz.

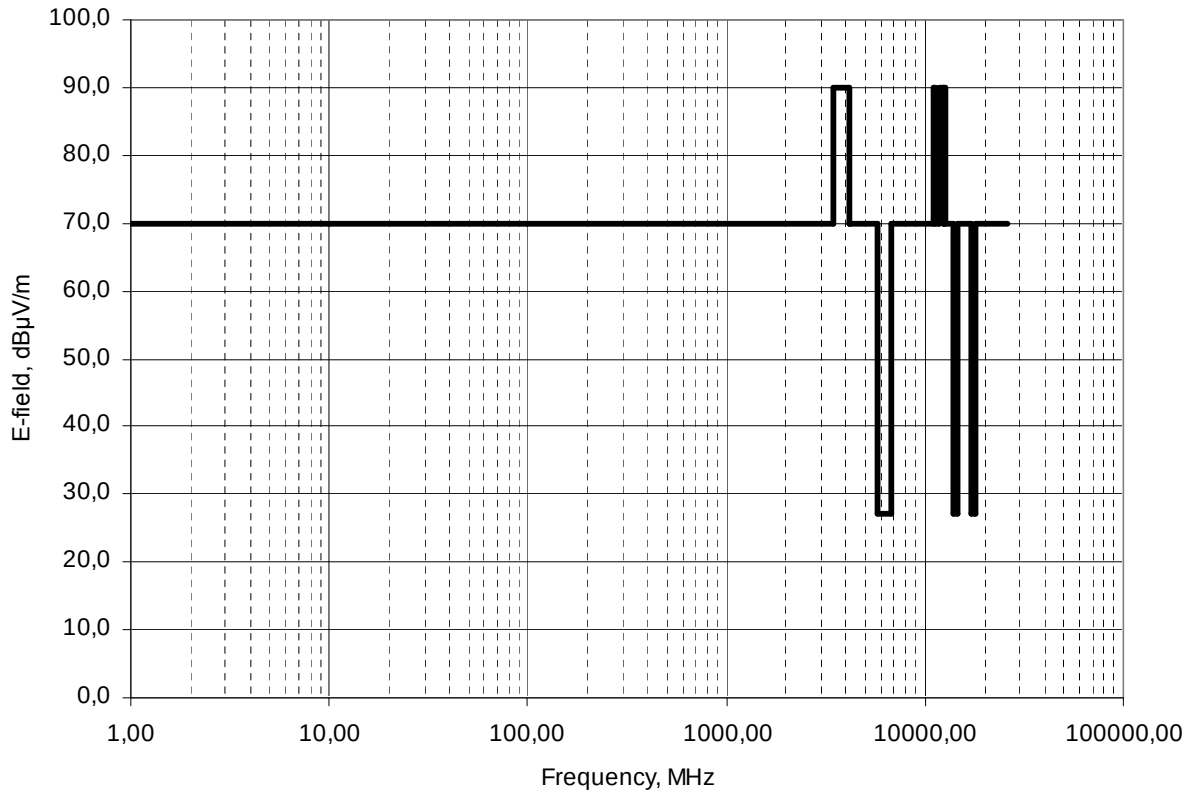


Figure 14 : Radiated Emissions, E-Field

7.1.2 Radiated Emissions H-Field

The Radiated Emissions DC H-field by payload & TCR active and passive units shall not exceed the values as follows :

- For HPI, TWTA, SSPA ≤ 101 dBpT
- For other units ≤ 97 dBpT

These limits are defined at 1 meter from the unit under test.

Unit magnetic field level shall be given by the co-contractor in the 3 axis (X,Y,Z).

The above specified levels shall be verified by test or analysis.

7.1.3 Radiated Susceptibility E-Field

Payload active units, fitted with its test harness (manufactured at flight level from EMC point view), shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given by the corresponding unit specification when it is subjected to an sine wave electrical field having the level of 120dBµV/m in the frequency range of from 1MHz to 26GHz (see Figure 15), except for:

- 140dBµV/m in the frequency range of C-band transmitters from 3450 to 4200MHz,
- 140dBµV/m in the frequency range of Ku-band transmitters from 10950 to 11200MHz, from 11700 to 12750MHz,
- 77dBµV/m in the frequency range of C-band receivers from 5775 to 6725MHz,
- 77dBµV/m in the frequency range of Ku-band receivers from 14000 to 14500MHz, and from 17300 to 18100MHz.

Note: All field values are RMS.

The sine wave signal shall be 30 % amplitude modulated by a 1 kHz square wave.

In the range from 25MHz to 26GHz, the tests shall be performed in both horizontal and vertical polarizations if a linearly-polarized antenna is used.

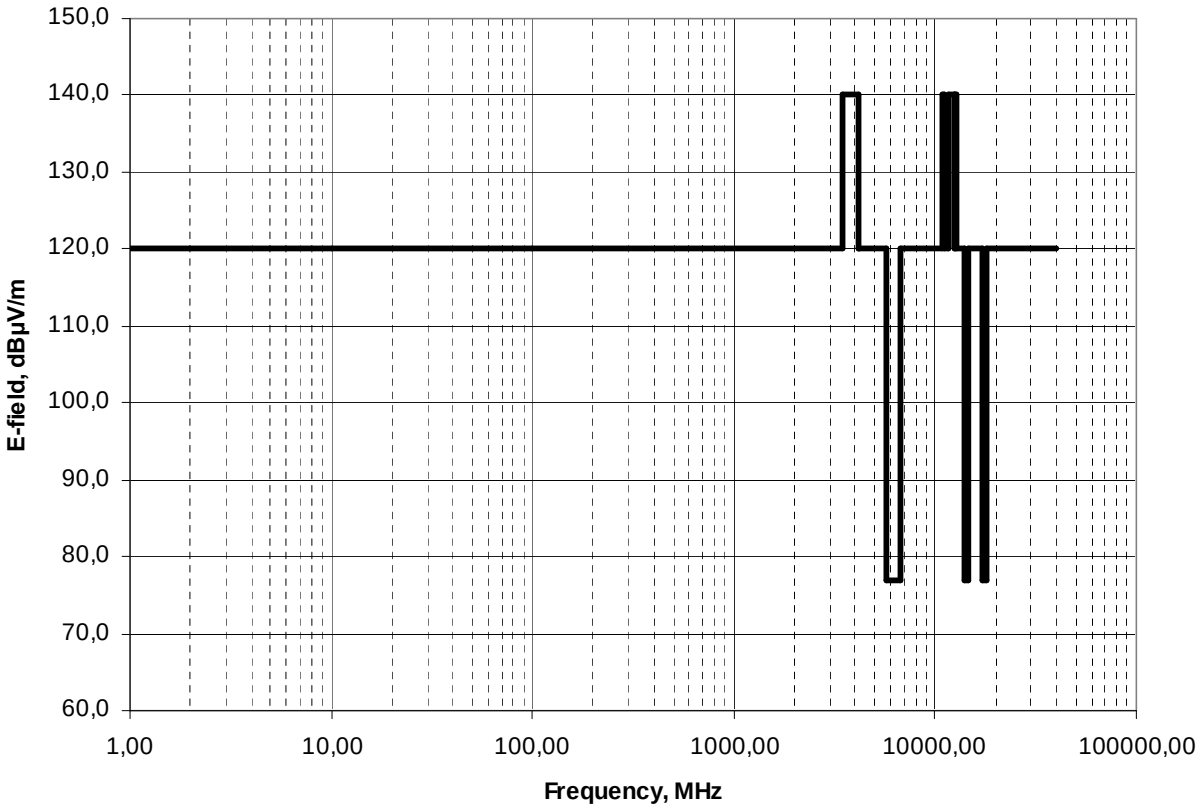


Figure 15: Radiated Susceptibility, E-Field

7.1.4 Radiated Susceptibility H-Field

Payload active and passive units, fitted with its test harness (manufactured at flight level from EMC point view), shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given by the corresponding unit specification when it is subjected to a DC magnetic field of 168 dBpT in the 3 axis (X, Y, Z).

7.1.5 Payload Passive Units Shielding Efficiency

The shielding efficiency (SE), defined as the ratio of the total interfering power at unit output with respect isotropic radiated power shall not exceed -75dBi for the units of the repeater input section (before the TWTA) and -65dBi for the units of the repeater output section (after the TWTA), at working frequency range.

The shielding effectiveness of the unit shall be measured from the RE sniff test or RS spray test methods as describe in the document "the reduced sniff RE and spray RS EMC test procedure – Ref: SDR-ASPI-TP-0058 " or similar procedure shall be approved by the prime.

7.2 Conducted Emissions and Susceptibility Requirements

7.2.1 Requirements for "100V" Primary Power Bus

7.2.1.1 Conducted Emissions

7.2.1.1.1 Frequency domain

Conducted emissions (differential mode) injected on the primary power lines by each payload unit shall not exceed the limit given in the Figure 16.

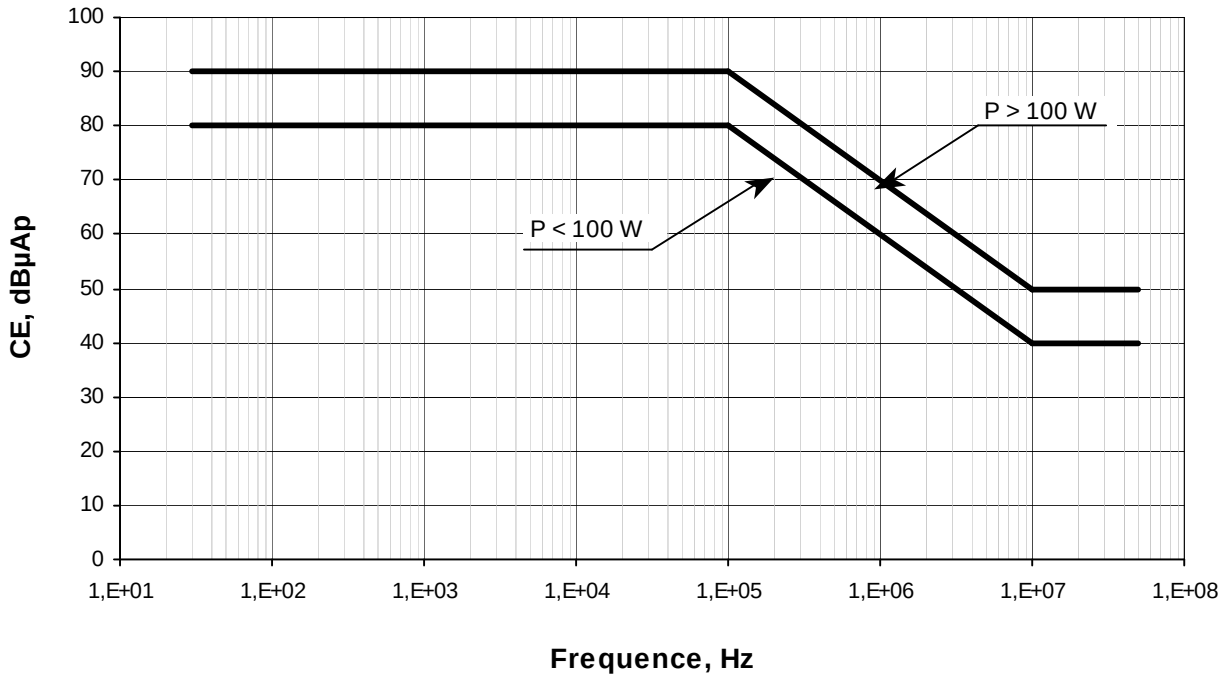


Figure 16: Conducted Emissions on Power Bus for Payload Equipment

The requirement is applicable on each line (positive and negative).

7.2.1.1.2 Time domain

Conducted emissions (differential mode) injected on the primary power lines by each payload unit shall not exceed 0.1 x Idc (A peak-to-peak), pulse period from 33ms to 10µs (30Hz - 100kHz).

7.2.1.1.3 In-rush current

When the unit is switched on and switched off, the in-rush current shall be lower than the limit defined in the Figure 17.

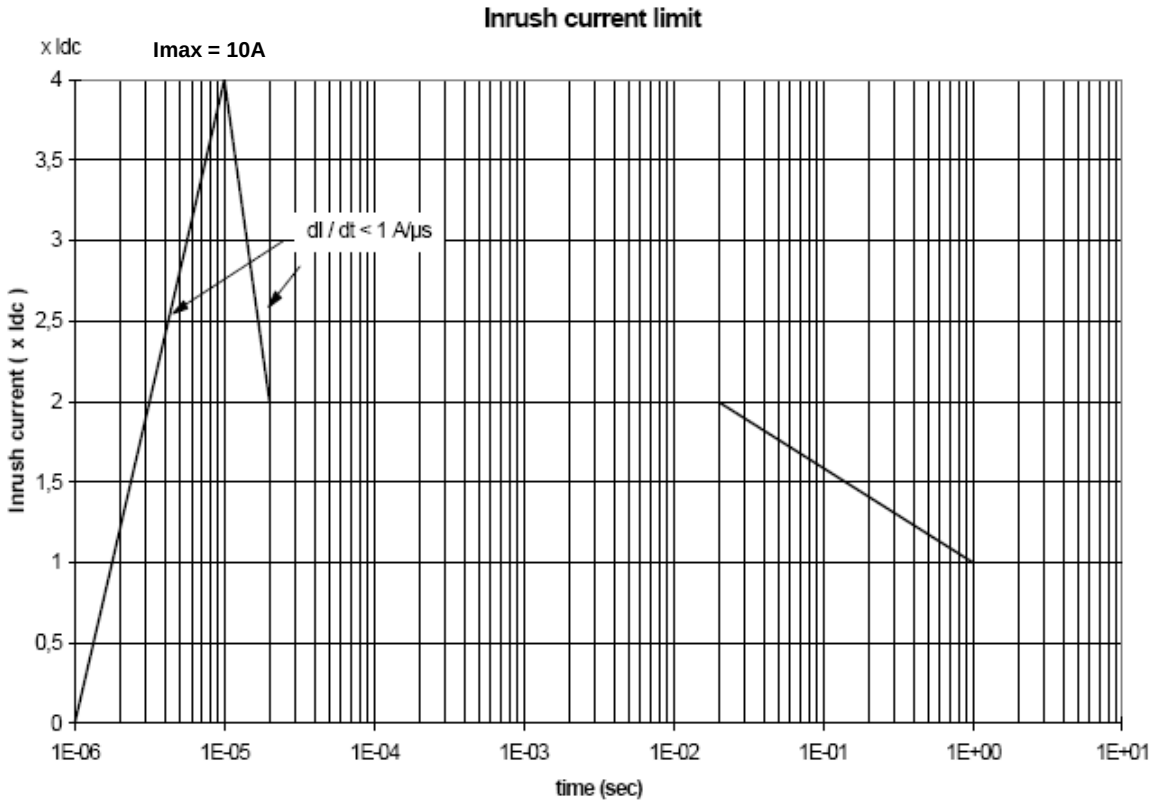


Figure 17: In-rush current limit and load current slew rate

Imax = 1A for Idc < 0.5A
Imax = 4 x Idc for 0.5A ≤ Idc ≤ 2.5A
Imax = 10A for Idc > 2.5A

In-rush and switch-off transient voltage shall not be more than ±2.5 Vp, duration is less than 1 ms, voltage rate is less than 1 V/µs.

7.2.1.2 Conducted Susceptibility

Each payload unit shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given by the corresponding unit specification when it is subjected to the following perturbations on positive primary power line interface connector versus 97.5 - 101 V nominal voltage reference :

7.2.1.2.1 Periodic-wave, frequency domain

- 1.5 V (RMS) from 30 Hz to 1 kHz with decreasing by 20 dB/decade within the range from 1kHz to 2kHz, then 1 V (RMS) from 2kHz to 50MHz.

The injected current shall be limited to 1 A (RMS) and the voltage may be reduced if necessary.

7.2.1.2.2 Transient

- long term transient:
  - E = +/-6V (peak), Tau < 2ms, tr ≤ 0.1 ms
  - E = -4V, Tau = 2ms, tr ≤ 0.1 ms
  - E = -1V, Tau = 10ms, tr ≤ 0.1 ms
  - ~~E = +6V (peak), Tau = 10 ms, tr ≤ 0.1 ms~~
  - ~~E = -4V (peak), Tau = 10 ms, tr ≤ 0.1 ms~~
  - ~~E = -6V (peak), Tau = 2 ms, tr ≤ 0.1 ms~~
  - Long term transient shape is given on Figure 18.

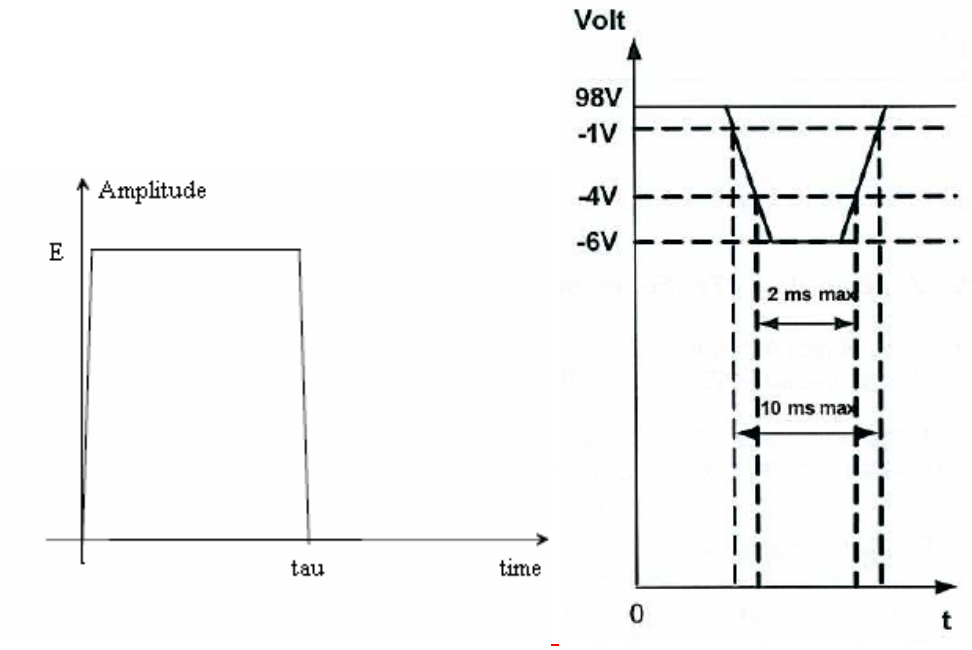


Figure 18 : Long term transient

- Short term transient:
  - E = ±15V (peak), Tau = 10 µs, tr ≤ 1 µs
  - Short term transient shape is given on figure 19.

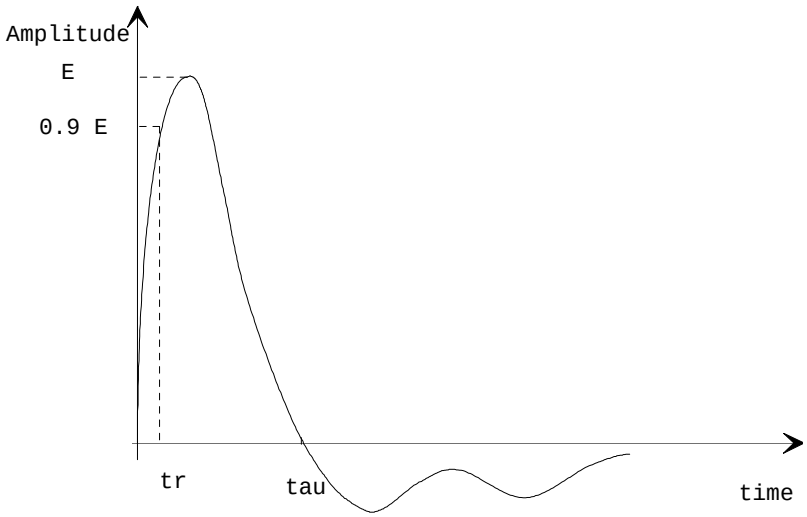


Figure 19 : Short term transient

The injected current shall be limited to 1 A (peak) and the voltage may be reduced if necessary.
Repetition frequency 1Hz and 10Hz.
The following tests shall be performed for transients injection:

- positive pulse at the highest supply voltage (101V),
- negative pulse at the lowest voltage (97.5V).

7.2.2 Requirements for "27V" Primary Power Bus

7.2.2.1 Conducted Emissions

7.2.2.1.1 Frequency domain

Conducted emissions (differential mode) injected on the primary power lines by the RDIU shall not exceed 95 dBµA (peak) within the frequency range from 10Hz to 30kHz, with decreasing by 20 dB/decade up to 45 dBµA (peak) within the frequency range from 30kHz to 50MHz.

Conducted emissions (differential mode) injected on the primary power lines by the CCU shall not exceed 74 dBµA (peak) within the frequency range from 10Hz to 30kHz, with decreasing by 20 dB/decade up to 34 dBµA (peak) within the frequency range from 30kHz to 50MHz.

The requirement is applicable on each line (positive and negative).

7.2.2.1.2 In-rush current

When the RDIU is switched on and switched off, the in-rush current shall be lower than the limit defined in the Figure 17.

In-rush and switch-off transient voltage shall not be more than ±2.5 Vp, duration is less than 1 ms, voltage rate is less than 1 V/µs.

7.2.2.2 Conducted Susceptibility

The RDIU shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given by the corresponding unit specification when it is subjected to the following perturbations on positive primary power line interface connector versus 25.5 - 28 V nominal voltage reference :

7.2.2.2.1 Periodic-wave

- Frequency domain: 1 V (RMS) from 10 Hz to 50 MHz.

The injected current shall be limited to 1 A (RMS) and the voltage may be reduced if necessary.

7.2.2.2.2 Transient

- Long term transient:
  - E = ±5V (peak), Tau = 20 ms, tr ≤ 20 µs
  - Long term transient shape is given on Figure 18.
- Short term transient:
  - E = ±15V (peak), Tau = 10 µs, tr ≤ 1 µs
  - Short term transient shape is given on figure 19.

The injected current shall be limited to 1 A (peak) and the voltage may be reduced if necessary.
Repetition frequency 1Hz and 10Hz.
Two tests shall be performed for transient injection : one with positive pulse at the highest supply voltage (28V) and the other with negative pulse at the lowest voltage (25.5V).

7.2.3 Requirements for Secondary Power Bus

7.2.3.1 Conducted Emissions (Source side)

Narrowband conducted emissions (differential mode) on secondary power lines, from the secondary DC supply voltages of the unit, shall not exceed the levels defined in the Figure 20.

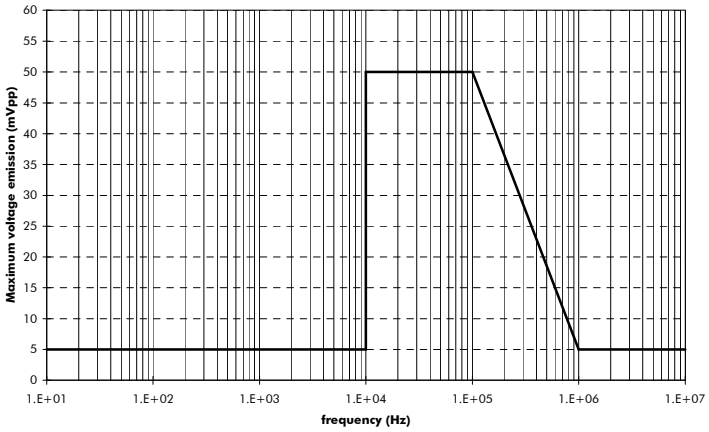


Figure 20: CE on Secondary Power Lines (source side)

This requirement is applicable only to unit which provides power to other units (example: centralised DC/DC converter or EPC for CAMP).

This requirement is applicable without CS injection on primary power bus and with a CS injection on primary power bus.

7.2.3.2 Conducted Susceptibility (User side)

The unit, connected to a secondary power bus, shall meet all performance requirements when subjected to the sine wave signal interference superimposed in differential mode on the secondary power lines given in the Figure 21.

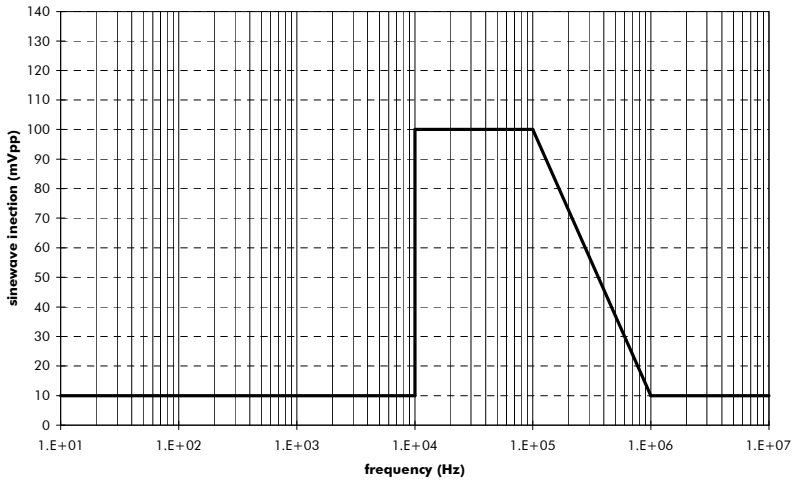


Figure 21: CS Injection on Secondary Power Lines (user side)

7.2.4 Requirements for TM/TC Lines

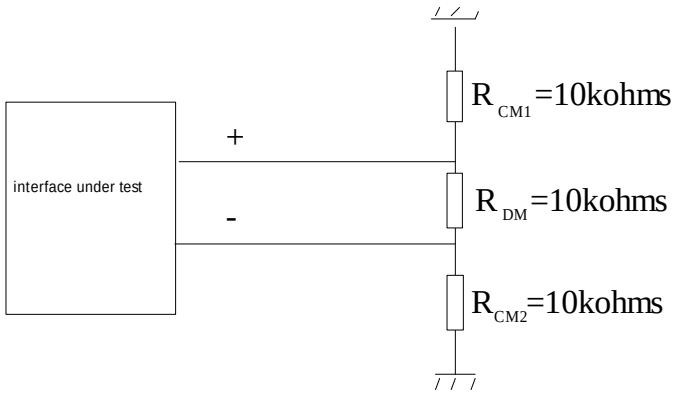
7.2.4.1 Interfaces between RDIU and Payload Units

7.2.4.1.1 Test limitation

All the here under tests shall be applicable at each TM/TC lines. In case of identical circuits, 2 circuits or 10 % (whichever is more) of each TM/TC type circuits shall be tested.

7.2.4.1.2 Test Configuration

The TM/TC lines under test shall be loaded by dummy load as shown in figure hereafter:



If the use of dummy load is not possible, the EGSE may be used for these tests. In that case, the interface schematics of EGSE shall be delivered.

7.2.4.1.3 Conducted emissions requirements (Source side)

7.2.4.1.3.1 Analog acquisition (AN)

- Time domain conducted emissions at source output interface shall not exceed a ripple of 20 mVpp (in differential mode) over 50 MHz minimum bandwidth.
  Higher levels spikes up to 300 mVpp are acceptable provided that its duration is not exceeding 5 µs.
- Time domain conducted emissions at source output interface shall not exceed a ripple of 1Vpp (in common mode) over 50 MHz minimum bandwidth.

7.2.4.1.3.2 Digital bi-level acquisition (DB) and Relay status acquisition (DR)

- Time domain conducted emissions at source output interface (except for RF switches) shall not exceed a ripple of 100 mVpp (in differential mode) over 50 MHz minimum bandwidth.
  Higher levels spikes up to 300 mVpp are acceptable provided that its duration is not exceeding 5 µs.
- Time domain conducted emissions at source output interface (except for RF switches) shall not exceed a ripple of 1Vpp (in common mode) over 50 MHz minimum bandwidth.

7.2.4.1.3.3 LLC command

- Time domain conducted emissions at source output interface shall not exceed a ripple of 1Vpp (in common mode) over 50 MHz minimum bandwidth.

7.2.4.1.4 Conducted susceptibility requirements (User side)

7.2.4.1.4.1 Telemetry lines (AN, DB, DR)

The interface selected shall not exhibit any failure, malfunction or unintended responses when subjected to common mode perturbation, with the following characteristics:

- 2Vpp sine wave signal in a frequency range of 1MHz to 50 MHz or 2Vpp square modulated sine injection with a duration > 5µs and a repetition frequency > 10 kHz.

The injected current shall be limited to 0.1 Arms. The voltage may be reduced if necessary.

7.2.4.1.4.2 Telecommand lines

No change of unit performance or telemetry status shall occur when positive or negative transients are injected between any telecommand line and its return in the absence of any command, with the following characteristics:

- 26 V 0-peak with a time duration of 100 µs (at half amplitude) and repetition rate of 2 msec .

7.2.4.2 Interfaces between RDIU/CCU and Platform

7.2.4.2.1 Conducted emissions requirements (Source side)

With no commands executed (under external interferences and operating signals in power circuits, control circuits, etc.), CCU shall not induce, in the control command (signals) generation reception/transmission circuits (with nominal voltage of 27V), any interferences with amplitude exceeding 2 V and time duration longer than 20 msec for the loads corresponding to the operating current range in the command circuits (CE).

7.2.4.2.1.1 Analog TM

The conducted emissions at source output interface shall not exceed a ripple of 15 mV 0-peak (in differential mode) over 50 MHz minimum bandwidth.

7.2.4.2.1.2 Bi-level TM

The conducted emission at source output interface shall not exceed a ripple of 200 mV 0-peak for “1” level and 300 mV 0-peak for “0” level (in differential mode) over 50 MHz minimum bandwidth.

7.2.4.2.1.3 Temperature TM

The conducted emission at source output interface shall not exceed a ripple of 75 µV 0-peak (in differential mode) over 50 MHz minimum bandwidth.

7.2.4.2.1.4 Information-logical interface between OCS-CU and CCU, ODGS and CCU

The conducted emission at source output interface shall not be more then:±0.5 Vp.

7.2.4.2.2 Conducted susceptibility requirements (User side)

No change of unit performance or telemetry status shall occur when positive or negative transients are injected between any telecommand line and its return during command execution, with the following characteristics:

- under interferences induced (see §7.2.2.1),
- and under command generation circuit contact chatter not longer than 5 ms;

No change of unit performance or telemetry status shall occur when positive or negative transients are injected between any telecommand line and its return in the absence of any command, with the following characteristics:

- ± 29 V 0-peak with a time duration of 100 µs maximum and repetition rate of minimum 1sec .

CCU shall nominally operate under interferences with max amplitude of ±2 V in the TM-data lines (information-logical interface between CU and TCR, ODGS and TCR).

7.2.5 Requirements for Bus OBDH 485

7.2.5.1 Driver conducted emissions

The following test setup shall be used to verify the driver conducted emissions.

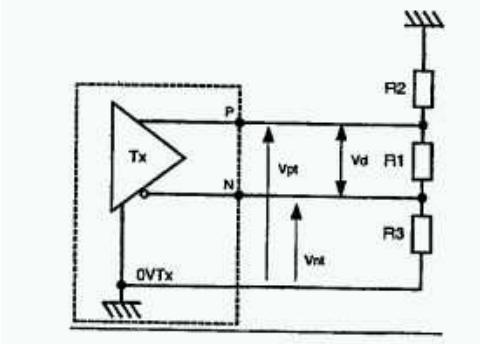


Figure 22: Driver CE test setup

R1 = 60 Ω ± 10%
R2 = R3 = 22 kΩ ± 10%

Measure shall be performed during CS representative test on the equipment primary or secondary power bus.

- Driver differential mode conducted emissions:

Time domain differential mode emitted noise measurement on inactive bus driver while at least one other interface is under activity shall not exceed 30mVpp over 50 MHz minimum bandwidth.

- Driver common mode conducted emissions:

Time domain common mode emitted noise measurement on inactive bus driver while at least one other interface is under activity shall not exceed 150mVpp over 50 MHz minimum bandwidth.

Oscilloscope measurement time base shall be tuned in order to :
- Identify noise envelope (large time base)
- Identify pulse characteristics (reduced time base)
These traces shall be set in the test report.

If common mode CE measurement (Vpt & Vnt) is greater than the limit required (150mVpp), complementary measurement is requested : Vpt & Vnt with R1 = 60 Ω & R2 = R3 = 10 Ω.

7.2.5.2 Receiver conducted emissions

The following test setup shall be used to verify the receiver conducted emissions.

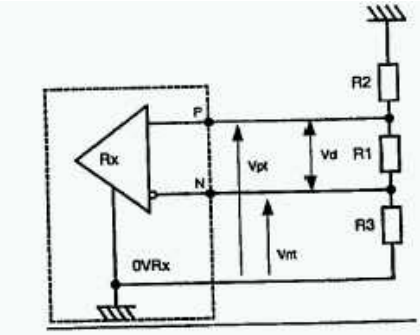


Figure 23: Receiver CE test setup

R1 = 60 Ω ± 10%
R2 = R3 = 22 kΩ ± 10%

Measure shall be performed during CS representative test on the equipment primary or secondary power bus.

- Receiver differential mode emissions:

Time domain differential mode emitted noise measurement on inactive bus receiver while at least one other interface is under activity shall not exceed 150mVpp over 50 MHz minimum bandwidth.

- Receiver common mode emissions:

Time domain common mode emitted noise measurement on inactive bus receiver while at least one other interface is under activity shall not exceed 150mVpp over 50 MHz minimum bandwidth.

Oscilloscope measurement time base shall be tuned in order to :
- Identify noise envelope (large time base)
- Identify pulse characteristics (reduced time base)
These traces shall be set in the test report.

If common mode CE measurement (Vpt & Vnt) is greater than the limit required (150mVpp), complementary measurement is requested : Vpt & Vnt with R1 = 60 Ω & R2 = R3 = 10 Ω.

7.2.5.3 Receiver Conducted Susceptibility in common mode

During normal operation, the interface shall not exhibit any failure, malfunction or unintended responses when a common mode sine wave of 2.8 Vpp from 500kHz to 50MHz is injected between the input lines and the bus reference coupler (mechanical ground).
The injected current shall be limited to 0.1 Arms and the voltage may be reduced if necessary.

7.3 Susceptibility to Electrostatic Discharges

7.3.1 Surface electrostatic discharges resulted from the magnetospheric plasma effects

The payload active units fitted with its test harness (manufactured at flight level from EMC point view) shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given by the corresponding unit specification when it is subjected to conducted discharges into the unit structure and on the unit bundle overshields, and into wire coupled along the unit bundles with the following characteristics :

- High Voltage level: 6 kV minimum
- Discharge current amplitude:
  a) at least 100 A peak minimum for discharge into the unit structure and on the unit bundle overshields,
  b) at least 50 A peak for discharge within a wire running along unit harness bundles.
- Discharge pulse duration: from 10^{-7} to 10^{-6} sec.
- Duration of discharge pulse edge: from 10^{-9} to 10^{-7} sec.
- Minimum number of discharges = 10 with a minimum repetition rate of one discharge per second.

The ESD immunity of the equipment shall be verified by analysis (computation), heritage, stand-alone tests and S/C tests (in accordance with ISS procedures) to ESD effects.

Some ESD tests shall be performed on EQM (when there exists, TBC at EQSR) as specified for the TAS nominal ESD test setup (see section 8.5.10) including:
a) Conducted discharges into the unit structure and on the unit bundle overshields,
b) Conducted discharges within the wire running along the unit harness bundles.

For other equipment, the qualification shall be demonstrated by analysis.

7.3.2 Internal (volume) discharges caused by high-energy electrons impact

The NASA-HDBK-4002 document shall be used as guidelines and design practices to minimize the detrimental effects of unit internal charging.

8. EMC/ESD TESTING AND MEASUREMENT REQUIREMENTS

The MIL-STD-461E requirements shall be used as baseline for the EMC test procedures.

8.1 Ambient electromagnetic level

During CE & RE testing, the ambient electromagnetic level measured with the Equipment Under Test de-energized and all auxiliary equipment turned on shall be at least 6 dB below the allowable specified limits. The ambient electromagnetic level shall be recorded in the EMC test report and shall not compromise the test results.

8.2 Shielded enclosures

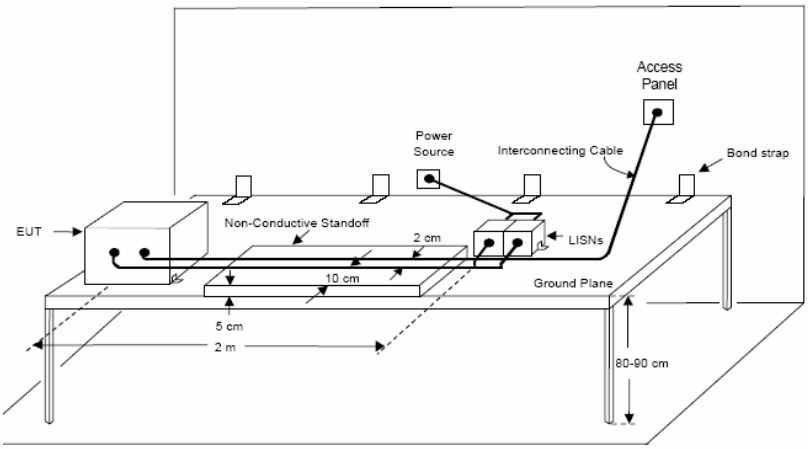
To prevent interaction between the EUT and the outside environment, shielded enclosures will usually be required for testing. These enclosures prevent external environment signals from contaminating emission measurements and susceptibility test signals from interfering with electrical and electronic items in the vicinity of the test facility.
Shielded enclosures must have adequate attenuation such that the ambient requirements of paragraph “Ambient electromagnetic level” are satisfied.
RF absorber material (carbon impregnated foam pyramids, ferrite tiles, and so forth) shall be used when performing electric field radiated emissions or radiated susceptibility testing inside a shielded enclosure to reduce reflections of electromagnetic energy and to improve accuracy and repeatability.

8.3 Other test sites

If other test sites are used, the ambient requirements of paragraph "Ambient electromagnetic level" shall be met.

8.4 Ground plane

The DUT shall be installed on a metallic ground plane as shown in the figure hereafter.



The ground plane shall have a surface resistance no greater than 0.1 milliohms per square. The DC resistance between metallic ground plane and the shielded enclosure shall be 2.5 milliohms or less.

The metallic ground plane shall be electrically bonded to the floor or wall of the basic shielded room structure at least once every 0.5 meter. The metallic bond straps shall be solid and maintain a five-to-one ratio or less in length to width.

8.5 EUT test configurations

8.5.1 Bonding of EUT

Only the provisions included in the design of the EUT shall be used to bond units such as equipment case and mounting bases together, or to the ground plane.
Bonding requirements: DC resistance ≤ 2.5mohms, inductance ≤ 100nH.

8.5.2 Orientation of EUT

EUT shall be oriented such that surfaces which produce maximum radiated emissions and respond most readily to radiate signals face the measurement antennas.

8.5.3 Construction and arrangement of EUT cables

The exposed test harness length shall be between 2 and 3 meters, 2 meters of which shall be exposed 10 cm from edge of the ground plane at a 5 cm height.

The EUT shall be set up with harness that simulates flight harness in shielding presence and terminations, twisting, ground and wiring properties

Details on the test harness construction used for testing shall be included in the EMC test procedure.

8.5.4 Interfaces of EUT

Loading and excitation of the test sample shall be representative of actual flight units and stimulating circuits as representative as practicable. When flight loads or sources are impractical or unavailable the impedance characteristics of such loads and sources shall be representatively simulated.

The simulation shall consist of reactive and resistive elements as necessary to:

- Maximize the measured ripples for the Emission tests,
- Maximize the sensitivity of the EUT for Susceptibility tests.

Antenna ports on the EUT shall be terminated with shielded, matched loads.

8.5.5 Operation of EUT

During emission measurements, the EUT shall be placed in an operating mode which produces maximum emissions. During susceptibility testing, the EUT shall be placed in its most susceptible operating mode. For EUT with several available modes (including software controlled operational modes), a sufficient number of modes shall be tested for emissions and susceptibility such that all circuitry is evaluated. The rationale for modes selected shall be included in the EMC test procedure.

8.5.6 Detector

A peak detector shall be used for all frequency domain emission and susceptibility measurements. This device detects the peak value of the modulation envelope in the receiver band pass. Measurement receivers are calibrated in terms of an equivalent Root Mean Square (RMS) value of a sine wave that produces the same peak value.

8.5.7 Emission testing

8.5.7.1 Bandwidths

The measurement receiver bandwidths listed in table “Bandwidth Measurement Emissions” shall be used for emission testing.
Larger receiver bandwidths may be used; however, they may result in higher measured emission levels. No bandwidth correction factors shall be applied to test data due to use of larger bandwidths.

Frequency Range	Bandwidth
30 Hz to 1 KHz	10 Hz
1 KHz to 10 KHz	100 Hz
10 KHz to 150 KHz	1 KHz
150 KHz to 30 MHz	10 KHz
30 MHz to 1 GHz	100 KHz
above 1 GHz	1 MHz

Table 12 : Bandwidth Measurement Emissions

8.5.7.2 Emission identification

Regardless of characteristics shall be measured with the measurement receiver bandwidths specified in table “Bandwidth Measurement Emissions” and compared against the applicable limits. Identification of emissions with regard to narrowband or broadband categorization is not applicable.

8.5.7.3 Emission data presentation

Amplitude versus frequency profiles of emission data shall be automatically generated and displayed at the time of test and shall be continuous. The displayed information shall account for all applicable correction factors (transducers, attenuators, cable loss, and the like) and shall include the applicable limit.

8.5.7.4 Time domain measurements using oscilloscope

The minimum bandwidth required for oscilloscope and its associated probe is 50MHz. Real differential voltage probe is required for all CE voltage measurements.
If necessary, several measurements using different time base shall be performed to characterize completely the CE signal. For example, if the CE is a repetitive spike, the time base of the first plot shall be tuned to characterize the time repetition of the spike and time base

of the second plot shall be tuned to characterize the spike (amplitude, duration, damped oscillation).

8.5.8 Susceptibility testing

8.5.8.1 Frequency scanning

For susceptibility measurements, the entire frequency range for each applicable test shall be scanned.

For swept frequency susceptibility testing, frequency scan rates and frequency step sizes of signal sources shall be selected with consideration of EUT response time, EUT susceptibility bandwidths and monitoring test equipment response time. The scan rate selected shall be justified by this criterion, and documented in the test report.

For discrete frequency susceptibility testing, the minimum number of test frequencies shall be at least 4 frequencies per decade (ex: 1, 3, 5 and 7). Additional test frequencies should be included for known equipment response frequencies, such as DC/DC switching frequencies, clock frequencies, OL and IF frequencies, Tx and Rx frequencies, etc.

8.5.8.2 Thresholds of susceptibility

When susceptibility indications are noted in EUT operation, a threshold level shall be determined where the susceptible condition is no longer present. Thresholds of susceptibility shall be determined as follows and described in the EMC test report:

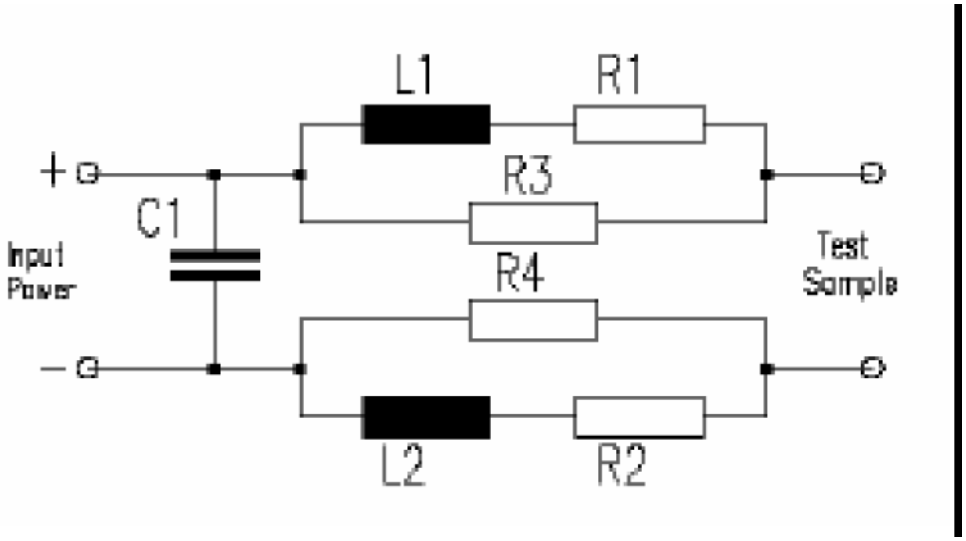
- When a susceptibility condition is detected, reduce the interference signal until the DUT recovers.
- Reduce the interference signal by an additional 6 dB.
- Gradually increase the interference signal until the susceptibility condition reoccurs. The resulting level is the threshold of susceptibility.
- Record this level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable.

8.5.9 LISN specification

In order to normalize the measurement conditions, the measurement of the conducted interference on the primary power supply leads shall be performed by standardizing the source impedance with a LISN, in accordance with the following bus impedances:

- For power lines for TWTA units, and TCR transmitters: 1 Ohm within the range from 10 Hz to 1 kHz, with linear increase up to 3 Ohms at frequency of 30 kHz, with subsequent increase by 20dB/decade up to 100 Ohms within the range from 30 kHz to 50 MHz.
- For power lines for other Payload or TCR units (including RDIU and CCU): 2 Ohms within the range from 10 Hz to 1 kHz with linear increase up to 3 Ohms at frequency of 30 kHz, with subsequent increase up to 100 Ohms by 20 dB/decade within the range from 30 kHz to 50 MHz.

The LISN shall be built according to schematic here below:



The components will be adjusted in order to get the proper bus impedance defined above.

The LISN - EUT power leads shall be an unshielded twisted pair of 2 meters length.

The power lead return line shall be connected to metallic ground plane on a single point close as possible to the capacitance C1. Connection to mechanical ground shall be as shorter as possible.

LISN installation shall be detailed in EMC test report. The actual LISN impedance shall be measured before to start the EMC tests and the diagram shall be included in the test report.

8.5.10 Electrostatic discharges susceptibility testing

8.5.10.1 Test setup

The Figure 24 shows the test setup applicable for ESD test on EQM unit.

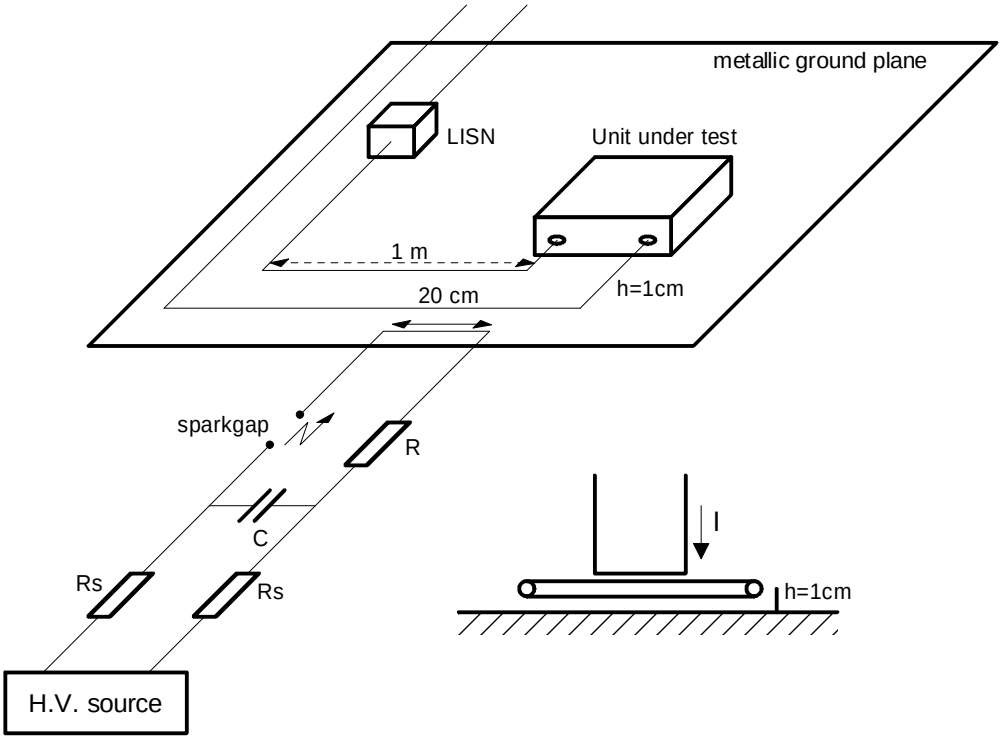


Figure 24: Test setup for Conducted Discharges within the wire running along the unit harness bundles

The ESD circuit characteristics will be adjusted in order to get the proper current. Standard components are defined in the following table.

Test setup components	
Rs = Decoupling resistor	4.7kΩ
C = Discharge capacitor	50pF
R = Discharge resistor	100Ω
Spark gap voltage	6kV

Table 13 - Test setup component definition

8.5.10.2 Conducted discharges into unit structure and bundle overshields

The two injection points shall be the most distant points of the unit structure and between the two ends of the bundle overshields, where electrical connection is feasible (mounting hole, bonding point, connector, cover screw, harness shells, ...).

8.5.10.3 Conducted discharges within the wire running along the unit harness bundles

The length of the wire running in parallel along the unit harness bundles shall be 0.2 m.

9. ARCING, CORONA , MULTIPACTOR, PLASMA ENVIRONMENT

Reference [X1000H-SPECIFIC-040]

Arcing, Corona, Multipactor

All units shall be designed to operate during launch and ascent (if required in the technical specification of the unit) and in space environment without arcing, corona or multipactor effects.

In Reference *

Reference [X1000H-SPECIFIC-041]

Magnetospheric plasma environment

For the geosynchronous orbit the maximum influence of the plasma is described as follows:

- electrons density of $1.12 \cdot 10^{6}$ 1/m3
- electrons energy of $1.2 \cdot 10^{4}$ eV
- ions density of $0.236 \cdot 10^{6}$ 1/m3
- ions energy of $2.95 \cdot 10^{4}$ eV

In plasma effect design analyses for Payload and TCR equipment, the environment specified for calculation, calculation methods and procedures in accordance with NASA TP-2361 shall to be taken into account.

Equipment operability ensuring rules, analyses, tests are to be in conformance with NASA TP-2361.

In Reference *

Reference [X1000H-SPECIFIC-042]

Propulsion Unit plasma environment

Equipment having not sealed bodies, equipment having 100V and higher power bus as a part of it shall withstand and maintain its specified performances at the impact of plasma thrusters with the following characteristics:

- Ions concentration (Xe+) : $5 \cdot 10^{14}$ ions/m-3
- Ions energy (Xe+) : 50 eV

The fact that the equipment will withstand the plasma impact shall be confirmed by analysis (calculation) and autonomous test (if necessary).

In Reference *

END OF DOCUMENT