

Information Documentaire / Document Information

Titre / Title : GENERAL DESIGN GUIDELINES _ EMC

Auteur / Author : ZUGAJ HERVE

Reference : SB4-6A-AS-SP-015 05/-

Electronic Signature

Page laissée blanche intentionnellement

Blank page intentionally left

AD01 Part3
Subsystems and Units Requirements
Electrical Design and Interface Requirements

<i>Written by</i>	<i>Responsibility</i> + handwritten signature if no informatic workflow tool
H. ZUGAJ	EMC Responsible
D. LEPORTIER	Electrical Architect
<i>Verified by</i>	
G. JAU	Electrical Architect Manager
R. ASPLANATO	EPS Manager
<i>Approved by</i>	
P. COQUET	Technical Reponsible
P. COCATRIX	Product Assurance
JP. CADOT	Program Manager

The validations evidence are kept through the documentation management system.

DOCUMENT CHANGE RECORDS**Paragraphs Change Record** (List of paragraphs modified, new or deleted)

Issue	Date	Change Record Description	Author
05	23/04/09	Refer to document 200456315W Document d'accompagnement to AD01 Part 3 issue5 (internal use only) Statistics: This issue contains 144 requirements published. Document generated from DOORS 8.2.0.2 and T-REK v5.1 p5 to Word 2000	H. ZUGAJ D. LEPORTIER

Requirements Change Record (List of requirements modified, new or deleted, sorted by ascending document issue)

TABLE OF CONTENTS

DOCUMENT CHANGE RECORDS	2
TABLE OF CONTENTS	3
1. SCOPE	6
2. DOCUMENTS	7
2.1 ORDER OF PRECEDENCE	7
2.2 ELECTRICAL DESIGN DOCUMENT	7
2.3 REFERENCE DOCUMENTS	7
3. EMC MARGIN AT SATELLITE LEVEL	8
4. EMC GENERAL REQUIREMENTS	9
5. DELIVERABLE DOCUMENTATION	10
6. CONDUCTED REQUIREMENTS ON PRIMARY POWER LINES	13
6.1 USERS OF 100V POWER BUS	13
6.1.1 Conducted emission - continuous mode	13
6.1.2 Inrush current	16
6.1.3 Plug in current	18
6.1.4 Transient current due to exceptional fluctuation of 100V supply	21
6.1.5 Conducted susceptibility - Continuous mode	25
6.1.6 Conducted susceptibility - Exceptional short term transients	26
6.1.7 Conducted susceptibility - Regular short term transients	29
6.1.8 Conducted susceptibility - 100V Plug in	31
6.1.9 Conducted susceptibility - Exceptional Fluctuation of 100V supply	33
6.1.10 Conducted susceptibility - Regular long term transients	34
6.2 POWER CONDITIONING UNIT	37
6.2.1 Conducted susceptibility & Conducted emission on 100V power output	37
6.2.2 PCU behavior during fuse blowing event	41
7. CONDUCTED REQUIREMENTS ON SECONDARY POWER LINES	43
8. CONDUCTED REQUIREMENTS ON SIGNAL LINES	46
8.1 SIGNAL LINES CONCERNED BY CONDUCTED REQUIREMENTS	46
8.2 CONDUCTED EMISSION (CE) REQUIREMENTS	47
8.2.1 CE-1	47
8.2.2 CE-2	48

8.2.3	CE-3.....	49
8.2.4	CE-4.....	51
8.2.5	CE-5 Conducted Emission for OBDH-485.....	54
8.2.5.1	Conducted emission limits on driver interface	54
8.2.5.2	Conducted emission limits on receiver interface	56
8.3	CONDUCTED SUSCEPTIBILITY ON SIGNAL LINES	57
8.3.1	CS-1.....	57
8.3.2	CS-2.....	61
9.	ELECTRIC FIELD RADIATED REQUIREMENTS.....	64
9.1	RADIATED EMISSION - GENERAL REQUIREMENTS	64
9.2	RADIATED EMISSION - SPECIFIC TEST SET UP FOR ELECTRICAL PROPULSION THRUSTERS	66
9.3	RADIATED SUSCEPTIBILITY REQUIREMENTS	67
10.	MAGNETIC REQUIREMENTS.....	70
11.	REPEATER AND TTC/RF PASSIVE SHIELDING EFFICIENCY.....	72
12.	SUSCEPTIBILITY TO ELECTROSTATIC DISCHARGES.....	73
13.	GENERAL TEST CONDITIONS	75
13.1	MEASUREMENT TOLERANCES	75
13.2	AMBIENT ELECTROMAGNETIC LEVEL.....	75
13.3	SHIELDED ENCLOSURES	75
13.4	GROUND PLANE	76
13.5	EUT TEST CONFIGURATIONS	77
13.5.1	Bonding of EUT.....	77
13.5.2	Orientation of EUT	77
13.5.3	Construction and arrangement of EUT cables.....	77
13.5.4	Interfaces of EUT	78
13.6	OPERATION OF EUT	79
13.7	DETECTOR	79
13.8	EMISSION TESTING	79
13.8.1	bandwidths.....	79
13.8.2	Emission identification	80
13.8.3	Frequency scanning.....	80
13.8.4	Emission data presentation.....	81
13.8.5	Time domain measurements using oscilloscope.....	81
13.9	SUSCEPTIBILITY TESTING.....	81
13.9.1	Frequency scanning.....	81
13.9.2	Thresholds of susceptibility.....	82



13.10	LISN SPECIFICATION.....	83
-------	-------------------------	----



1. SCOPE

This document establishes the EMC / ESD performance and test method requirements applicable to any SPACEBUS 4000 units and subsystems.

2. DOCUMENTS

2.1 Order of precedence

In case of conflict between any Equipment Specification document and this general applicable document, requirements defined in Equipment Specification shall take precedence.

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

2.2 Electrical design document

The following document contain the main design requirements applicable for electrical, EMC and ESD aspects.

[AD1] : Subsystem and units Requirements - Electrical Design and Interfaces Requirements

doc n° : SB4-AS-SP-065 issue 3

2.3 Reference documents

The following documents listed hereinafter are not contractual. They are mentioned for information only as they have been used as basis for some requirements defined in the present specification document.

[RD1] : Requirements for the control of electromagnetic interference characteristics

MII-STD-461 E

[RD2] : Electromagnetic compatibility requirements for space systems

MII-STD-1541

[RD3] : European Cooperation for Space Standardization

Electromagnetic compatibility : ECSSE-20-07

[RD4] : Electro explosive subsystem safety requirement

MII-STD-1576 (USAF)

3. EMC MARGIN AT SATELLITE LEVEL

Reference **SBX-4CF-AD01-P3-REQ-009**

[FC Applicability: SYSTEM]

General EMC margin (ratio between susceptibility and interference) shall be greater than 6dB.

This general requirement is not applicable to pyrotechnics circuits and TDMA operation

*

Reference **SBX-4CF-AD01-P3-REQ-010**

[FC Applicability: SYSTEM]

The power produced at each EED (electro explosive device) by the electromagnetic environment acting on the pyrotechnic function (EED + pyrotechnics circuit) shall be at least 20dB below the maximum pin to pin DC no fire power.

*

Reference **SBX-4CF-AD01-P3-REQ-011**

[FC Applicability: SYSTEM]

Worst case power variation due to payload TDMA operation shall not be greater than load variation amplitude defined for PCU conducted susceptibility requirements.

*

Reference **SBX-4CF-AD01-P3-REQ-012**

[FC Applicability: SYSTEM]

The PCU regulation voltage shall not be in the worst case condition (TDMA operation & S3R-BDR intermode) greater than the CS level (continuous sine wave) required for units on primary power lines.

*

4. EMC GENERAL REQUIREMENTS

Reference **SBX-4CF-AD01-P3-REQ-013**

[FC Applicability: ALL CF (hardware)]

All unit and/or subsystem shall be able to operate without any degradation of performance in all specified launch, ground and flight environments.

*

Reference **SBX-4CF-AD01-P3-REQ-014**

[FC Applicability: ALL CF (hardware)]

Compliance and applicability matrix are under equipment and/or subsystem contractor responsibility with Prime contractor approval.

*

Reference **SBX-4CF-AD01-P3-REQ-015**

[FC Applicability: ALL CF (hardware)]

Qualification process based on analysis or similarity shall be approved by the prime contractor.

*

Reference **SBX-4CF-AD01-P3-REQ-016**

[FC Applicability: ALL CF (hardware)]

In case of out of specification results, the problem areas shall be investigated in detail. Appropriate solutions shall be proposed by the equipment and/or subsystem contractor and approved by the prime contractor.

*

Proposed test methods may be slightly adapted. These adaptations will be approved through test procedures.



5. DELIVERABLE DOCUMENTATION

Reference **SBX-4CF-AD01-P3-REQ-019**

[FC Applicability: ALL CF (hardware)]

The following documentation covering EMC activities at equipment and/or subsystem level shall be delivered :

Documentation	minimum contain	comment
* Frequency management	<ul style="list-style-type: none"> - list of frequencies present inside the unit - frequency assignment and location 	- this list could be included in ICD/IDS document

Documentation	minimum contain	comment
* grounding / bonding diagram (0V plan) and interface drawing	<ul style="list-style-type: none"> - main bus grounding paths - secondary supplies grounding paths - unit interfaces with electrical reference detail - interconnecting wires - power and signal lines grounding plan - unit bonding - interface circuits with EMC filters 	- these informations could be included in ICD/IDS document

Documentation	minimum contain	comment
*EMC compliance matrix	- document in a matrix form taking each paragraph of the EMC specification document and providing the status of requirements (compliant or no compliant)	- in case of no compliance with the requirement stated in the paragraph, a remark justifying the out of specification will be added

Documentation	minimum contain	comment
*EMC analysis	<ul style="list-style-type: none"> - prediction of susceptibility to internally and externally generated RS and CS - prediction of emission RE and CE - prediction of susceptibility to ESD - magnetic cleanliness 	

Documentation	minimum contain	comment
* test methods and procedures	<ul style="list-style-type: none"> -EMC Test plan -EMC test methods - Equipment susceptibility criteria -Detailed test set-up <ul style="list-style-type: none"> * EGSE interface schematics * Harness arrangement * cable definition (shield, twist,..) * dummy load 	EMC test plan can be included in more general test plan document

INTERNAL THALES ALENIA SPACE



REFERENCE: SB4-6A-AS-SP-015

DATE: 23/04/09

ISSUE: 05

PAGE: 12/87

Documentation	minimum contain	comment
* test report	<ul style="list-style-type: none">- modifications to the procedure- summary of results-detailed review of results including all measurement plots- description of susceptibilities and associated EMC susceptibility thresholds- non conformances list	

*

6. CONDUCTED REQUIREMENTS ON PRIMARY POWER LINES

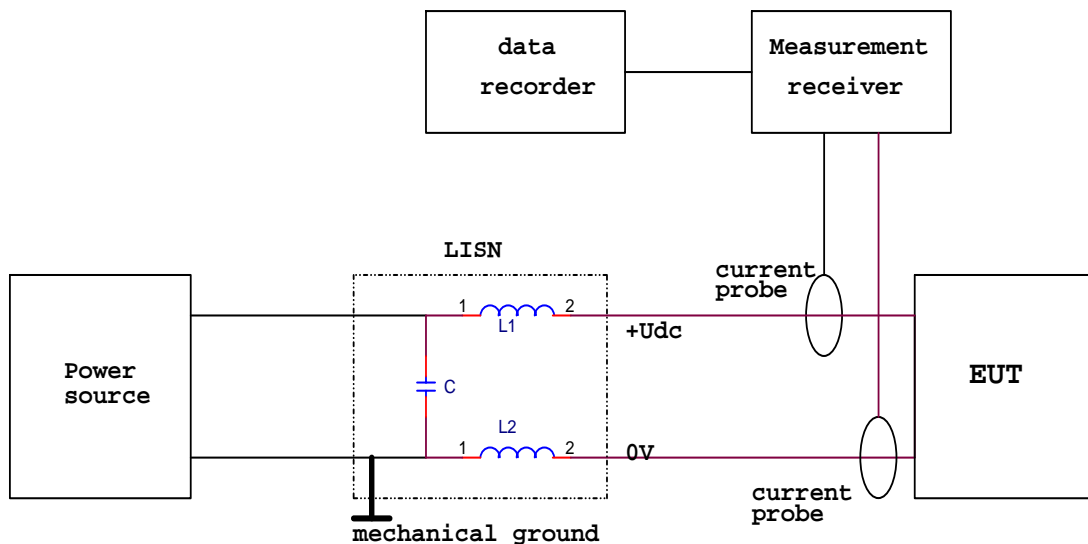
6.1 Users of 100V power bus

6.1.1 Conducted emission - continuous mode

Reference **SBX-4CF-AD01-P3-REQ-018**

[FC Applicability: ALL CF (hardware)]

Test method :



- LISN definition : Refer to section 13.10
- $U_{dc} = 100V$ (-2V / +2V)

Measurement shall be performed :

- current probe clamped on +Udc lead and current probe clamped on 0V lead.
- measurement receiver = spectrum analyzer with peak detector and oscilloscope to perform both spectral and time domain measurements.

*

Reference **SBX-4CF-AD01-P3-REQ-020**

[FC Applicability: ALL CF (hardware)]

Limits in Narrow band Frequency domain for unit with a DC consumption < 100W and outside TDMA operation.

-
- $CE \leq 80\text{dB}\mu\text{A}_{\text{peak}}$ ($77\text{dB}\mu\text{Arms}$) from 30Hz to 200KHz,
 - -20dB/decade decreasing from 200KHz to 20MHz,
 - $CE \leq 40\text{dB}\mu\text{A}_{\text{peak}}$ ($37\text{dB}\mu\text{Arms}$) from 20MHz to 50MHz.
-

*

Reference **SBX-4CF-AD01-P3-REQ-021****[FC Applicability:** ALL CF (hardware)]

Time domain conducted emission shall be recorded on +Udc for unit with a DC consumption < 100W and outside TDMA operation.

Refer to section 13.8.5 concerning measurement condition in time domain.

*

Reference **SBX-4CF-AD01-P3-REQ-022****[FC Applicability:** ALL CF (hardware)]

Limits in Narrow band Frequency domain for unit with a DC consumption $\geq 100\text{W}$ and outside TDMA operation.

- $CE \leq 90\text{dB}\mu\text{A}_{\text{peak}}$ ($87\text{dB}\mu\text{Arms}$) from 30Hz to 200KHz,
 - -20dB/decade CE decreasing from 200KHz to 20MHz,
 - $CE \leq 50\text{dB}\mu\text{A}_{\text{peak}}$ ($47\text{dB}\mu\text{Arms}$) from 20MHz to 50MHz.
-

*

Reference **SBX-4CF-AD01-P3-REQ-023****[FC Applicability:** ALL CF (hardware)]

Time domain conducted emission shall be recorded on +Udc for unit with a DC consumption $\geq 100\text{W}$ and outside TDMA operation.

Refer to section 13.8.5 concerning measurement condition in time domain.

*

Reference **SBX-4CF-AD01-P3-REQ-025****[FC Applicability:** REPEATER]

Limits in Time domain inside TDMA operation (no drive to full drive TDMA amplitude)

CE measurements shall be performed for TDMA frequencies : 100Hz, 1KHz, 3KHz, 5KHz, 7.5KHz, 10KHz, 20kHz, 30KHz, 50KHz with a TDMA duty cycle = 50%

TDMA peak to peak current amplitude measured on +Udc shall be in the following limit :

$$I_{pp} (amps) \leq 1.5 \times \left[\frac{P_D - P_{ND}}{100} \right]$$

for TDMA frequencies $\leq 10\text{KHz}$

P_D : full drive DC consumption in watts

P_{ND} : no drive DC consumption in watts

For TDMA frequencies $> 10\text{KHz}$, I_{pp} amplitude shall decrease versus F_{TDMA} with a slope $\geq 20\text{dB/decade}$.

*

Reference **SBX-4CF-AD01-P3-REQ-027**

[FC Applicability: REPEATER]

NO drive to FULL drive transition and in FULL drive to NO drive transition shall be compliant with :

$$\left[\frac{dI}{dt} \right]_{Max} (A/sec\ onds) \leq 2E^4 \times \left[\frac{P_D - P_{ND}}{100} \right]$$

*

Reference **SBX-4CF-AD01-P3-REQ-028**

[FC Applicability: PROP-P]

Limits in narrow band Frequency domain for PPU primary power interface directly connected to the PCU.

- * $CE \leq 90\text{dB}\mu\text{Apeak}$ ($87\text{dB}\mu\text{Arms}$) from 30Hz to 50KHz,
- * $CE \leq 110\text{dB}\mu\text{Apeak}$ ($107\text{dB}\mu\text{Arms}$) from 50KHz to 200KHz,
- * $CE \leq 80\text{dB}\mu\text{Apeak}$ ($77\text{dB}\mu\text{Arms}$) from 201KHz to 10MHz,
- * $CE \leq 50\text{dB}\mu\text{Apeak}$ ($47\text{dB}\mu\text{Arms}$) from 10.1MHz to 50MHz.

This limit is applicable for PPU in steady state regulated thrust mode and PPU in limitation mode.

*

Reference **SBX-4CF-AD01-P3-REQ-029**

[FC Applicability: PROP-P]

Time domain conducted emission shall be recorded on +Udc for PPU in steady state regulated thrust mode and PPU in limitation mode.

Refer to section 13.8.5 concerning measurement condition in time domain.

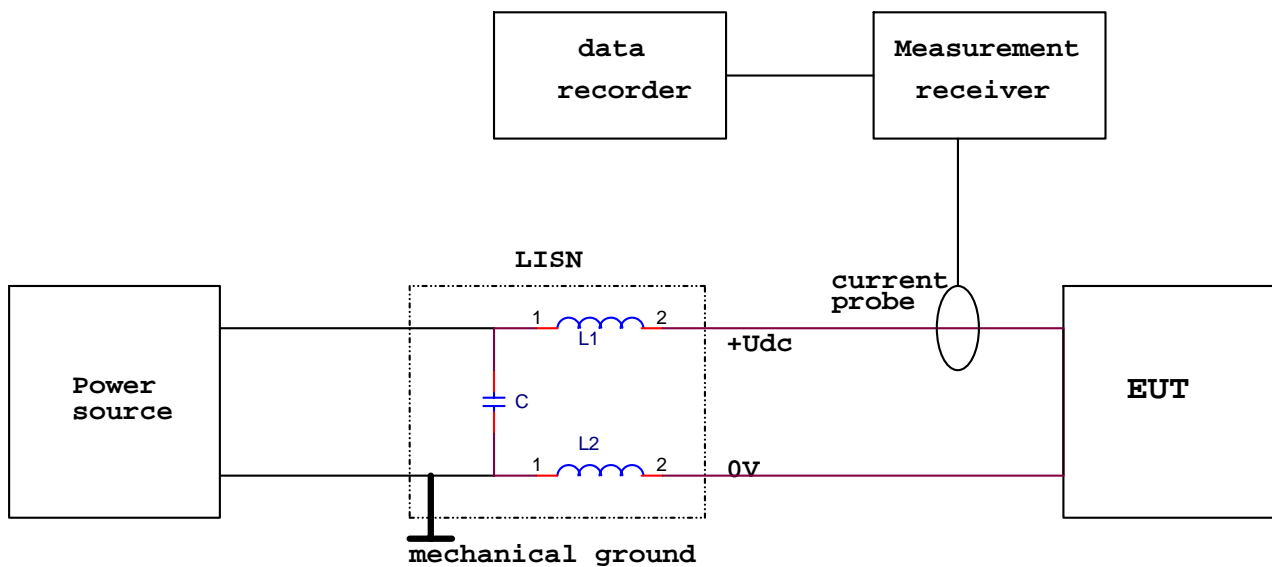
*

6.1.2 Inrush current

Reference **SBX-4CF-AD01-P3-REQ-030**

[FC Applicability: ALL CF (hardware)]

Test method :



- LISN definition : Refer to section 13.10
- $U_{dc} = 100V$ (-2V / +2V)
- current probe clamped on +Udc lead
- measurement receiver = oscilloscope

*

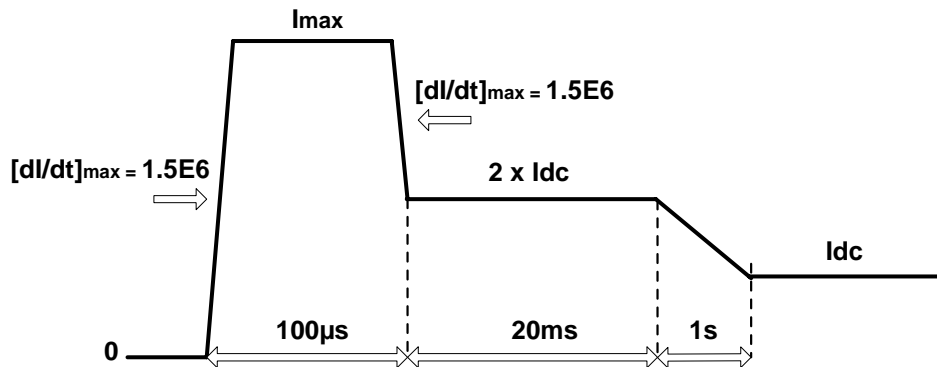
Reference **SBX-4CF-AD01-P3-REQ-031**

[FC Applicability: ALL CF (hardware)]

Limits applicable :

- during switch ON and switch OFF (several seconds between ON & OFF commands)
- during any change of unit configuration (motor start -up, thrusters, heaters, ...)

Idc = maximum DC current of the unit for power voltage supply = 100V



$I_{max} = 1A$ for $I_{dc} < 0.5A$

$I_{max} = 4 \times I_{dc}$ for $0.5A \leq I_{dc} \leq 2.5A$

$I_{max} = 10A$ for $I_{dc} > 2.5A$

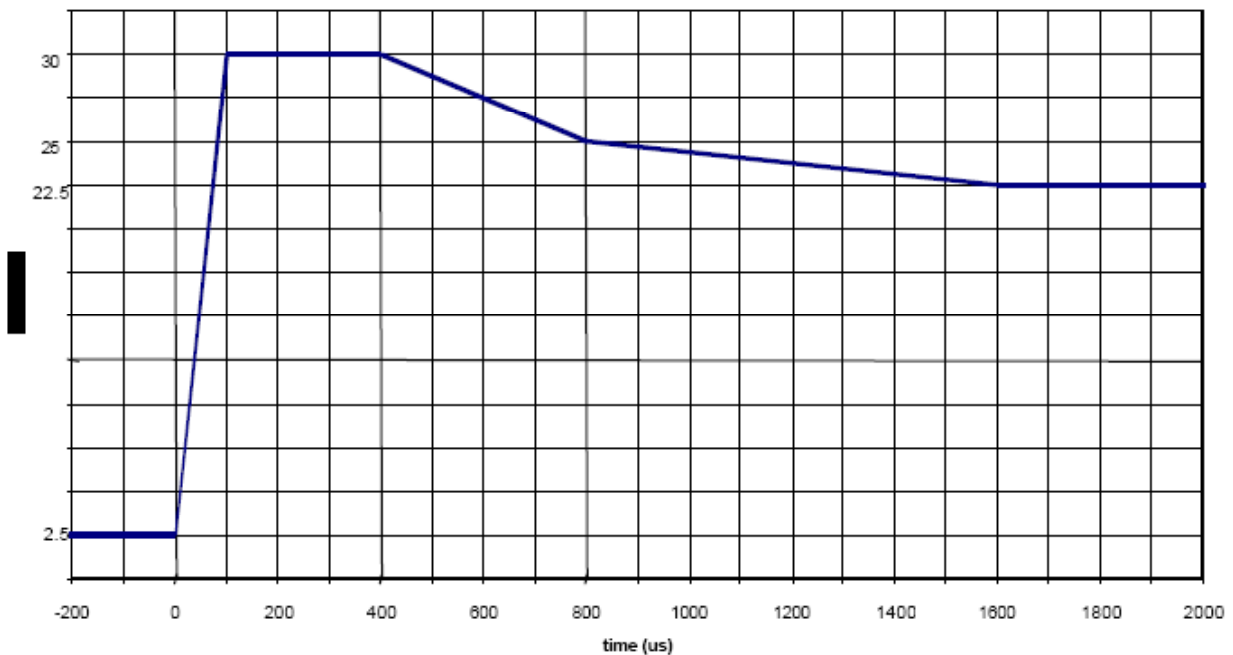
*

Reference **SBX-4CF-AD01-P3-REQ-032**

[FC Applicability: PROP-P]

Limit applicable to the PPU power interface directly connected to the PCU (X1-X4 interfaces) during the start up of the thruster.

Inrush on J01 at thruster start up



*

6.1.3 Plug in current

Reference **SBX-4CF-AD01-P3-REQ-033**

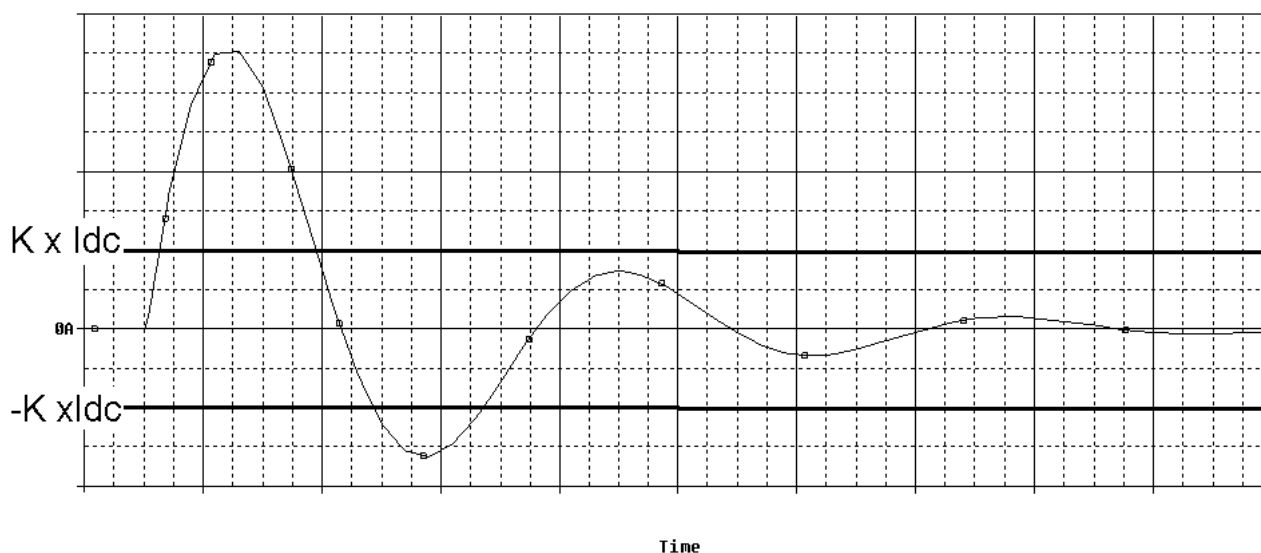
[FC Applicability: ALL CF (hardware)]

The plug in current shall be compliant with the criteria :

$$A = \int I_{transient}^2 \times dt \quad \text{with } |I_{transient}| \geq K \times I_{dc} \quad \text{with } K = 4$$

I_{dc} : DC current unit consumption for $U_{dc} = 100V$

Unit DC power consumption	A
$P \leq 25W$	$< 2.0 \text{ E-3}$
$25W < P \leq 50W$	$< 8.0 \text{ E-3}$
$50W < P \leq 125W$	$< 5.0 \text{ E-2}$
$125W < P \leq 250W$	< 0.2 (2 if AEM P600L)
$P > 250W$	< 0.45 (6 if AEM P600L)

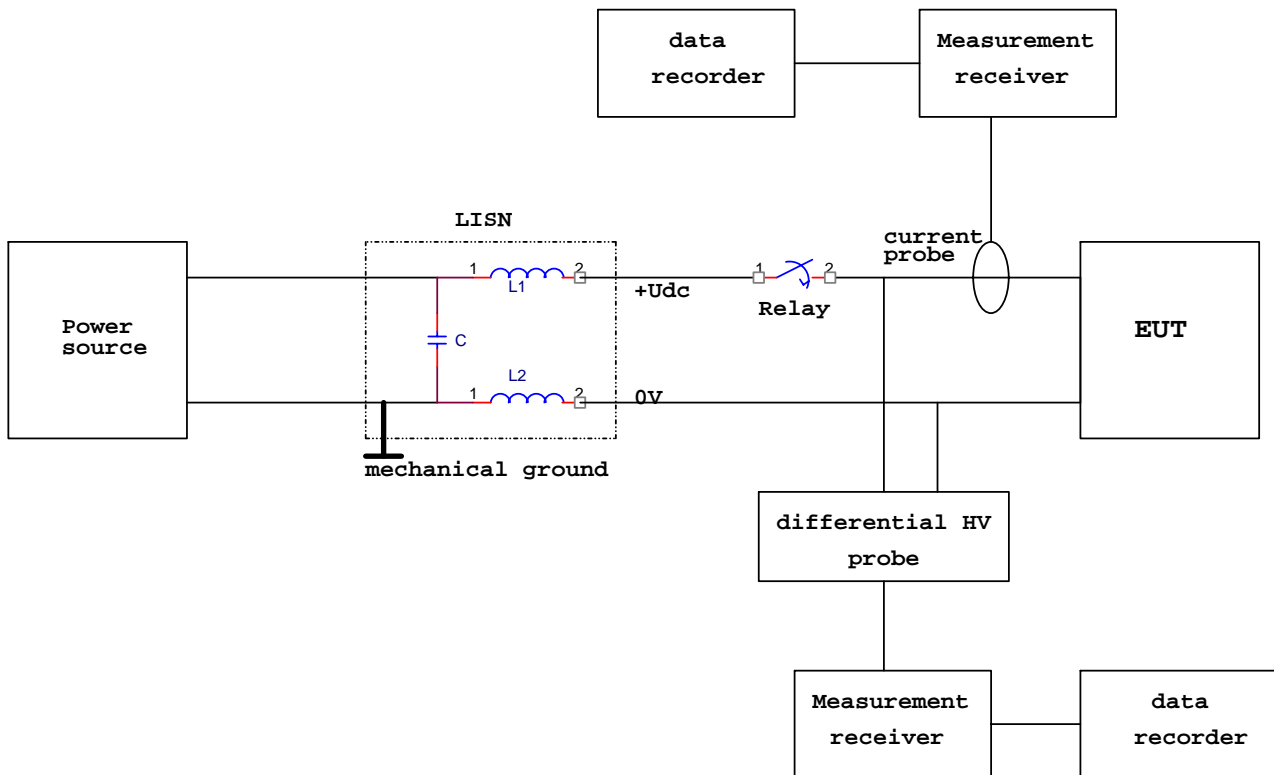


*

Reference **SBX-4CF-AD01-P3-REQ-034**

[FC Applicability: ALL CF (hardware)]

Test method 1 :

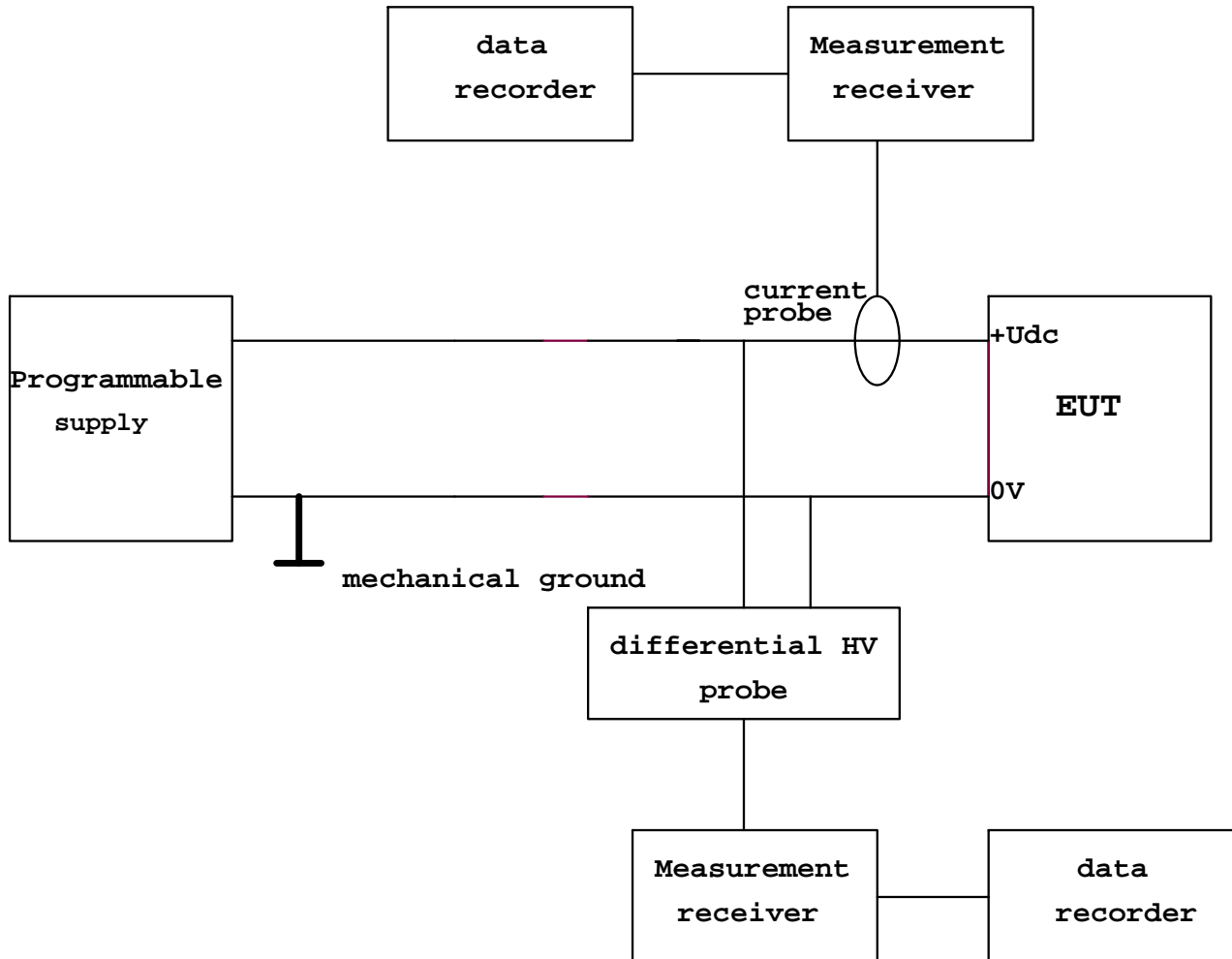


- LISN definition : Refer to section 13.10
- measurement receiver = oscilloscope
- Power supply voltage stabilized : $U_{dc} = 100V (-2V / +2V)$
- Switch ON the relay contact
- plug in current and voltage transition shall be recorded

Test method 2 :

A programmable supply can be used instead of the use of test method including a relay.

With this method LISN shall be removed



- Voltage transition between 0V to 100V shall be performed with $dV/dt \geq 5V/\mu s$.
- measurement receiver = oscilloscope
- plug in current and voltage transition shall be recorded

*

6.1.4 Transient current due to exceptional fluctuation of 100V supply

Reference **SBX-4CF-AD01-P3-REQ-035**

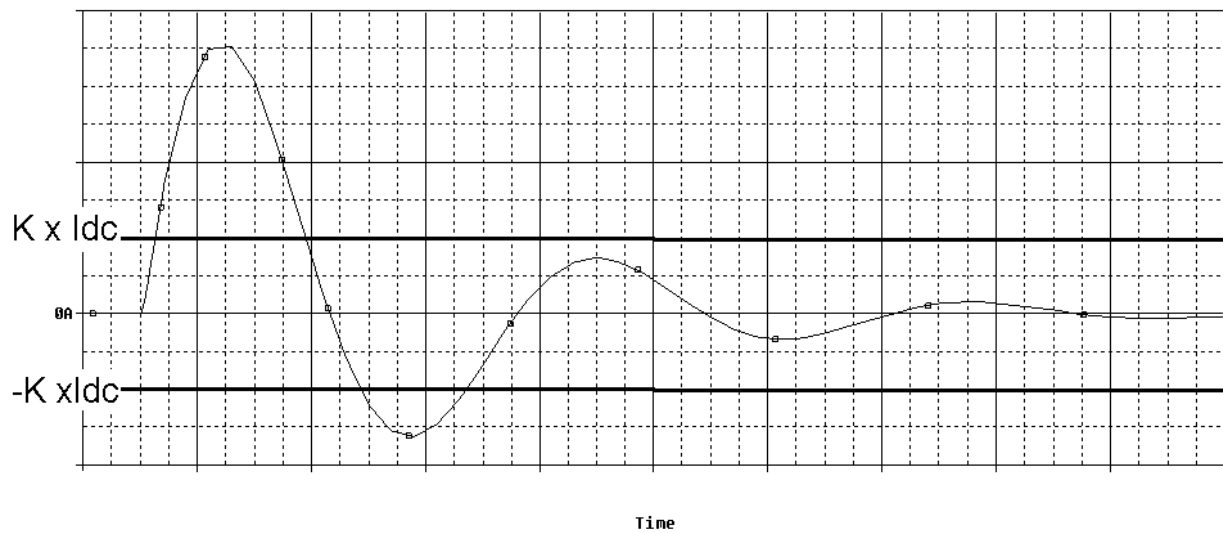
[FC Applicability: ALL CF (hardware)]

Transient current shall be compliant with the criteria :

$$A = \int I_{transient}^2 \times dt \quad \text{with } |I_{transient}| \geq K \times I_{dc} \quad \text{with } K = 4$$

I dc: DC current unit consumption for Udc = 100V

Unit DC power consumption	A
$P \leq 25W$	$< 1.0 \text{ E-3}$
$25W < P \leq 50W$	$< 4.0 \text{ E-3}$
$50W < P \leq 125W$	$< 2.5 \text{ E-2}$
$125W < P \leq 250W$	< 0.1 (1 if AEM P600L)
$P > 250W$	< 0.23 (3 if AEM P600L)



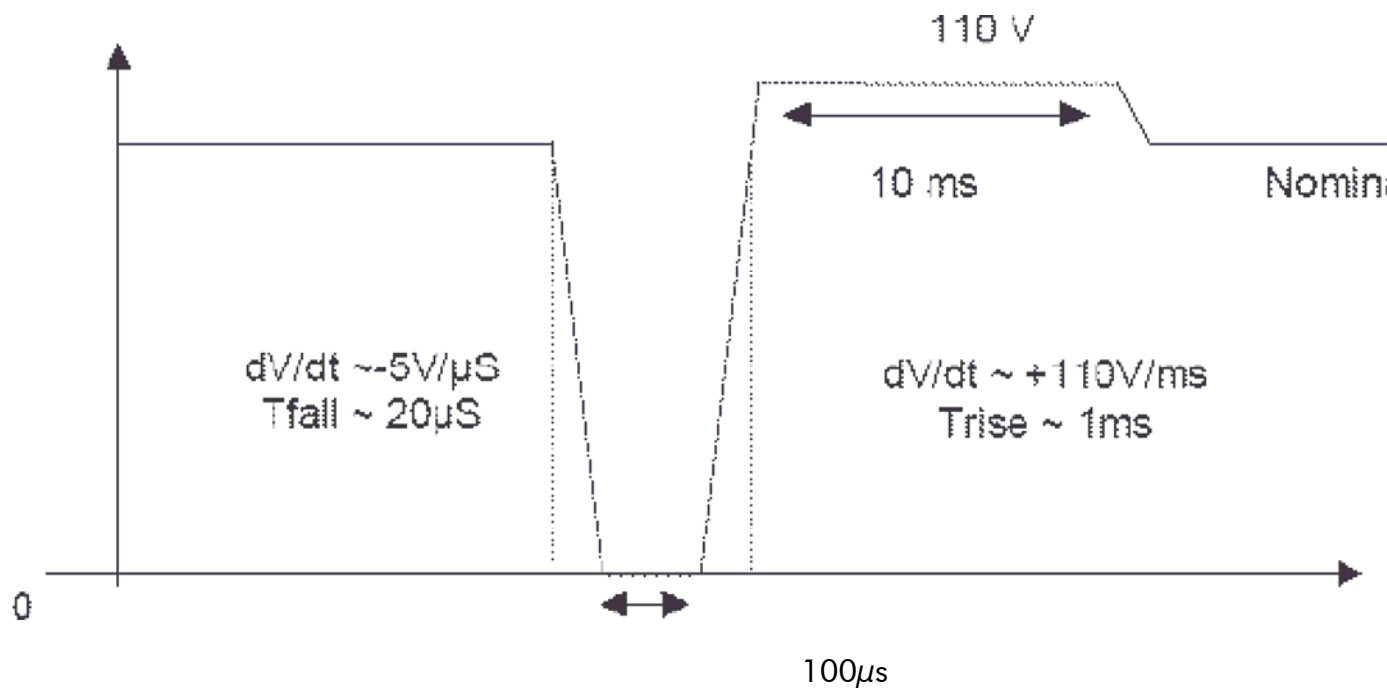
*

Reference **SBX-4CF-AD01-P3-REQ-036**

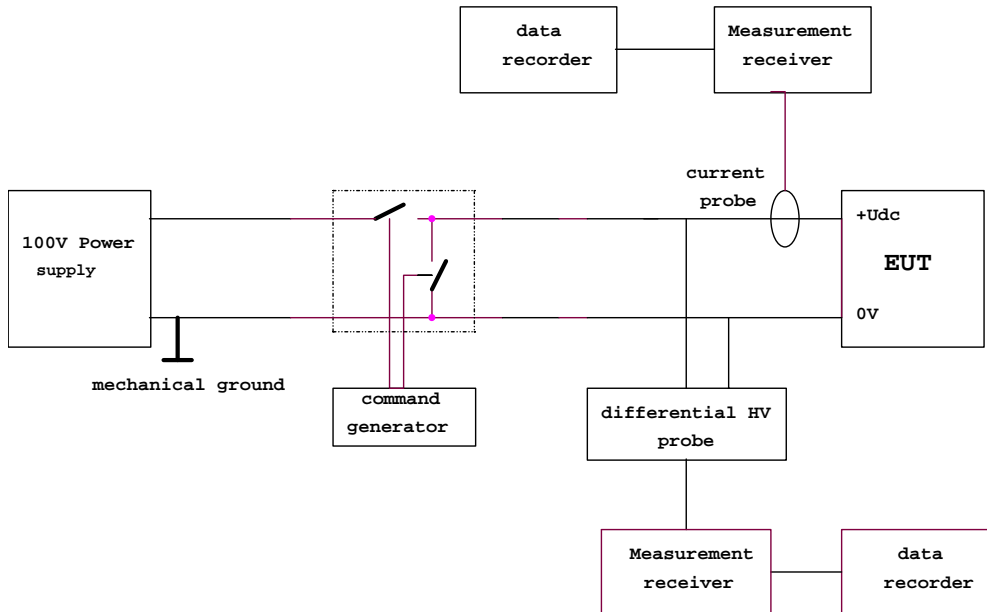
[FC Applicability: ALL CF (hardware)]

Test method :

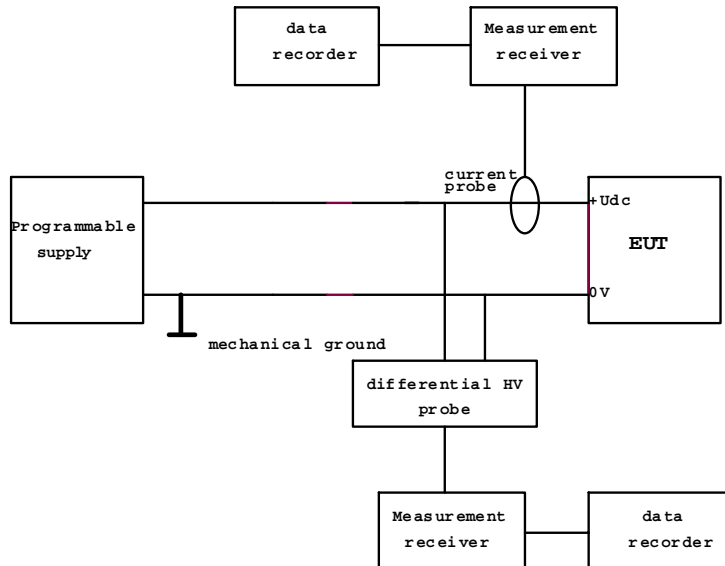
- Voltage supply transition from 100V to 0V and from 0V to 100V will comply with the following shape :



- measurement receiver = oscilloscope
- transient current and voltage transition shall be recorded
- Recommended test set up (1 or 2) :
- test set up 1



• test set up 2 :



*

6.1.5 Conducted susceptibility - Continuous mode

Reference **SBX-4CF-AD01-P3-REQ-037**

[FC Applicability: ALL CF (hardware)]

The EUT shall not exhibit failure or unintended responses when subjected to a sine wave signal with the following characteristics :

CS Limit applied in differential mode (between + Udc and return line) :

- 2Vrms : from 30Hz to 1kHz,
- decreasing by 20dB/decade from 1kHz to 2KHz,
- 1Vrms from 2KHz to 50MHz.
- Injected current limitation (all limitations shall be indicated in the test report) :
 - 1Arms : from 30Hz to 10KHz,
 - decreasing by 20dB/decade from 10KHz to 100KHz,
 - 0.1Arms from 100KHz to 30MHz,
 - decreasing by 20dB/decade from 30MHz to 50MHz.
- Induced common mode voltage limitation (all limitations shall be indicated in the test report) :
 - 2Vrms : from 30Hz to 1kHz,
 - decreasing by 20dB/decade from 1kHz to 2KHz,
 - 1Vrms from 2KHz to 50MHz.

*

Reference **SBX-4CF-AD01-P3-REQ-038**

[FC Applicability: ALL CF (hardware)]

In case of equipment susceptibility, the injected interference level shall be reduced until the units recovers its nominal performances. The susceptibility level threshold shall be recorded.

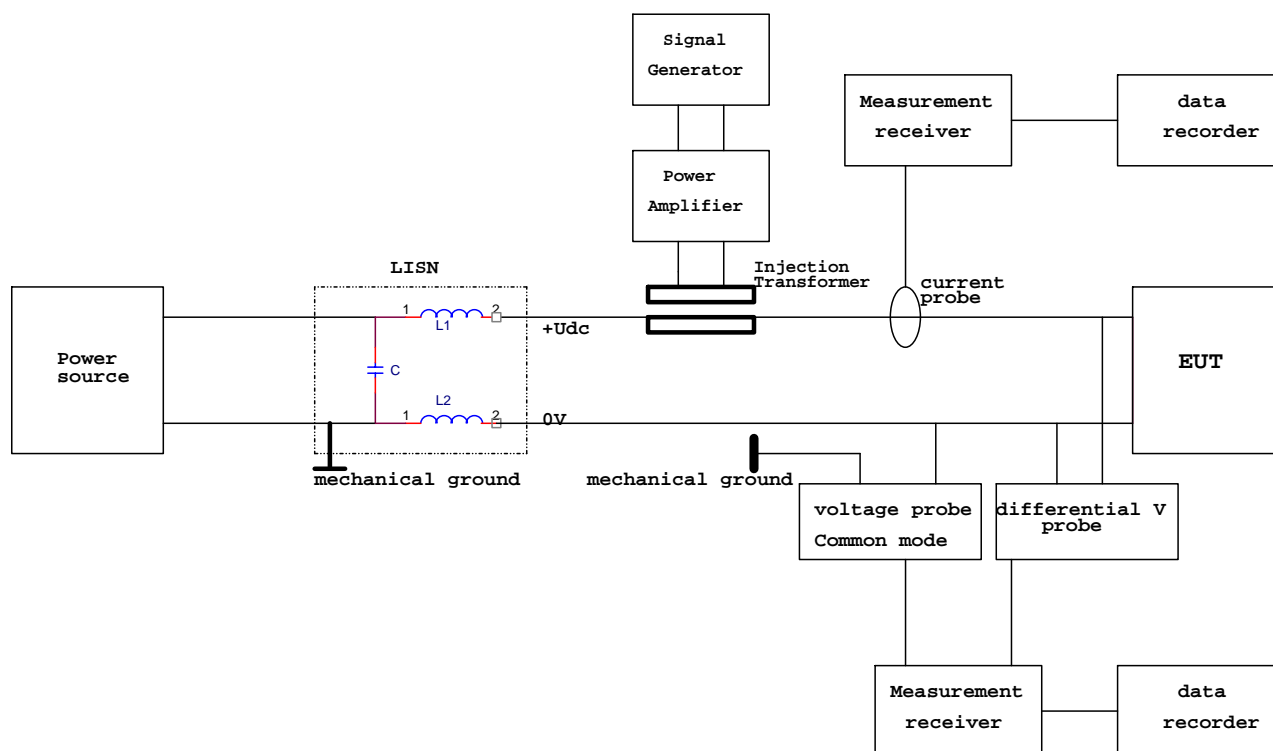
*

Reference **SBX-4CF-AD01-P3-REQ-039**

[FC Applicability: ALL CF (hardware)]

Test Method :

Voltage injected in differential mode, current injected (+Udc wire) and induced common mode voltage shall be controlled and recorded for each frequency tested.



- LSN definition : Refer to section 13.10
- $U_{dc} = 100V (-2V / +0V)$
- Measurement receiver = oscilloscope
- Injection by transformer or dedicated probe

*

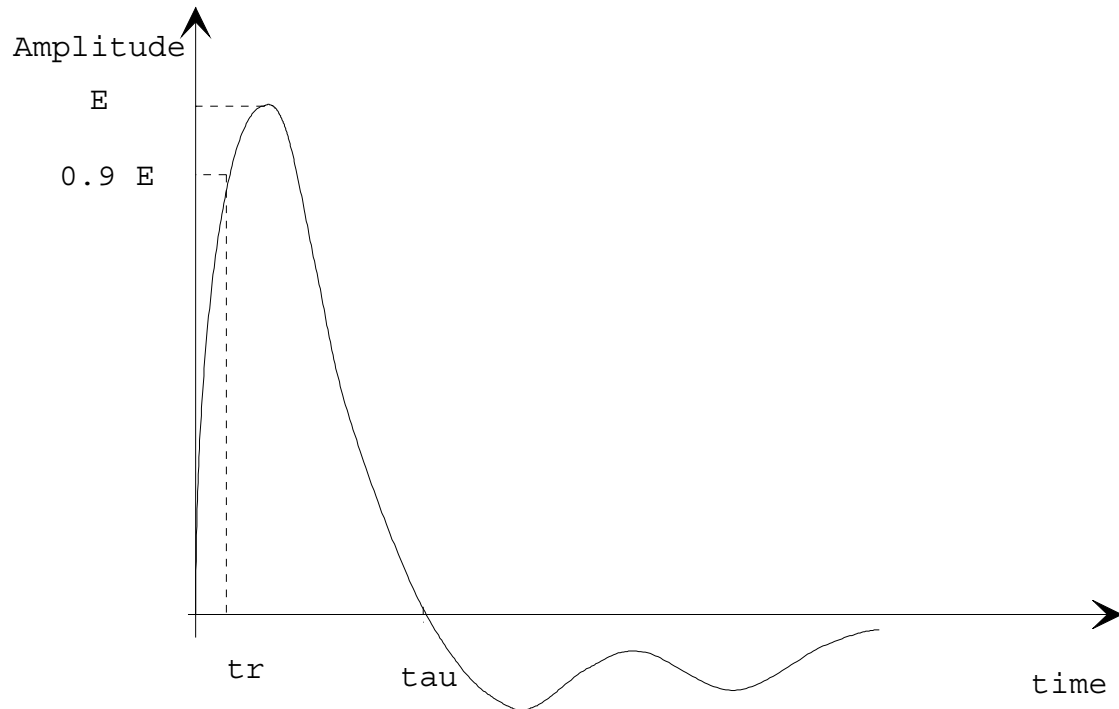
6.1.6 Conducted susceptibility - Exceptional short term transients

Reference **SBX-4CF-AD01-P3-REQ-040**

[FC Applicability: ALL CF (hardware)]

Equipment shall not exhibit failure or unintended responses when subjected to the following voltage transient :

- Amplitude : $U = 50V$ peak (both polarities)
- Rise time : $t_r \leq 2\mu s$
- Duration : $10\mu s \leq \tau < 20\mu s$
- Injected current amplitude limitation : NO



- Requirement applicable for transient applied between +Udc wire and mechanical ground
- Requirement applicable for transient applied between 0V return wire and mechanical ground
- Transient shall be considered as single events but shall repeated to cover all critical functional modes

*

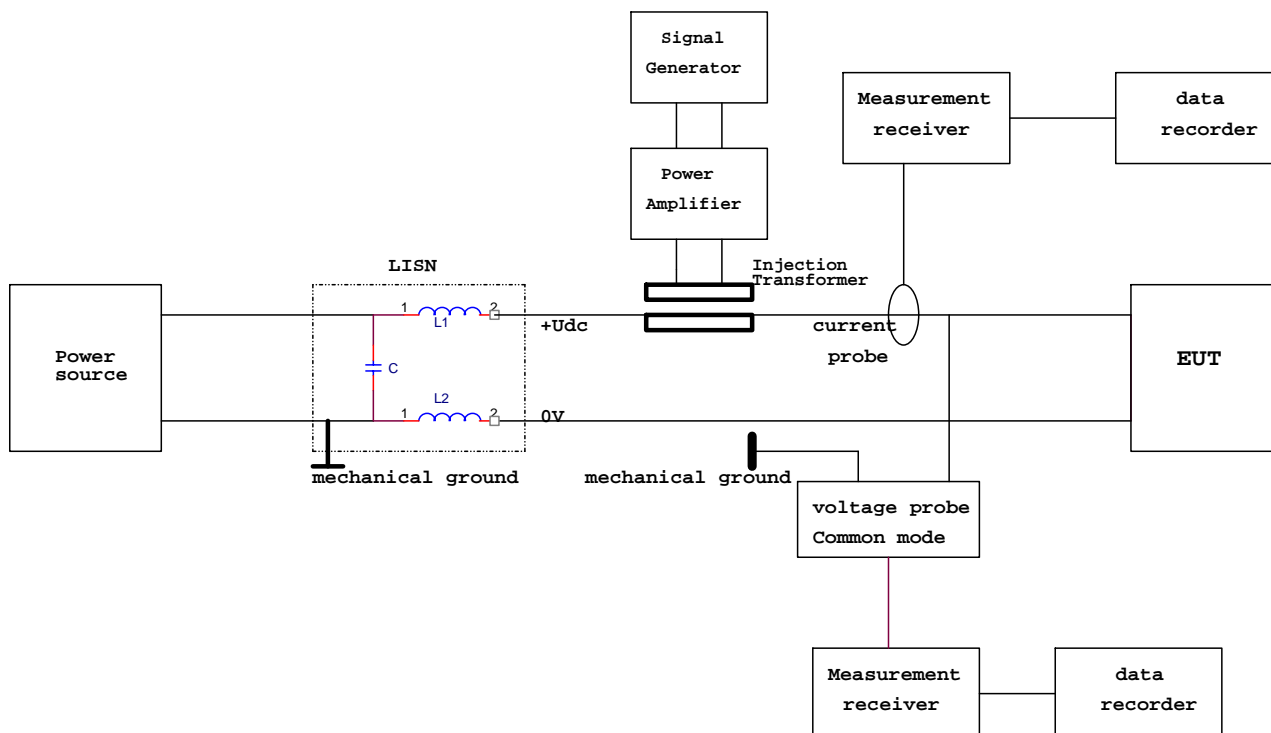
Reference **SBX-4CF-AD01-P3-REQ-041****[FC Applicability: ALL CF (hardware)]**

In case of equipment susceptibility, the injected interference level shall be reduced until the units recovers its nominal performances. The susceptibility threshold level shall be recorded.

*

Reference **SBX-4CF-AD01-P3-REQ-042****[FC Applicability: ALL CF (hardware)]**

recommanded Test method :



- LISN definition : Refer to section 13.10
- $U_{dc} = 100V (-2V / +0V)$
- Measurement receiver = oscilloscope
- Injection by transformer or dedicated probe
- injections (both polarities) shall be performed on +Udc wire :
 - apply to the transient voltage defined in Req-040 between +Udc wire and mechanical ground,
 - record the transient voltage characteristic injected between +Udc wire and mechanical ground,
 - record the transient current characteristic induced on +Udc wire
- injection (both polarities) shall be performed on 0V return wire :
 - apply the transient voltage defined in Req-040 between 0V return wire and mechanical ground,
 - record the transient voltage characteristic injected between 0V return wire and mechanical ground,
 - record the transient current characteristic induced on 0V return wire.

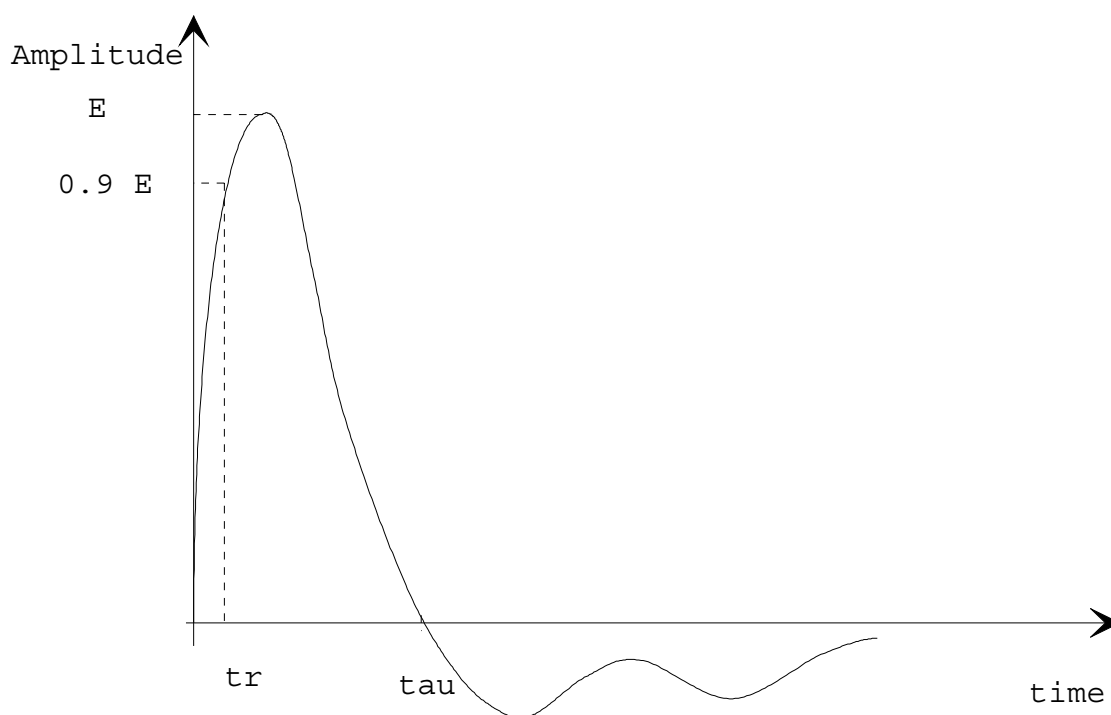
6.1.7 Conducted susceptibility - Regular short term transients

Reference **SBX-4CF-AD01-P3-REQ-043**

[FC Applicability: ALL CF (hardware)]

Equipment shall not exhibit failure or unintended responses when subjected to the following voltage transient :

- Amplitude : $U = 10\text{V}$ peak (both polarities)
- Rise time : $t_r \leq 2\mu\text{s}$
- Duration : $10\mu\text{s} \leq \tau < 20\mu\text{s}$
- Injected current amplitude limitation : NO



- Induced voltage limitation (between 0V return and mechanical ground : 10V peak
- Requirement applicable for transient applied between +Udc wire and 0V return wire
- Transient shall be considered as single events but shall repeated to cover all critical functional modes

*

Reference **SBX-4CF-AD01-P3-REQ-044**

[FC Applicability: ALL CF (hardware)]

Référence Fichier : SB4-6A-AS-SP-015_05.doc du 26/06/2009 10:02

THALES

Référence du modèle : 100173569N_06.dot

All rights reserved, 2007, Thales Alenia Space

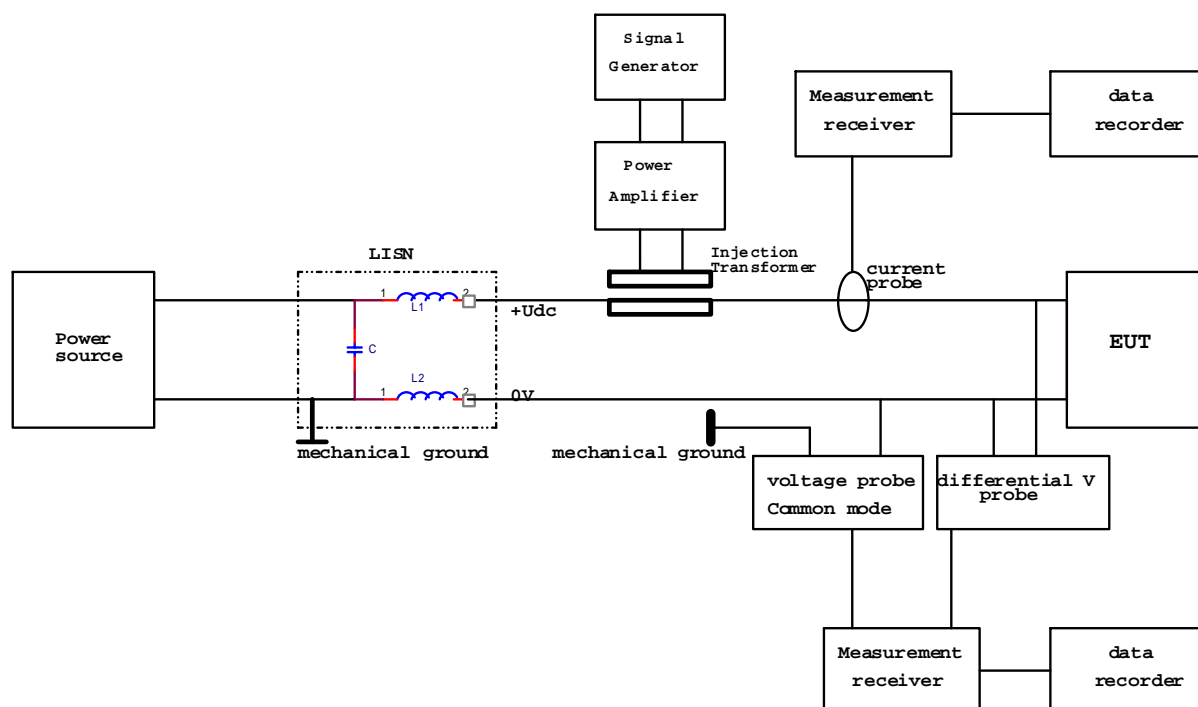
In case of equipment susceptibility, the injected interference level shall be reduced until the units recovers its nominal performances. The susceptibility threshold level shall be recorded.

*

Reference SBX-4CF-AD01-P3-REQ-045

[FC Applicability: ALL CF (hardware)]

Test method :



- LISN definition : Refer to section 13.10
- $U_{dc} = 100V (-2V / +0V)$
- Measurement receiver = oscilloscope
- Injection by transformer or dedicated probe
- injections (both polarities) shall be performed on +Udc wire :
 - apply to the transient voltage defined in Req-043 between +Udc wire and 0V return wire,
 - record the transient voltage characteristic injected between +Udc wire and 0V return wire,

- record the transient current characteristic induced on +Udc wire,
- control regarding limitation requirement and record the transient voltage characteristic induced between 0V return wire and mechanical ground.

*

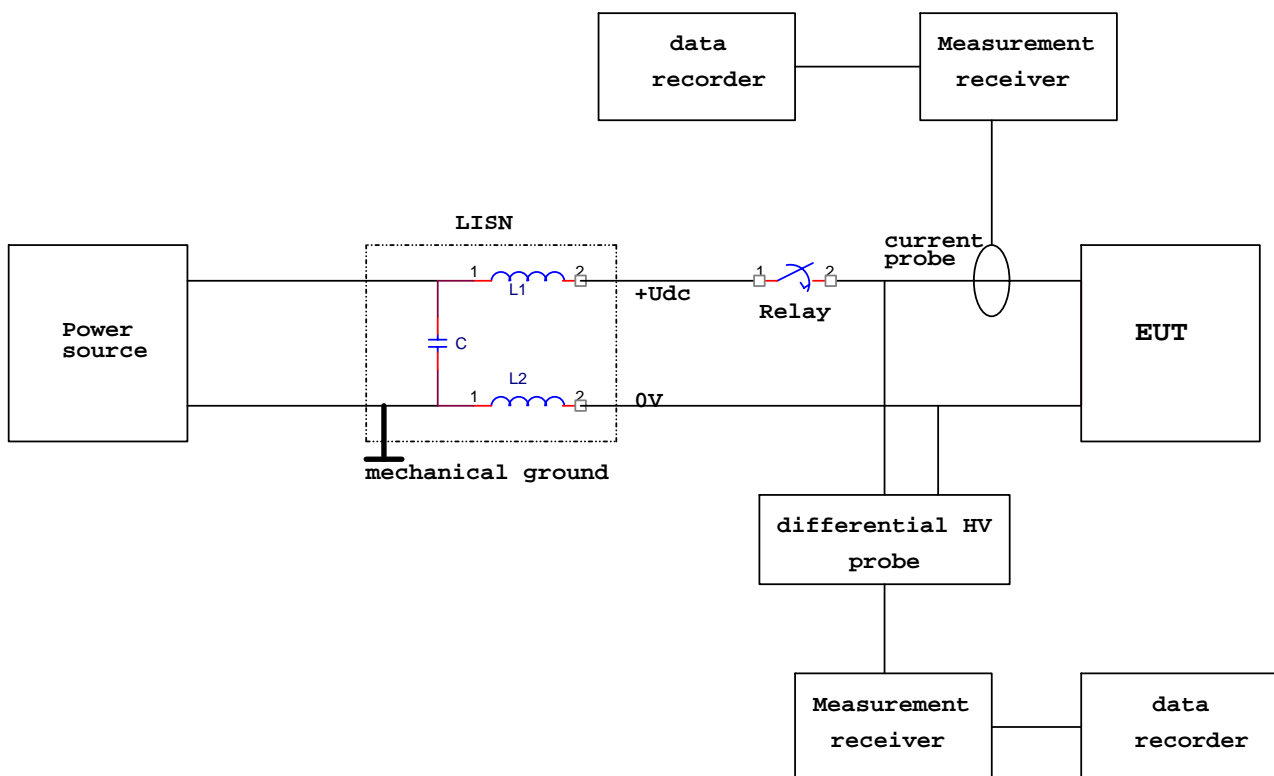
6.1.8 Conducted susceptibility - 100V Plug in

Reference SBX-4CF-AD01-P3-REQ-046

[FC Applicability: ALL CF (hardware)]

Equipment shall safely survive without any overstressing or damage when subjected to 0V - 100V plug in connection :

Test method 1 :

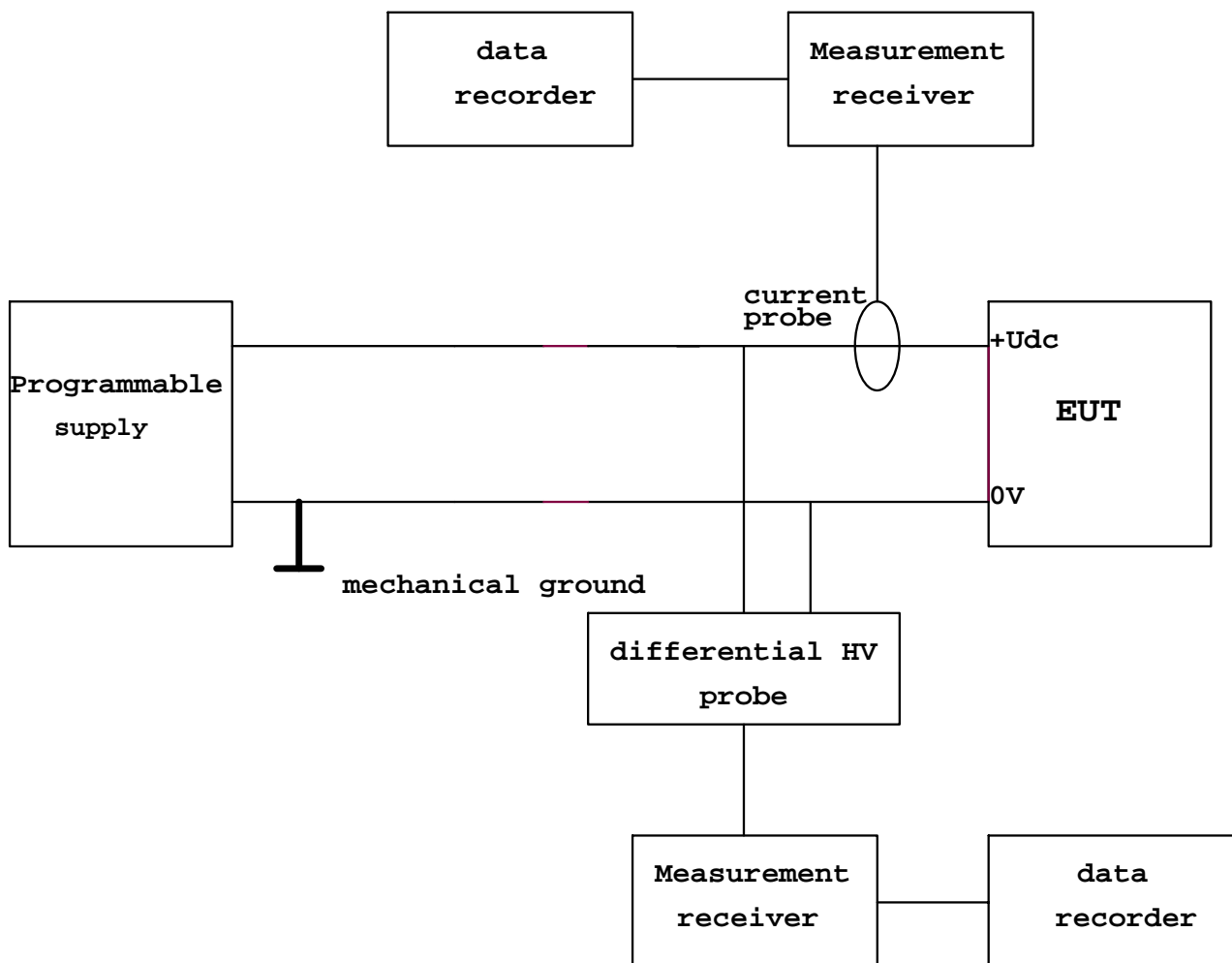


- LSN definition : Refer to section 13.10
- measurement receiver = oscilloscope
- Power supply voltage stabilized : $U_{dc} = 100V (-2V / +2V)$
- Switch ON the relay contact
- plug in current and voltage transition shall be recorded

Test method 2 :

A programmable supply can be used instead of the use of test method including a relay.

With this method LISN shall be removed



- Voltage transition between 0V to 100V shall be performed with $dV/dt \geq 5V/\mu s$.
- measurement receiver = oscilloscope
- plug in current and voltage transition shall be recorded

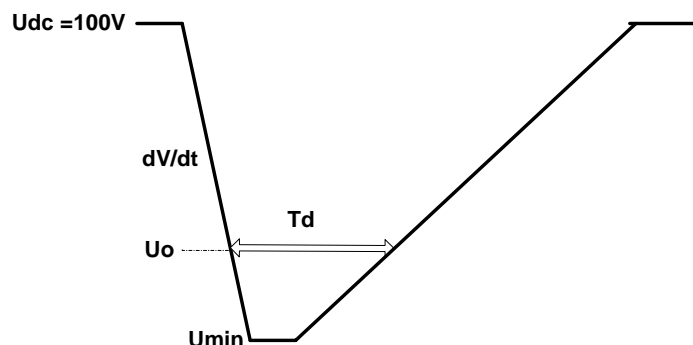
*

6.1.9 Conducted susceptibility - Exceptional Fluctuation of 100V supply

Reference **SBX-4CF-AD01-P3-REQ-047**

[FC Applicability: ALL CF (hardware)]

Equipment shall not exhibit failure or unintended responses when subjected to the following voltage fluctuation :



- $dV/dt = 0.4V/\mu s$ (+/- $0.1V/\mu s$)
- 1st test configuration (not applicable to units with switch off threshold $>90V$)
 - U_o = switch off threshold + 20V
 - U_{min} = switch off threshold + (1V to 2V)
 - $T_d \min \geq 200\mu s$
 - Injected current amplitude limitation : NO
- 2nd test configuration applicable to all units
 - U_o = switch off threshold
 - $U_{min} = 50V$
 - $T_d \min \geq 200\mu s$
 - Injected current amplitude limitation : NO
- Transient shall be considered as single events but shall repeated to cover all critical functional modes

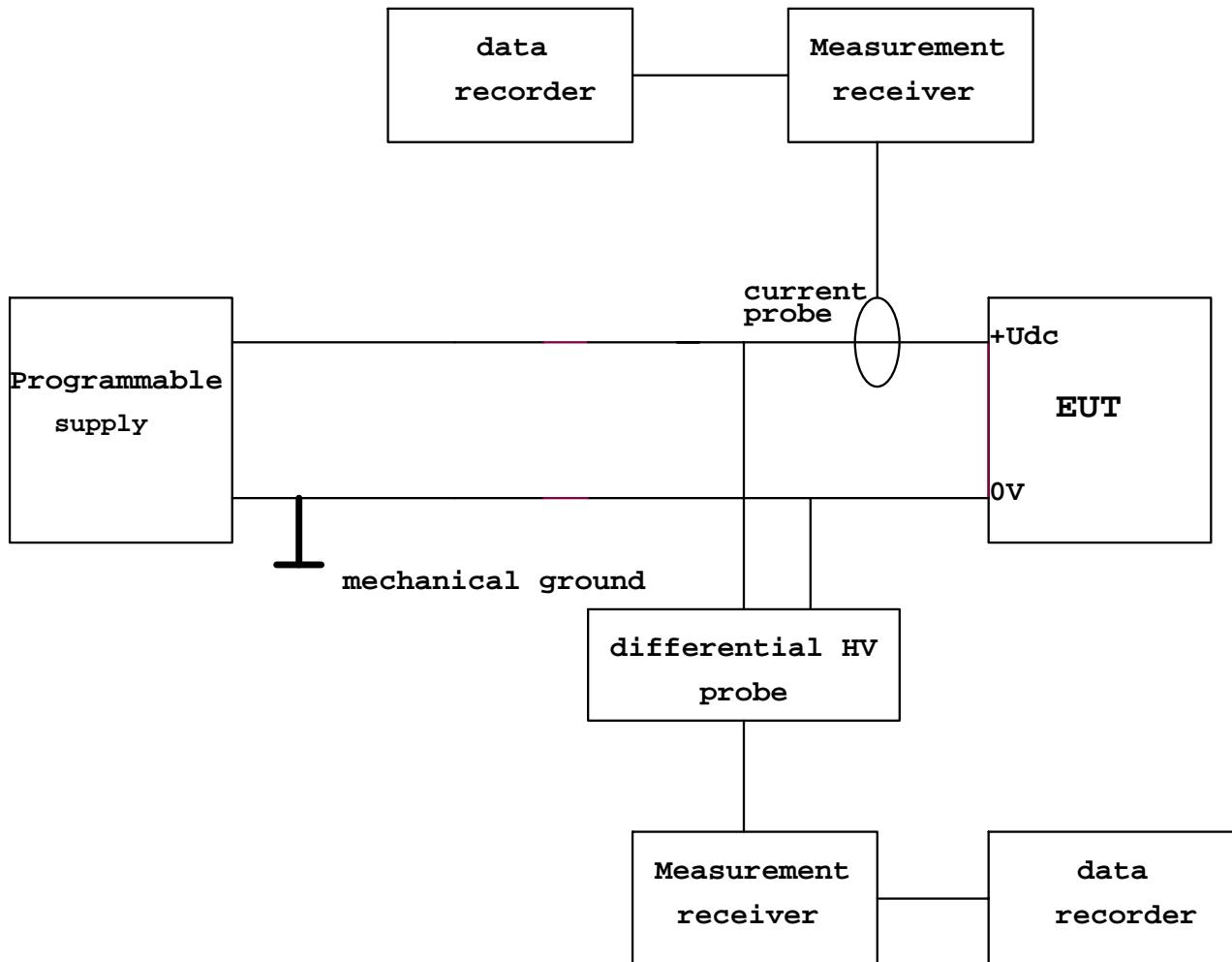
*

Reference **SBX-4CF-AD01-P3-REQ-048**

[FC Applicability: ALL CF (hardware)]

Test method :

- The unit under test shall be initially in a configuration which maximise the interference



- measurement receiver = oscilloscope
- voltage and current transients and shall be recorded

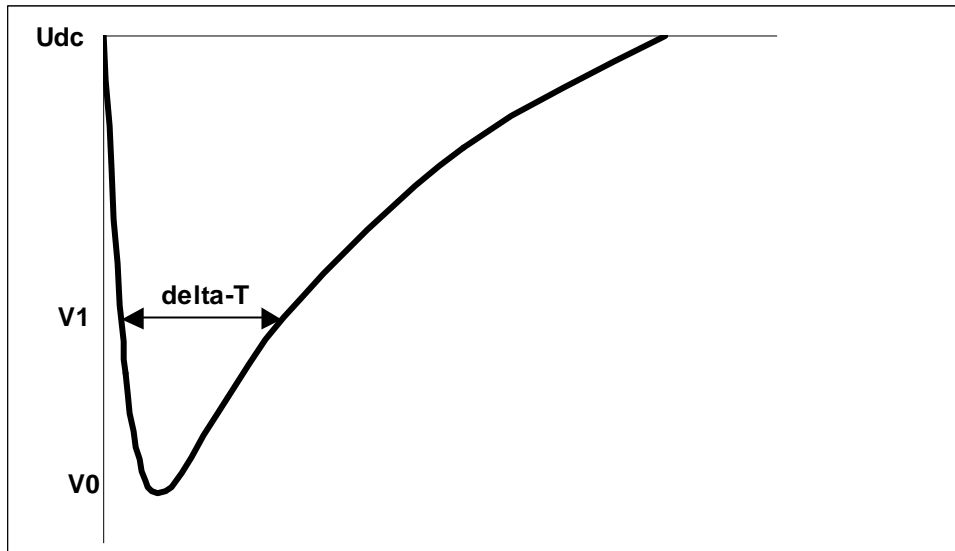
*

6.1.10 Conducted susceptibility - Regular long term transients

Reference **SBX-4CF-AD01-P3-REQ-049**

[FC Applicability: ALL CF (hardware)]

Equipment shall not exhibit failure or unintended responses when subjected to the following voltage transient :



- U_{dc} : DC voltage at the inputs of equipment : $U_{dc} = 98V$
- $V_0 = 94V$ ($U_{dc} - V_0 = 4V$) $\Delta T @ V_0 = 40\mu s \pm 20\%$
- $V_1 = 95V$ ($U_{dc} - V_1 = 3V$) $\Delta T @ V_1 = 400\mu s \pm 10\%$
- transition time (U_{dc} to V_0) : $t_r \leq 100\mu s$
- Injected current amplitude limitation : NO
- Transient shall be considered as single events but shall repeated to cover all critical functional modes

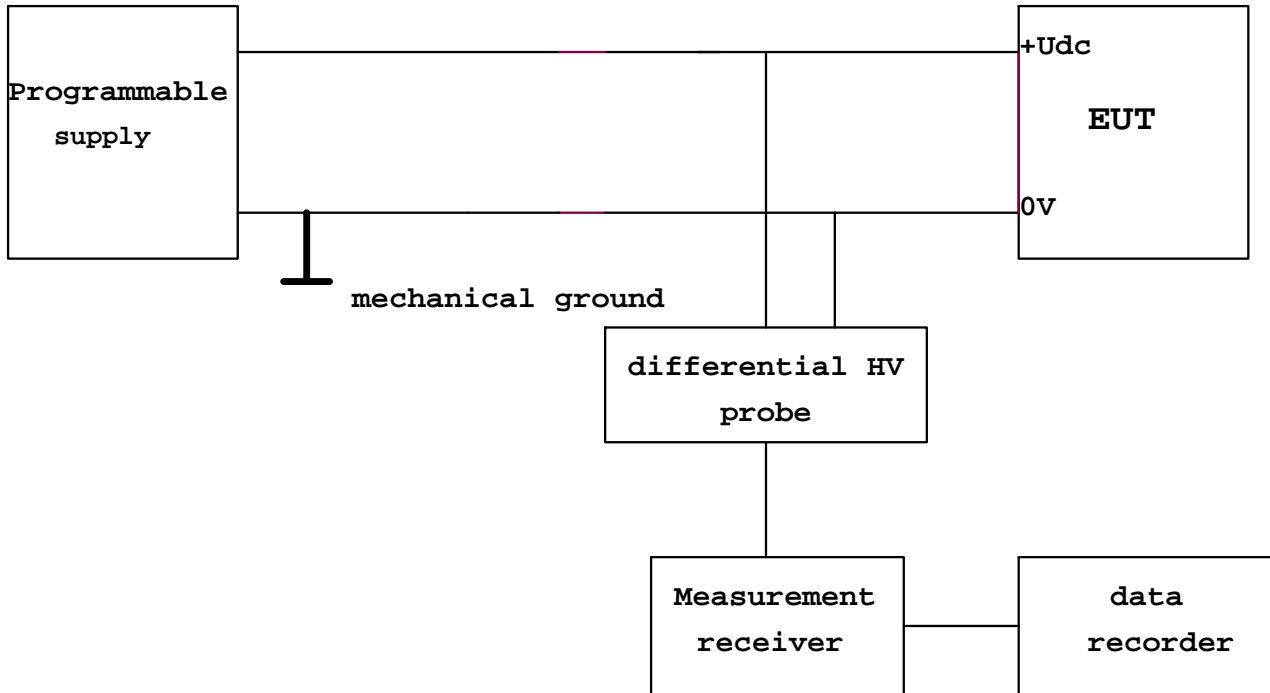
*

Reference **SBX-4CF-AD01-P3-REQ-050**

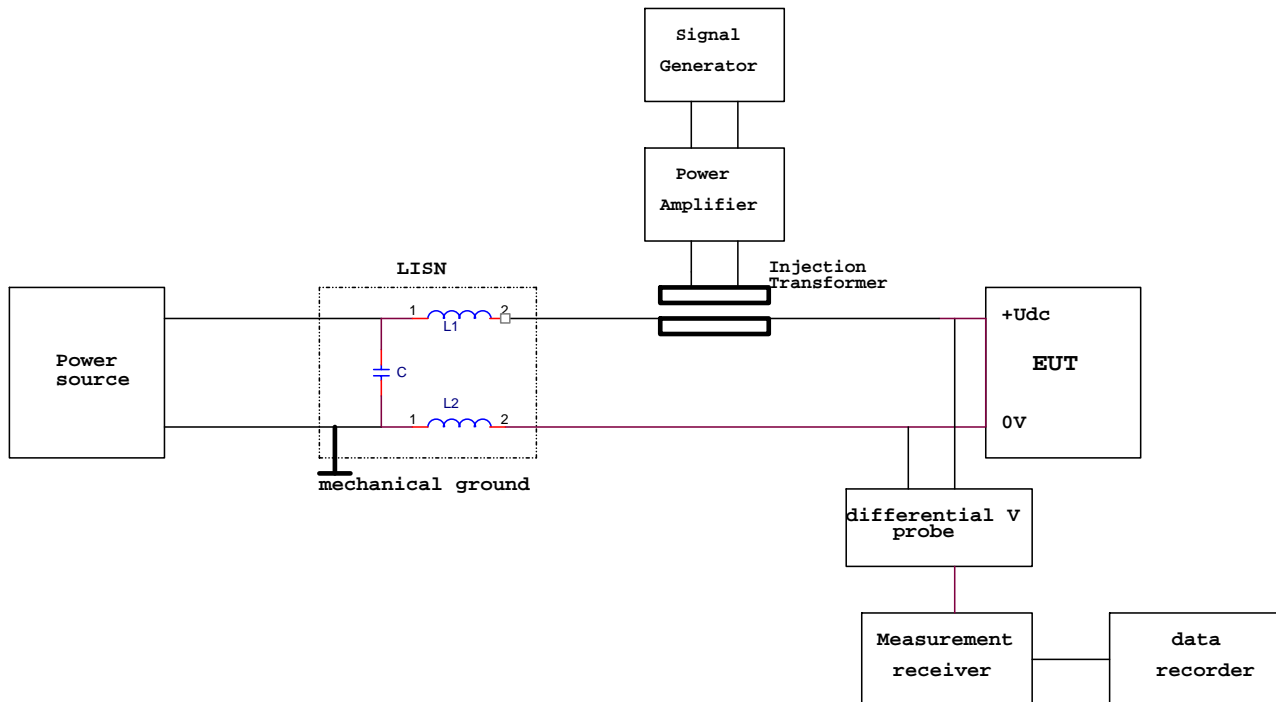
[FC Applicability: ALL CF (hardware)]

Test method 1 :

- measurement receiver = oscilloscope



Test method 2 :



- measurement receiver = oscilloscope
- LISN definition : Refer to section 13.10
- Injection by transformer or dedicated probe

*

6.2 Power conditioning unit

6.2.1 Conducted susceptibility & Conducted emission on 100V power output

Reference SBX-4CF-AD01-P3-REQ-051

[FC Applicability: POWER]

Conducted susceptibility Limit:

- The conducted susceptibility limit (CS) shall be defined in term of current amplitude and temporal waveform
- PCU shall not exhibit failure or unintended response when subjected to this CS limit.

- Justification shall take into account all the necessary parameters defining the electrical and thermal PCU environment (heat pipe or base plate temperature, solar array & battery characteristics)

*

Reference SBX-4CF-AD01-P3-REQ-052

[FC Applicability: POWER]

Regulation voltage ripple shall be less than :

- when PCU submitted to CS requirement (REQ-051) :
 - 4.7Vpp for MF-VR \leq 500Hz
 - decreasing (\cong 40dB/dec) from 500Hz to 1KHz
 - 1.4Vpp for 1KHz $<$ MF-VR \leq 10KHz
 - 1Vpp for MF-VR $>$ 10KHz
- without CS requirement :
 - 0.7Vpp for any MF-VR

note : MF-VR shall be understood as the Main Frequency of Regulation Voltage Ripple observed in time domain.

*

Reference SBX-4CF-AD01-P3-REQ-053

[FC Applicability: POWER]

Single event or repetitive spike at the output of the PCU shall not exceed 1Vpp in any PCU regulation mode with and without CS requirement (REQ-051).

note : One Spike shall be understood as a transient signal (typically short oscillation) with a time duration of few 100ns to few μ s.

*

Reference SBX-4CF-AD01-P3-REQ-054

[FC Applicability: POWER]

Equipment shall not exhibit failure or unintended responses when subjected to the following load current step :

- 45A step (both polarities) with $dl/dt = 1A/\mu s$ (single event or repetition $<$ 1Hz)

*

Reference SBX-4CF-AD01-P3-REQ-055

[FC Applicability: POWER]

The bus voltage variation when PCU submitted to the load current step (REQ-054) shall be lower than 3.7V and shall not be greater than 3V during more than 400 μ s.

The bus voltage shall return to mean regulation value in less than 4.5ms.

Note : "the voltage variation " shall be understood as around the mean regulation voltage.

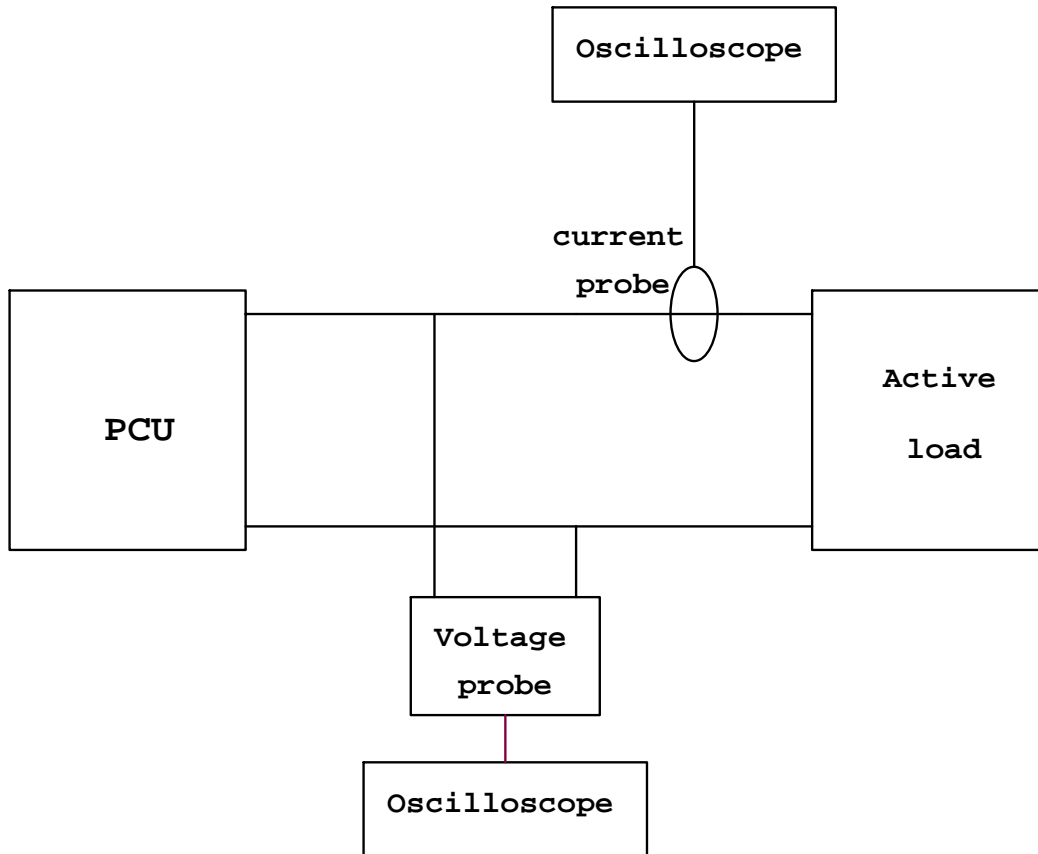
*

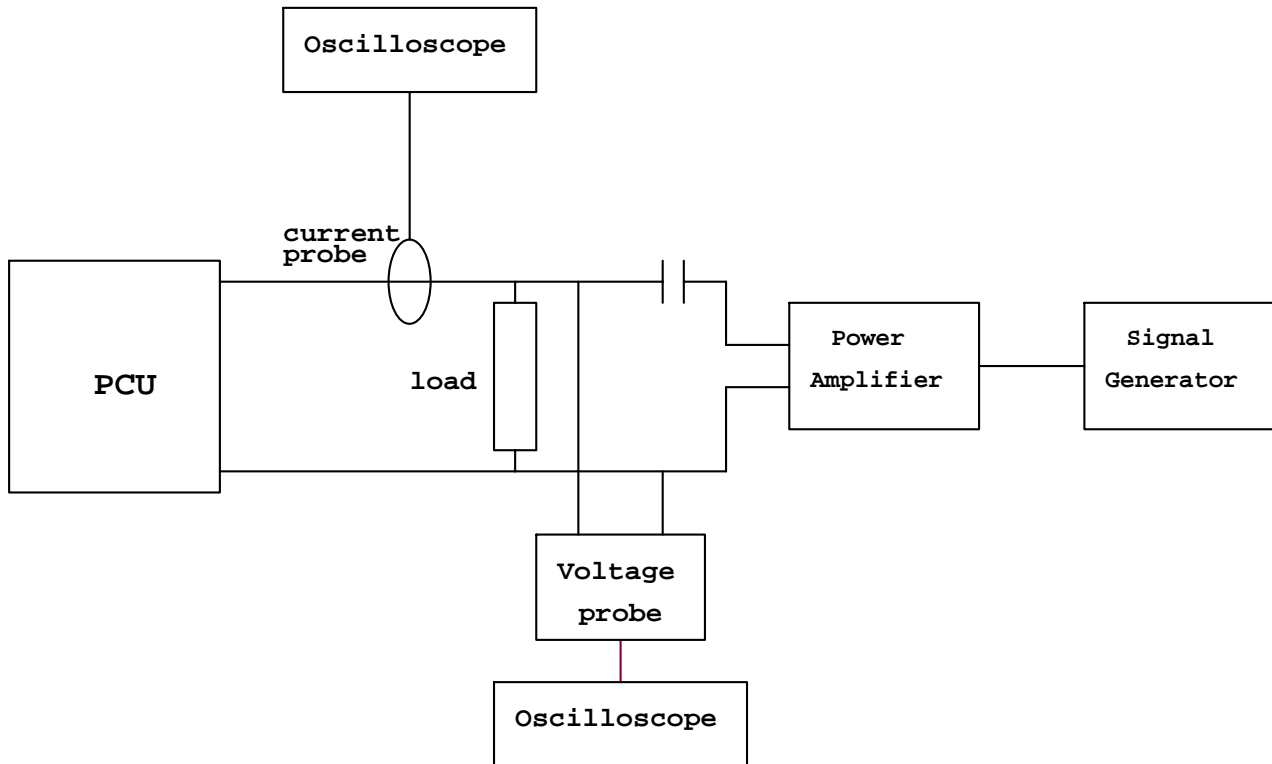
Reference **SBX-4CF-AD01-P3-REQ-056**

[FC Applicability: POWER]

Test method :

- PCU shall be tested in sun mode, eclipse mode and inter domain mode.
- In each mode, the worst case configuration validated by the prime contractor shall be taken into account (solar array current, battery voltage, number of BDR ON, ...).
- The sweep speed of CS (Req-051) shall be adapted to be sure to measure a stabilized regulation voltage in each PCU mode tested.
- injected current, voltage ripple & spikes shall be recorded.





*

6.2.2 PCU behavior during fuse blowing event

Reference **SBX-4CF-AD01-P3-REQ-057**

[FC Applicability: POWER]

Equipment shall not exhibit failure or unintended responses when subjected to fuse blowing event.

*

Reference **SBX-4CF-AD01-P3-REQ-058**

[FC Applicability: POWER]

The PCU output voltage shall not drop below 55V

*

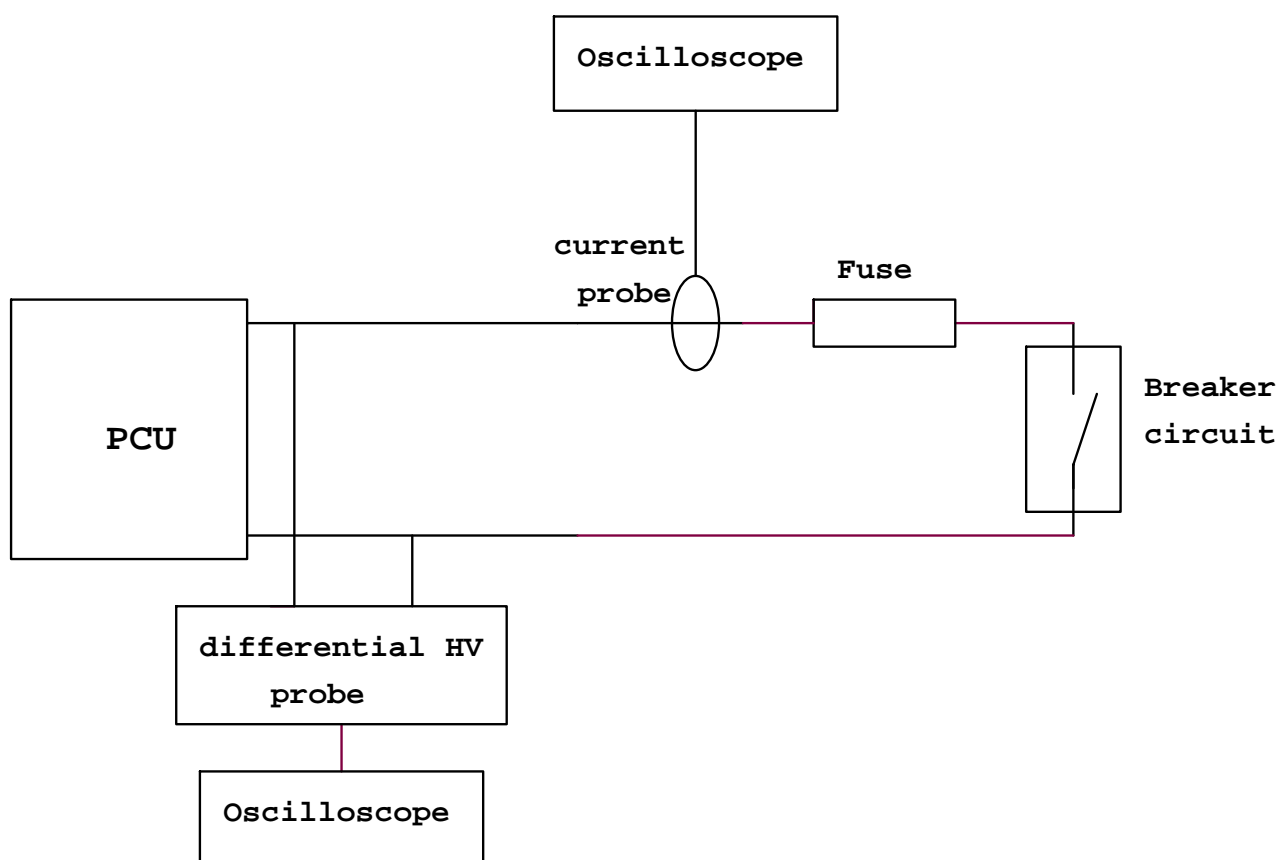
Reference **SBX-4CF-AD01-P3-REQ-059**

[FC Applicability: POWER]

Test method :

- PCU shall be tested in sun mode and eclipse mode.

- In each mode, the worst case configuration validated by the prime contractor shall be taken into account (solar array current, battery voltage, number of BDR ON, fuse ratings,...).
- The cable length between PCU output and fuse shall be in the range $2\text{m} \leq \text{Length} \leq 3\text{m}$.



*

7. CONDUCTED REQUIREMENTS ON SECONDARY POWER LINES

Reference **SBX-4CF-AD01-P3-REQ-060**

[FC Applicability: ALL CF (hardware)]

Conducted requirements (Emission and Susceptibility limits) shall be defined case by case (EPC-CAMP, PPU-FU-PPS1350/SPT100, CVIRES-IRES,...) with the following rules :

- Minimum CS /CE margin = 6dB,
- AD0-P3 requirements (CE on primary power lines & signal lines) applicable with CS applied on secondary power lines,
- CE on secondary power lines applicable with CS applied on primary power lines.

*

Reference **SBX-4CF-AD01-P3-REQ-061**

[FC Applicability: ALL CF (hardware)]

Conducted requirements on secondary power lines shall be approved by the prime (satellite level approval).

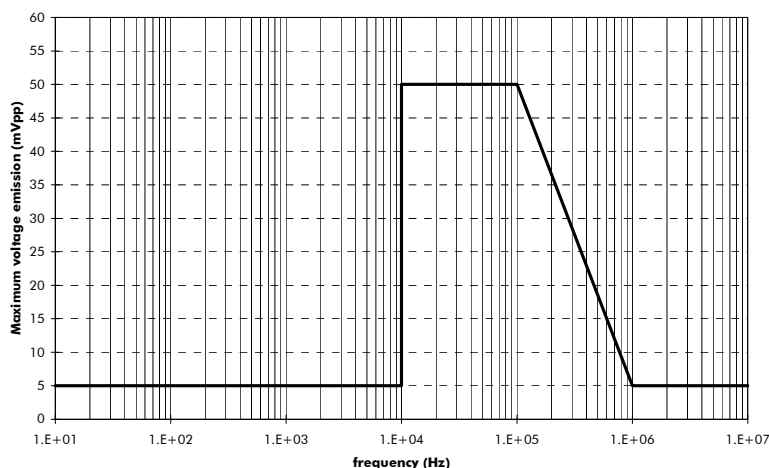
*

Reference **SBX-4CF-AD01-P3-REQ-162**

[FC Applicability: REPEATER, TCR]

Conducted Emissions on Secondary Power Bus on repeater and TCR

- **Source Side**
- The following requirements are applicable when CS injection is performed on primary power lines.
- The conducted differential and common voltage emissions on secondary power bus, from the secondary DC supply voltages of the unit, shall not exceed the levels defined in the following figure :



- This requirement is applicable only to unit which provides power to other units (example : centralized DC/DC converter or EPC for CAMP)
- This requirement is applicable without CS injection on primary power input and with an CS injection on primary power input .

*

Reference **SBX-4CF-AD01-P3-REQ-161**

[FC Applicability: REPEATER, TCR]

Conducted Emissions on Secondary Power Bus on repeater and TCR

- **user Side**
- the conducted current emissions injected on each secondary power line, by an unit connected to a secondary power bus, shall not exceed 60 dBμA (RMS) from 10 Hz to 1 MHz, then decreasing at 20 dB/decade from 1 MHz to 10 MHz.

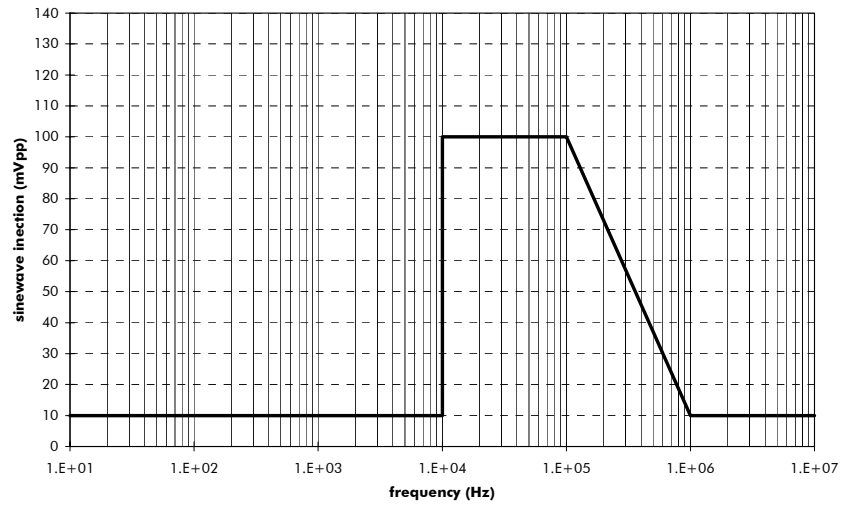
*

Reference **SBX-4CF-AD01-P3-REQ-160**

[FC Applicability: REPEATER, TCR]

Conducted Susceptibility on Secondary Power Bus User on repeater and TCR

- The unit, connected to a secondary power bus, shall meet all performance requirements when subjected to the following signal interference superimposed on the secondary input power bus :



*

8. CONDUCTED REQUIREMENTS ON SIGNAL LINES

8.1 Signal lines concerned by Conducted requirements

Reference **SBX-4CF-AD01-P3-REQ-062**

[FC Applicability: ALL CF (hardware)]

Signal interfaces	Source side		User side	
	CE	CS	CE	CS
ML-16 (SBDL type)	CE-1	NO	CE-1	NO
DS-16 (SBDL type)	CE-1	NO	CE-1	NO
SMU/Receiver (SBDL type)	CE-1	NO	CE-1	NO
SMU/transmitter (SBDL type)	CE-1	NO	CE-1	NO
Umbilical (SBDL type)	CE-1	NO	CE-1	NO
SMU/ciphering (SBDL type)	CE-1	NO	CE-1	NO
Alarm	CE-1	NO	CE-1	NO
Synchro	CE-1	NO	CE-1	NO
Digital bi level	CE-2	NO	CE-2	NO
Digital switch single ended (relay & opto)	CE-2	NO	CE-2	NO
Digital switch closure matrix	CE-3	NO	NO	CS-2
Analog TM	CE-4	NO	NO	CS-1
Thermistors	CE-4 (*)	NO	NO	CS-1
Standard pressure transducer TM	CE-4	NO	NO	CS-1
HAPT TM	CE-4	NO	NO	CS-1
Potentiometers (TM motors)	CE-4	NO	NO	CS-1
Micro switch & optical switch	CE-2	NO	CE-2	NO
Deployment strain gauge	NO	NO	NO	CS-1
Battery "analog measure"	NO	NO	NO	CS-1
Coarse sun sensor (CSS)	NO	NO	NO	CS-1
Wheel TC & TM	CE-2	NO	CE-2	NO
OBDH	CE-5	NO	CE-5	NO
1553	Refer to MIL-STD-1553B notice 4 § 4.5.2			

(*) : CE-4 applicable only if thermistor is located inside unit under test.

*

Reference **SBX-4CF-AD01-P3-REQ-063**

[FC Applicability: ALL CF (hardware)]

If equipment under test has more than 2 identical signal interfaces (same electrical design), a minimum of 2 of these interfaces shall be tested.

*

Reference **SBX-4CF-AD01-P3-REQ-064**

[FC Applicability: ALL CF (hardware)]

Equipment under test shall be in operational mode which maximize the conducted emissions (ex : motor command, ...).

*

8.2 Conducted Emission (CE) Requirements

8.2.1 CE-1

Reference **SBX-4CF-AD01-P3-REQ-065**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V limit measured in time domain :

- V limit = 100mVpp (pp = peak to peak)

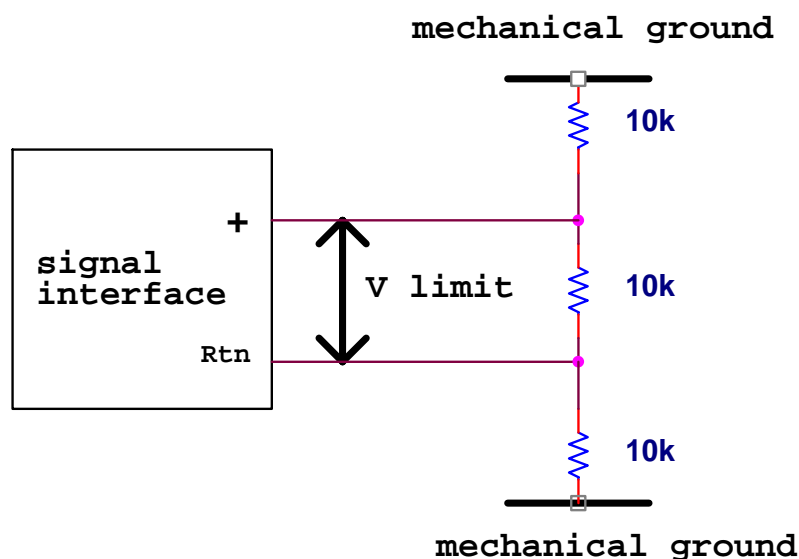
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-066**

[FC Applicability: ALL CF (hardware)]

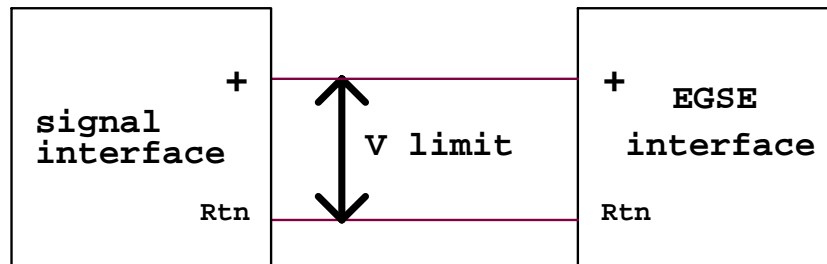
The following test set up (with 10K resistors) is preferred to measure the conducted emission



CE Measurements shall be included in the test report.

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

If EGSE is necessary to place EUT in operating mode, the following test set up can be used :



- EGSE electrical interface design shall be compliant with [AD1]
- EMC noise measurement (EGSE = ON , EUT = OFF) shall be performed.

*

8.2.2 CE-2

Reference **SBX-4CF-AD01-P3-REQ-067**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V limit measured in time domain :

- V limit = 300mVpp (pp = peak to peak)

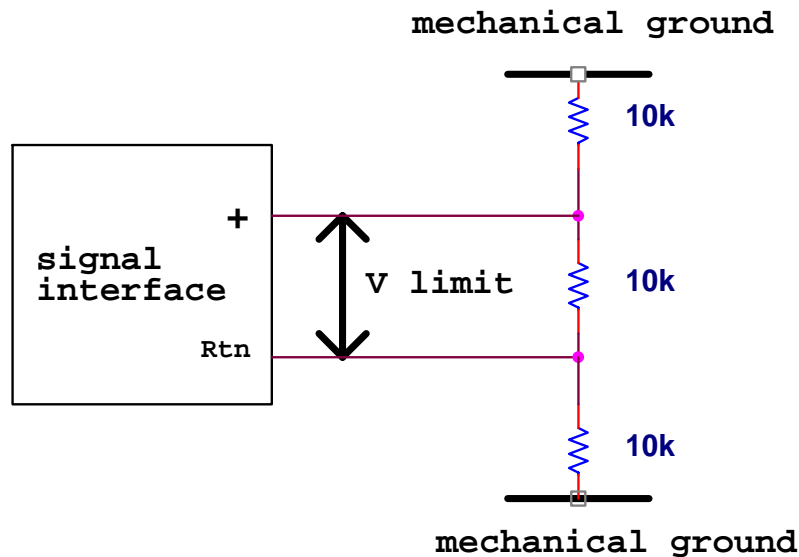
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-068**

[FC Applicability: ALL CF (hardware)]

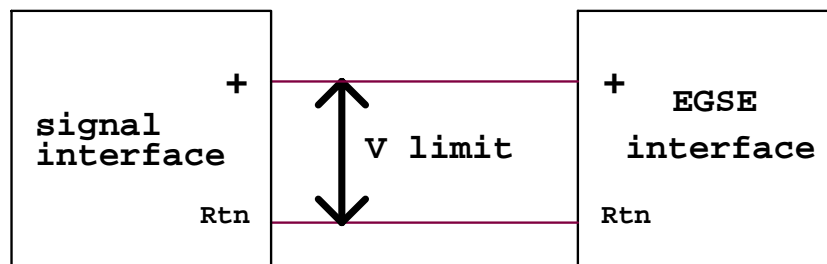
The following test set up (with 10K resistors) is preferred to measure the conducted emission



CE Measurements shall be included in the test report.

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

If EGSE is necessary to place EUT in operating mode, the following test set up can be used :



- EGSE electrical interface design shall be compliant with [AD1]
- EMC noise measurement (EGSE = ON , EUT = OFF) shall be performed.

*

8.2.3 CE-3

Reference **SBX-4CF-AD01-P3-REQ-069**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V limit measured in time domain :

Référence Fichier : SB4-6A-AS-SP-015_05.doc du 26/06/2009 10:02

THALES

Référence du modèle : 100173569N_06.dot

All rights reserved, 2007, Thales Alenia Space

- Vcm limit = 1Vpp (pp = peak to peak)

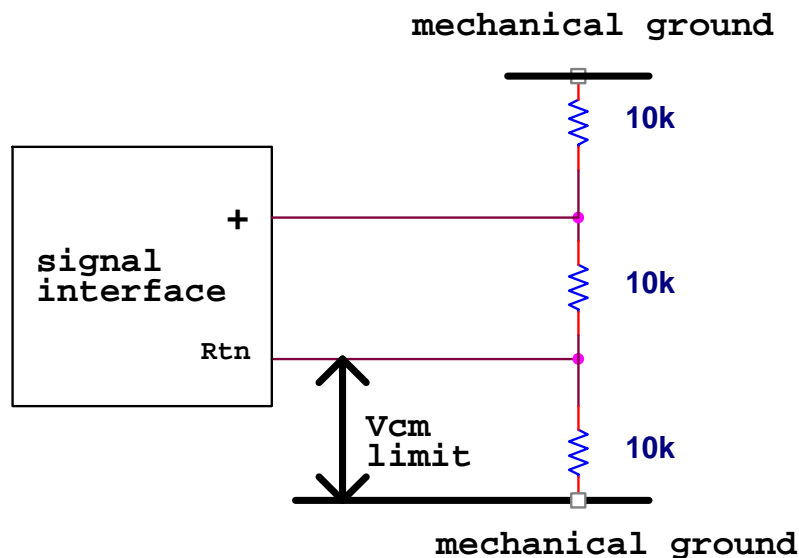
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-070**

[FC Applicability: ALL CF (hardware)]

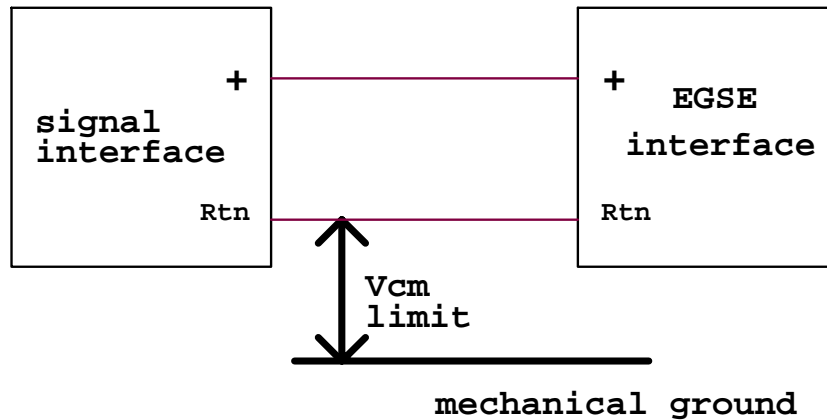
The following test set up (with 10K resistors) is preferred to measure the conducted emission



CE Measurements shall be included in the test report.

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

If EGSE is necessary to place EUT in operating mode, the following test set up can be used :



- EGSE electrical interface design shall be compliant with [AD1]
- EMC noise measurement (EGSE = ON , EUT = OFF) shall be performed.

*

8.2.4 CE-4

Reference **SBX-4CF-AD01-P3-REQ-071**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V limit measured in time domain :

- V limit = 100mVpp (pp = peak to peak)

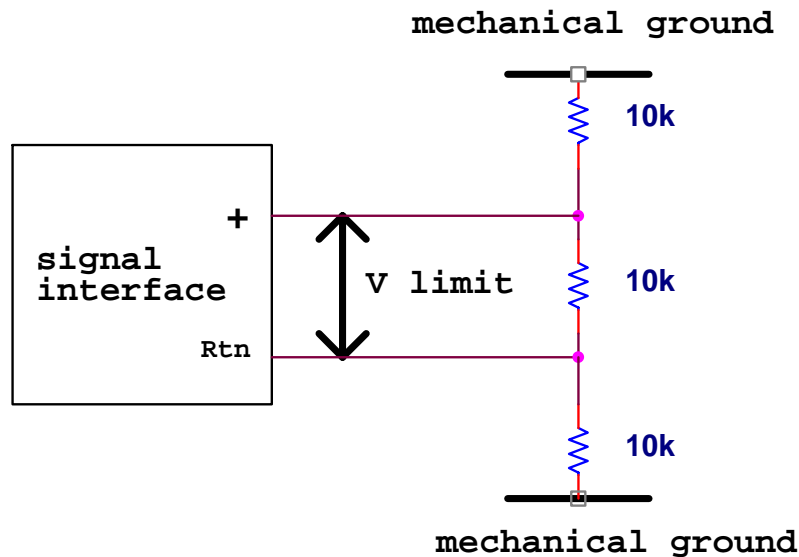
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-072**

[FC Applicability: ALL CF (hardware)]

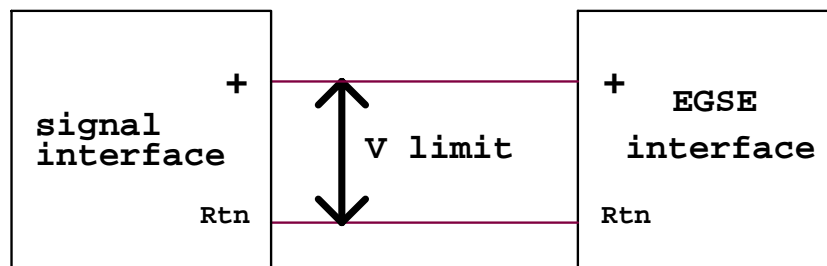
The following test set up (with 10K resistors) is preferred to measure the conducted emission



CE Measurements shall be included in the test report.

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

If EGSE is necessary to place EUT in operating mode, the following test set up can be used :



- EGSE electrical interface design shall be compliant with [AD1]
- EMC noise measurement (EGSE = ON , EUT = OFF) shall be performed.

*

Reference SBX-4CF-AD01-P3-REQ-073

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V limit measured in time domain :

- Vcm limit = 300mVpp (pp = peak to peak)

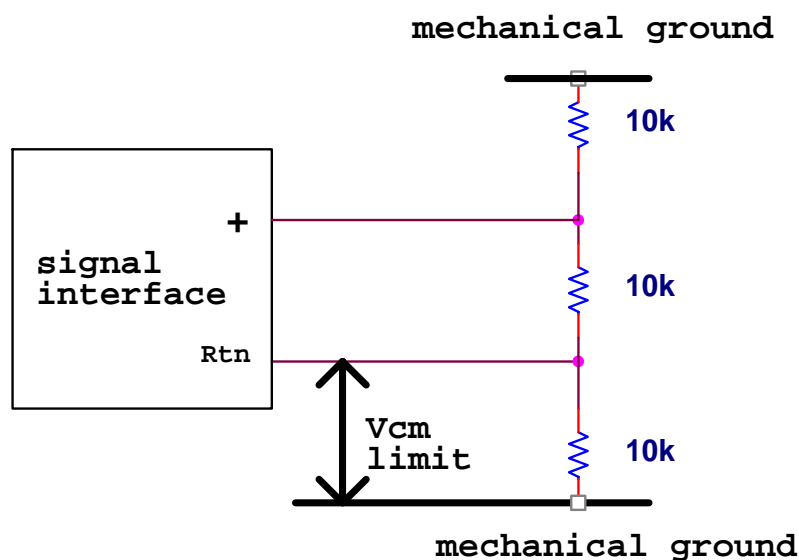
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-074**

[FC Applicability: ALL CF (hardware)]

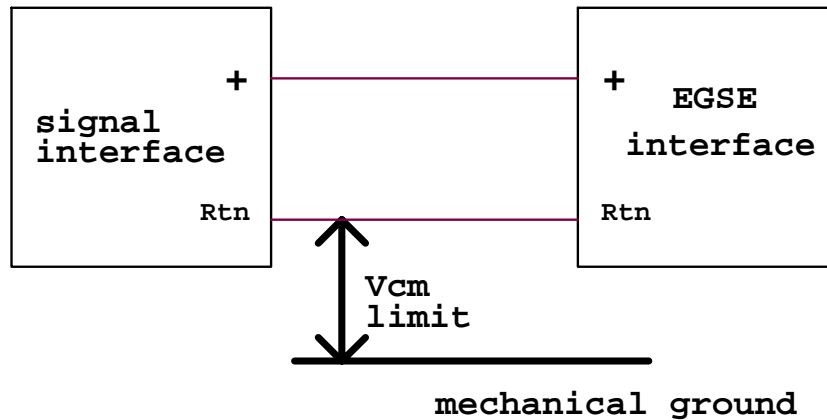
The following test set up (with 10K resistors) is preferred to measure the conducted emission



CE Measurements shall be included in the test report.

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

If EGSE is necessary to place EUT in operating mode, the following test set up can be used :



- EGSE electrical interface design shall be compliant with [AD1]
- EMC noise measurement (EGSE = ON , EUT = OFF) shall be performed.

*

8.2.5 CE-5 Conducted Emission for OBDH-485

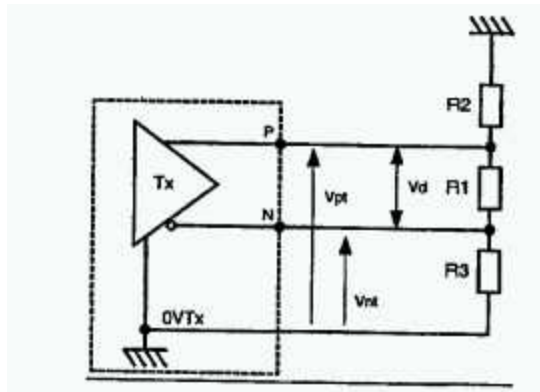
8.2.5.1 Conducted emission limits on driver interface

Reference **SBX-4CF-AD01-P3-REQ-075**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V_d (differential mode) measured in time domain on inactive bus driver while at least one other interface is under activity :

- $V_d \leq 30\text{mVpp}$



$R1 = 60\Omega$, $R2 = R3 = 22k\Omega$

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

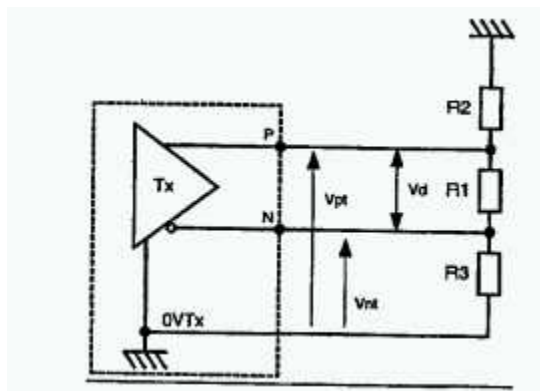
*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-076**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V_{pt} and V_{nt} (common mode) measured in time domain on inactive bus driver while at least one other interface is under activity :



- $V_{pt} \leq 150mV_{pp}$ and $V_{nt} \leq 150mV_{pp}$

$R1 = 60\Omega$, $R2 = R3 = 22k\Omega$

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-077**

[FC Applicability: ALL CF (hardware)]

If V_{pt} and/or V_{nt} (common mode measurements) are greater than the limit required, complementary V_{pt} & V_{nt} measurements with $R1 = 60\Omega$, $R2 = R3 = 10\Omega$ shall be performed and recorded in the test report.

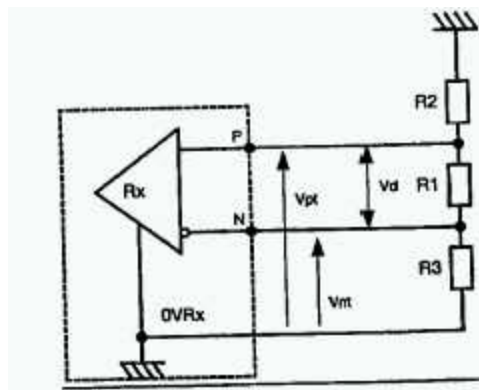
*

8.2.5.2 Conducted emission limits on receiver interface

Reference **SBX-4CF-AD01-P3-REQ-078**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V_d (differential mode) measured in time domain on inactive bus driver while at least one other interface is under activity :



- $V_d \leq 30mV_{pp}$

$R1 = 60\Omega$, $R2 = R3 = 22k\Omega$

Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

Note : “spikes “ shall be understood as single or repetitive voltage transient

*

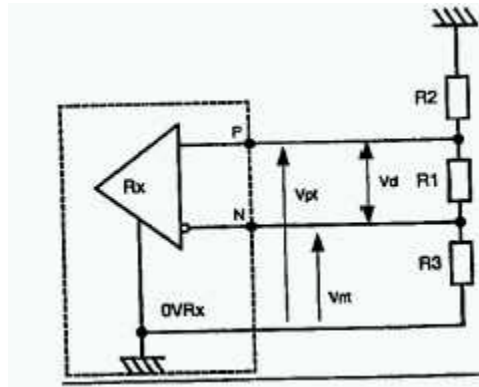
Reference **SBX-4CF-AD01-P3-REQ-079**

[FC Applicability: ALL CF (hardware)]

Conducted emission including spikes shall not exceed V_{pt} and V_{nt} (common mode) measured in time domain on inactive bus driver while at least one other interface is under activity :

- $V_{pt} \leq 150mV_{pp}$ and $V_{nt} \leq 150mV_{pp}$

$R1 = 60\Omega$, $R2 = R3 = 22k\Omega$



Refer to section 13.8.5 for the time domain measurement (voltage probe & oscilloscope)

*

Note : “spikes “ shall be understood as single or repetitive voltage transient

Reference **SBX-4CF-AD01-P3-REQ-080**

[FC Applicability: ALL CF (hardware)]

If V_{pt} and/or V_{nt} (common mode measurements) are greater than the limit required, complementary V_{pt} & V_{nt} measurements with $R1 = 60\Omega$, $R2 = R3 = 10\Omega$ shall be performed and recorded in the test report.

*

8.3 Conducted susceptibility on signal lines

8.3.1 CS-1

Reference **SBX-4CF-AD01-P3-REQ-081**

[FC Applicability: ALL CF (hardware)]

Conducted susceptibility requirement applicable in differential mode (between $In+$ and $In-$) :

- Amplitude peak to peak = 1V with an injected current limitation = 30mA

CS signal waveform :

- sine carrier 100% modulated by a square wave :
- duration of the burst : 1 μ s

- burst repetition : 100KHz
- frequency range of the sine carrier : 3MHz to 30MHz.

*

Reference SBX-4CF-AD01-P3-REQ-082

[FC Applicability: ALL CF (hardware)]

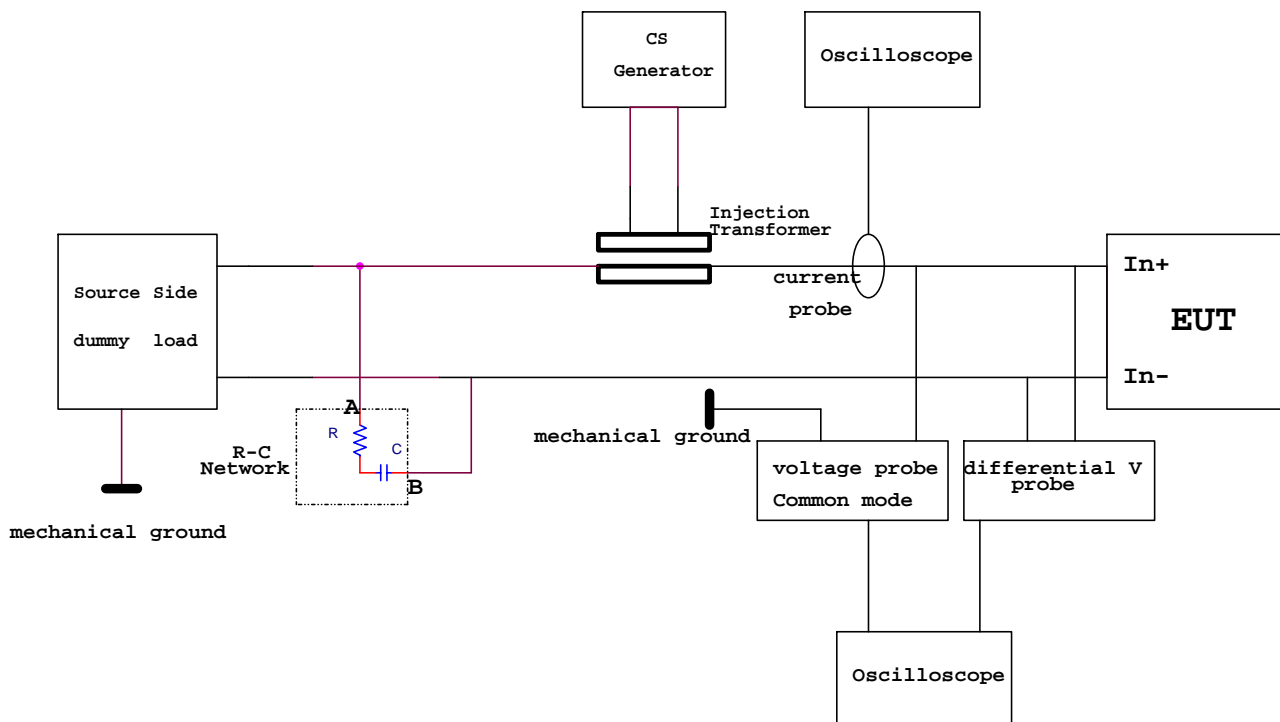
Equipment shall not exhibit failure or unintended responses when subjected to CS on signal lines

*

Reference SBX-4CF-AD01-P3-REQ-083

[FC Applicability: ALL CF (hardware)]

To perform CS test in differential mode (between In+ and In-), the following test set up is requested :



- R-C network definition : R value in the range 10Ω - 20Ω , $C = 10\text{nF}$
- R-C network connection : **A** connected to In+ line and **B** connected to In- line
- refer to [AD1] for source side dummy load
- Injection by transformer or dedicated probe

-
- Current injection control with a probe clamped on In+ line
 - Voltage injection control between In+ and In- with a differential voltage probe
 - Voltage injection control between In+ and mechanical ground with a voltage probe connected between In+ line and mechanical ground.
 - CS Voltage amplitude (peak to peak value) between In+ and mechanical ground shall not exceed 2.8Vpp.
-

*

Reference **SBX-4CF-AD01-P3-REQ-084**

[FC Applicability: ALL CF (hardware)]

Conducted susceptibility requirement applicable in common mode (between In+ and mechanical ground) :

- Amplitude peak to peak = 2.8V with an injected current limitation = 30mA

CS signal waveform :

- sine carrier 100% modulated by a square wave :
 - duration of the burst : 1μs
 - burst repetition : 100KHz
 - frequency range of the sine carrier : 3MHz to 30MHz.
-

*

Reference **SBX-4CF-AD01-P3-REQ-085**

[FC Applicability: ALL CF (hardware)]

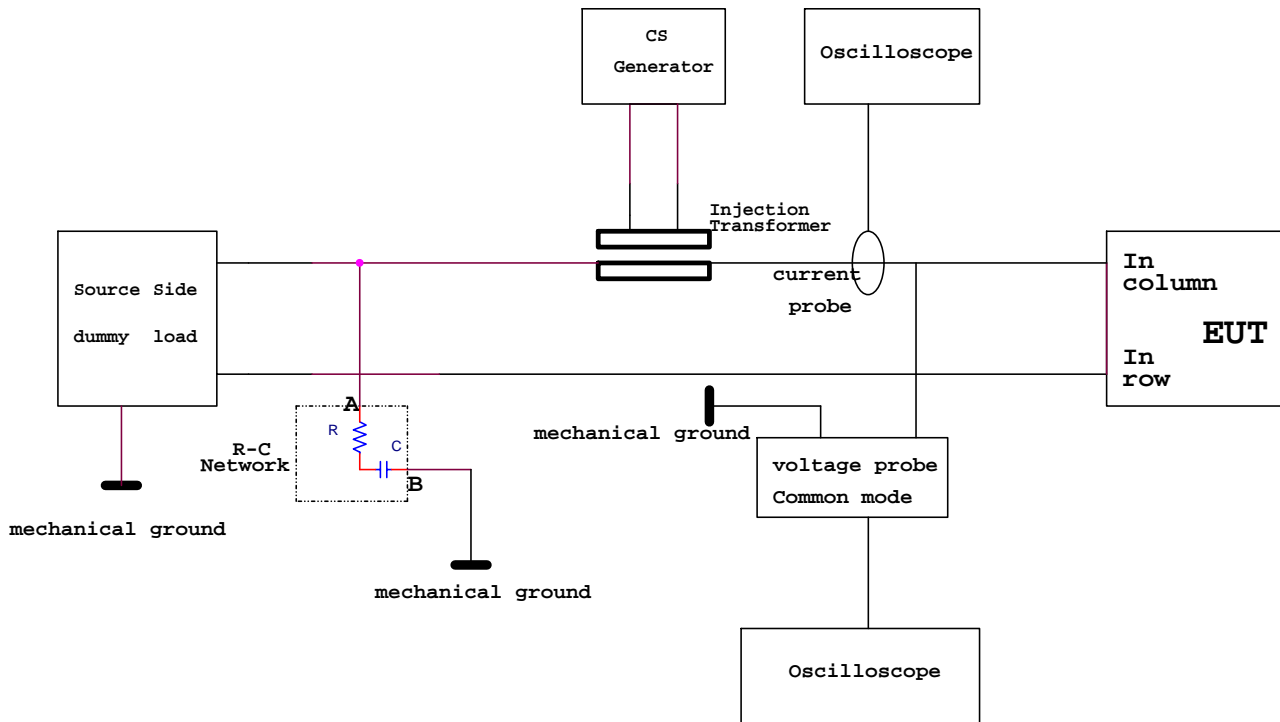
Equipment shall not exhibit failure or unintended responses when subjected to CS on signal lines

*

Reference **SBX-4CF-AD01-P3-REQ-086**

[FC Applicability: ALL CF (hardware)]

To perform CS test (between In+ and mechanical ground), the following test set up is requested :



- R-C network definition : R value in the range 10Ω - 20Ω , $C = 10\text{nF}$
- R-C network connection : **A** connected to In+ line and **B** connected to mechanical ground
- refer to [AD1] for source side dummy load
- Injection by transformer or dedicated probe
- Current injection control with a probe clamped on In+ line
- Voltage injection control between In+ and Mechanical ground with a voltage probe connected between In+ line and mechanical ground.
- Voltage injection control between In+ and In- with a differential voltage probe connected between In+ line and In- line.
- CS Voltage amplitude (peak to peak value) between In+ and In- shall not exceed 1Vpp.

*

Reference SBX-4CF-AD01-P3-REQ-087

[FC Applicability: ALL CF (hardware)]

For each CS frequency, injected voltage amplitude (between In+ and In-), injected voltage amplitude (between In+ and mechanical ground) and Injected current amplitude (on line In+ shall be recorded.

*

Reference SBX-4CF-AD01-P3-REQ-088

[FC Applicability: ALL CF (hardware)]

If susceptibilities are observed during the test, the CS susceptibility threshold shall be identified :

CS frequency, injected voltage amplitude (between In+ and In-), injected voltage amplitude (between In+ and mechanical ground) and Injected current amplitude (on line In+).

*

8.3.2 CS-2

Reference SBX-4CF-AD01-P3-REQ-089

[FC Applicability: ALL CF (hardware)]

Conducted susceptibility requirement applicable between matrix switch closure acquisition column input and mechanical ground (refer to [AD1]) :

- Amplitude peak to peak = 2.8V with an injected current limitation = 30mA

CS signal waveform :

- sine carrier 100% modulated by a square wave :
- duration of the burst : 1μs
- burst repetition : 100KHz
- frequency range of the sine carrier : 3MHz to 30MHz.

*

Reference SBX-4CF-AD01-P3-REQ-090

[FC Applicability: ALL CF (hardware)]

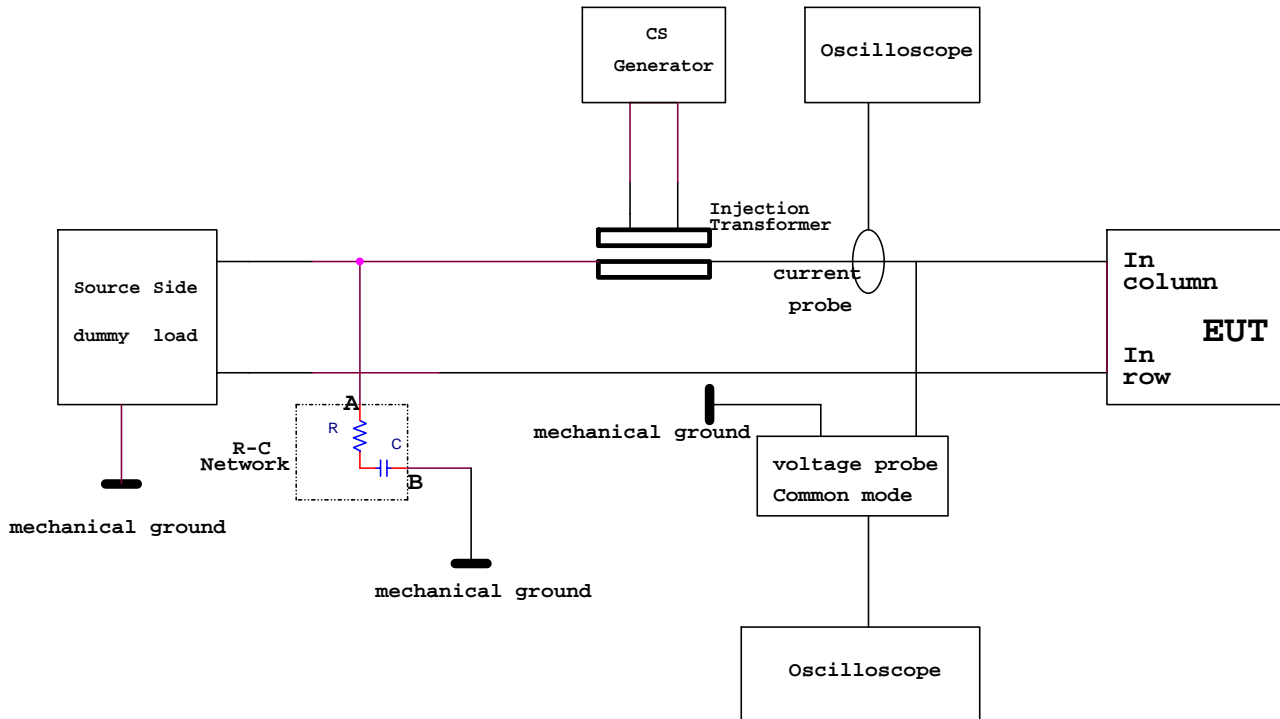
Equipment shall not exhibit failure or unintended responses when subjected to CS on signal lines

*

Reference SBX-4CF-AD01-P3-REQ-091

[FC Applicability: ALL CF (hardware)]

To perform CS test between witch closure acquisition column input and Mechanical ground, the following test set up is requested :



- R-C network definition : R value in the range 10Ω - 20Ω , $C = 10\text{nF}$
- R-C network connection : **A** connected to In+ line and **B** connected to mechanical ground
- refer to [AD1] for source side dummy load
- Injection by transformer or dedicated probe
- Current injection control with a probe clamped on In column line
- Voltage injection control between In column line and Mechanical ground with a voltage probe

*

Reference **SBX-4CF-AD01-P3-REQ-092**

[FC Applicability: ALL CF (hardware)]

For each CS frequency, injected voltage amplitude and Injected current amplitude shall be recorded.

*

Reference **SBX-4CF-AD01-P3-REQ-093**

[FC Applicability: ALL CF (hardware)]



REFERENCE: SB4-6A-AS-SP-015

DATE: 23/04/09

ISSUE: 05

PAGE: 63/87

If susceptibilities are observed during the test, the CS susceptibility threshold shall be identified :

CS frequency, injected voltage amplitude and Injected current amplitude.

*

9. ELECTRIC FIELD RADIATED REQUIREMENTS

9.1 Radiated emission - general requirements

Reference **SBX-4CF-AD01-P3-REQ-094**

[FC Applicability: ALL CF (hardware)]

Radiated emission limits are defined at 1 meter distance from unit fitted with its harness. Intentional and unintentional radiated emissions through the harness shall be included in the limit specification.

*

Reference **SBX-4CF-AD01-P3-REQ-095**

[FC Applicability: ALL CF (hardware)]

For RF equipments Radiated emission limits are applicable considering EUT connected to RF passive loads or EGSE.

*

Reference **SBX-4CF-AD01-P3-REQ-096**

[FC Applicability: ALL CF (hardware)]

Radiated emission limits are defined in narrow frequency band (refer to section 13 for the test conditions).

*

Reference **SBX-4CF-AD01-P3-REQ-097**

[FC Applicability: ALL CF (hardware)]

Radiated emission measurements shall be performed in Horizontal and Vertical polarizations of the test antenna.

*

Reference **SBX-4CF-AD01-P3-REQ-098**

[FC Applicability: ALL CF (hardware)]

Radiated emission limits (r.m.s value) applicable in transfer, orbit and emergency phases :

- **70dB μ V/m** from 30MHz to 40000MHz
- **30dB μ V/m** in the following slots (Telecom payload uplinks bands) :
 - L-Band : 1610MHz - 1710MHz
 - S-Band : 1980MHz - 2110MHz & 2655MHz - 2690MHz
 - C-Band : 5725MHz - 7075MHz

-
- X-Band : 7900MHz - 8400MHz
 - Ku-Band : 12950MHz - 14800MHz & 17300MHz - 18100MHz
 - Ka-Band : 27500MHz - 31000MHz
 - EHF-Band : 43500MHz - 45500MHz
 - **90dBμV/m** in the following slots (Telecom payload downlink bands) :
 - L-Band : 1490MHz - 1560MHz
 - S-Band : 2160MHz - 2220MHz & 2480MHz - 2535MHz
 - C-Band : 3400MHz - 4200MHz & 4500MHz - 4800MHz
 - X-Band : 7250MHz - 7750MHz
 - Ku-Band : 10700MHz - 12750MHz
 - Ka-Band : 17700MHz - 21200MHz
-

*

Reference **SBX-4CF-AD01-P3-REQ-099**

[FC Applicability: ALL CF (hardware)]

Radiated emission limits (r.m.s value) for equipments ON during launch phase in slots corresponding to launch vehicles uplinks bands :

- **17dBμV/m** in the 400MHz - 500MHz band (HII-A & ATLAS)
 - **35dBμV/m** in the 408MHz - 480MHz band (AR5 & Delta)
 - **30dBμV/m** in the 600MHz - 700MHz band (LM)
 - **20dBμV/m** in the 762MHz - 776MHz (Sea Launch, Proton K)
 - **30dBμV/m** in the 1500MHz - 1650MHz (Proton M & LM)
 - **20dBμV/m** in the 1572MHz - 1579MHz (LM)
 - **35dBμV/m** in the 2025MHz - 2110MHz band (AR5)
 - **30dBμV/m** in the 5450MHz - 5910MHz (Proton M, LM, AR5, Delta, ATLAS)
 - **45dBμV/m** in the 5925MHz - 7075MHz (AR5)
 - **55dBμV/m** in the 14000MHz - 14800MHz (AR5)
-

*

Reference **SBX-4CF-AD01-P3-REQ-100**

[FC Applicability: ALL CF (hardware)]

For non RF/IF equipments RE tests shall be performed up to 3GHz.

*

Reference SBX-4CF-AD01-P3-REQ-150

[FC Applicability: REPEATER, TCR]

For RF/IF equipments, improvement of RE tests is possible :
RE sniff tests approved by the prime,
reverberation Chamber method approved by the prime.

*

9.2 Radiated emission - specific test set up for electrical propulsion thrusters

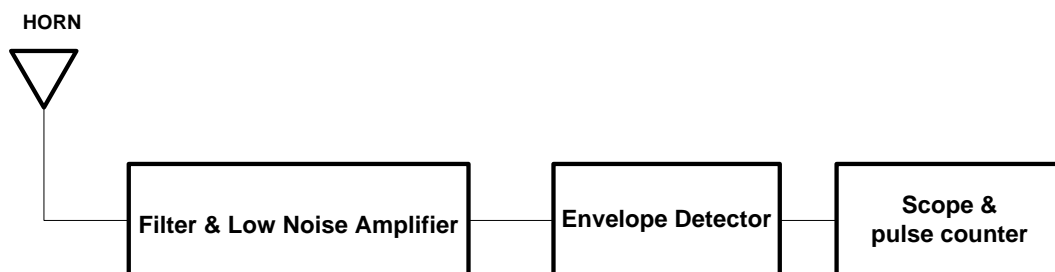
It's recognized that radiated E field by electrical propulsion thrusters is impulsive with spectral band larger than the payload receiver bandwidth.

In consequence, standard measurement method (frequency narrow band measurement) is not sufficient to assess the perturbation risk of the payload receivers).

Reference SBX-4CF-AD01-P3-REQ-101

[FC Applicability: PROP-P]

EMC test plan shall include an instrumentation able to characterize in telecom payload uplinks the peak amplitude of the broadband emission, the pulse duration and the time occurrence.



A test set up based on the following principle shall be used :

- * the chain (Filter, LNA) detect the radiated emission in selected frequency band (telecom payload uplinks bands)
- * Wide band envelope detector able to characterize the pulse envelope in time domain (pulse width expected in the range 10ns - 200ns)
- * digital oscilloscope with a sufficient BP (min 500MHz recommended) to measure pulse characteristic
- * the pulse counter function allow to characterize the time occurrence versus the scope trigger level defining a trigger level of radiated emission amplitude.

*

9.3 Radiated susceptibility requirements

Reference **SBX-4CF-AD01-P3-REQ-102**

[FC Applicability: ALL CF (hardware)]

- Limit for units located inside satellite structure :

Over the frequency range defined hereinafter the unit fitted with its harness shall meet all performance requirements during E-filed radiated susceptibility tests.

From 30MHz to 40000MHz (*) : **E = 1V/m (rms)**

Except in the following slots (Telecom payload downlink bands) : **E = 10V/m (rms)**

- L-Band : 1490MHz - 1560MHz
- S-Band : 2160MHz - 2220MHz & 2480MHz - 2535MHz
- C-Band : 3400MHz - 4200MHz & 4500MHz - 4800MHz
- X-Band : 7250MHz - 7750MHz
- Ku-Band : 10700MHz - 12750MHz
- Ka-Band : 17700MHz - 21200MHz

(*) : For non RF/IF units equipments the frequency range can be limited to 30MHz - 18000MHz

*

Reference **SBX-4CF-AD01-P3-REQ-103**

[FC Applicability: ALL CF (hardware)]

- Limit for units located outside satellite structure :

Over the frequency range defined hereinafter the unit fitted with its harness shall meet all performance requirements during E-filed radiated susceptibility tests.

From 30MHz to 40000MHz (*) : **E = 1V/m (rms)**

Except in the following slots (Telecom payload downlink bands) :

- **E = 200V/m (rms)** in L-Band : 1490MHz - 1560MHz
- **E = 200V/m (rms)** in S-Band : 2160MHz - 2220MHz & 2480MHz - 2535MHz
- **E = 200V/m (rms)** in C-Band : 3400MHz - 4200MHz & 4500MHz - 4800MHz
- **E = 200V/m (rms)** in X-Band : 7250MHz - 7750MHz
- **E = 200V/m (rms)** in Ku-Band : 10700MHz - 12750MHz
- **E = 200V/m (rms)** in Ka-Band : 17700MHz - 21200MHz

(*) : For non RF/IF units equipments the frequency range can be limited to 30MHz - 18000MHz

*

Reference **SBX-4CF-AD01-P3-REQ-104**

[FC Applicability: REPEATER, TCR]

- Limit for RF receivers at their Rx frequency and image frequency :

RF receiver fitted with its harness shall meet all performance requirements during E-filed radiated susceptibility tests.

- **E = 5.6mV/m (rms)** at its Rx frequency

*

Reference **SBX-4CF-AD01-P3-REQ-105**

[FC Applicability: ALL CF (hardware)]

Units ON during launch phase fitted with their harness shall meet all performance requirements during E-filed radiated susceptibility tests in the following frequency slots :

- 1000MHz - 1500MHz (AR5)
- 20V/m (rms) for units outside the satellite structure.
- 2200MHz - 2500MHz (AR5, Delta, Atlas, LM, Sea Launch)
- 50V/m (rms) for units outside the satellite structure.
- 2900MHz - 3400MHz (AR5)
- 20V/m (rms) for units outside the satellite structure.
- 5400MHz - 5900MHz (ATLAS, AR5, Delta) :
 - 200V/m (rms) for units outside the satellite structure,
 - 10V/m (rms) for units inside the satellite structure.

*

Reference **SBX-4CF-AD01-P3-REQ-151**

[FC Applicability: ALL CF (hardware)]

Units OFF during launch phase and outside of the spacecraft shall not be degraded by the E field defined inside the previous requirement.

*

Reference **SBX-4CF-AD01-P3-REQ-106**

[FC Applicability: ALL CF (hardware)]

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

*

Reference **SBX-4CF-AD01-P3-REQ-107**

[FC Applicability: ALL CF (hardware)]

Radiated susceptibility tests shall be performed in both horizontal and vertical polarisations.



REFERENCE: SB4-6A-AS-SP-015

DATE: 23/04/09

ISSUE: 05

PAGE: 69/87

*

Reference **SBX-4CF-AD01-P3-REQ-152**

[FC Applicability: REPEATER, TCR]

For RF/IF equipments, improvement of RS tests is possible :
RS spray tests approved by the prime,
reverberation Chamber method approved by the prime.

*

10. MAGNETIC REQUIREMENTS

Reference **SBX-4CF-AD01-P3-REQ-108**

[FC Applicability: ALL CF (hardware)]

for all units excepted battery and TWT

Magnetic moment module (M) of fully operational equipment shall not exceed 0.5 Am^2 in any direction.

Magnetic components projection (Mx, My, Mz) on each axis (X,Y,Z) shall be provided :

$$M = \sqrt{(M_x)^2 + (M_y)^2 + (M_z)^2}$$

*

Reference **SBX-4CF-AD01-P3-REQ-109**

[FC Applicability: POWER]

for battery

Magnetic moment amplitude (M) of each battery module shall not exceed in any direction :

- $3\text{Am}^2 + [0.3 \text{ Am}^2 \times \text{Ibat}]$,

Ibat : maximum charge current & discharge current specified for battery module.

Magnetic components projection (Mx, My, Mz) on each axis (X,Y,Z) shall be provided :

$$M = \sqrt{(M_x)^2 + (M_y)^2 + (M_z)^2}$$

*

Reference **SBX-4CF-AD01-P3-REQ-110**

[FC Applicability: REPEATER]

for TWT

Magnetic moment module (M) of fully operational equipment shall not exceed 1.0 Am^2 in any direction.

Magnetic components projection (Mx, My, Mz) on each axis (X,Y,Z) shall be provided :

$$M = \sqrt{(M_x)^2 + (M_y)^2 + (M_z)^2}$$

*

Reference **SBX-4CF-AD01-P3-REQ-111**

[FC Applicability: ALL CF (hardware)]

If the magnetic moment is calculated from DC H field measurement, it's recommended to perform measurements at a minimum distance from the unit corresponding to 2 times of the largest unit dimension.

*

Reference **SBX-4CF-AD01-P3-REQ-112**

[FC Applicability: SYSTEM]

Units arrangement shall be operated to compensate the total magnetic moment on the satellite under the limit defined hereinafter :

Platform	12 Am ² including battery
Solar array	2 Am ² including failure of one panel section
Repeater	20 Am ²
Plasma propulsion subsystem	3 Am ² PPS in OFF state 17 Am ² in operating mode

Note : the main units concerned by the compensation arrangement are :
battery modules for Platform
TWT and HPI for repeater

*

Reference **SBX-4CF-AD01-P3-REQ-113**

[FC Applicability: ALL CF (hardware)]

Equipment shall not exhibit failure and unintended responses during and after application of DC H -field = 180dBpT (1E-3 Tesla) in the 3 axis (X,Y,Z).

*



11. REPEATER AND TTC/RF PASSIVE SHIELDING EFFICIENCY

Reference **SBX-4CF-AD01-P3-REQ-114**

[FC Applicability: REPEATER, TCR]

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 section (before the TWTA) and **-65dBi** for the units of the repeater output section (after the TWTA) and TTC-RF subsystem, at working frequency range.

*

Reference **SBX-4CF-AD01-P3-REQ-115**

[FC Applicability: REPEATER, TCR]

The shielding effectiveness of the unit shall be measured from RE sniff test or RS spray test methods or reverberation chamber method approved by the prime.

*

12. SUSCEPTIBILITY TO ELECTROSTATIC DISCHARGES

Reference **SBX-4CF-AD01-P3-REQ-116**

[FC Applicability: ALL CF (hardware)]

The unit (or group of units) under test fitted with its test harness shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances indicated in the corresponding unit specification when subjected to : discharges into unit structure and discharge into a wire inside the bundle.

The discharge current signal shall have the following characteristics :

- amplitude: 50 A peak min
- duration: 50 nsec
- rise time: 10 ns

*

Reference **SBX-4CF-AD01-P3-REQ-117**

[FC Applicability: ALL CF (hardware)]

the ESD pulse discharge shall be applied at a pulse rate of about 1 per second for a period of 30 seconds

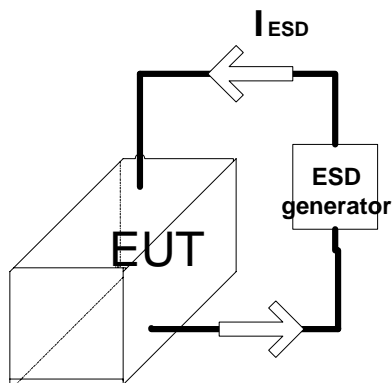
*

Reference **SBX-4CF-AD01-P3-REQ-118**

[FC Applicability: ALL CF (hardware)]

The discharges test into unit structure shall be accomplished by using diametrically opposed locations through the unit structure.

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



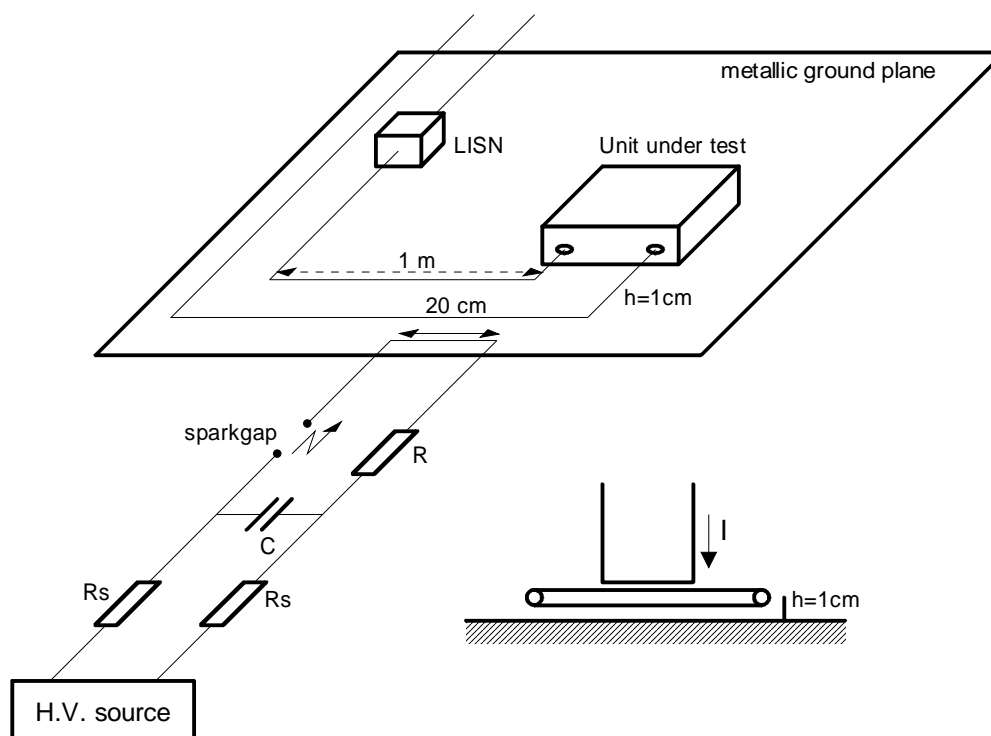
*

Reference **SBX-4CF-AD01-P3-REQ-119**

[FC Applicability: ALL CF (hardware)]

The ESD test set-up for discharge into a wire inside the bundle shall be as follow:

The distance of the parallel wire inside the bundle shall be 0.2 m and shall be as close as possible to the bundle.



*

Reference **SBX-4CF-AD01-P3-REQ-120**

[FC Applicability: ALL CF (hardware)]

in order to get the proper required ESD current, the component values of ESD generator used for REQ-118 & REQ-119 shall be adjusted around the following typical recommended values :

- Decoupling resistor : $R_s \approx 4.7k\Omega$
- Discharge capacitor : $C \geq 50pF$
- Discharge resistor : $R \approx 100\Omega$
- Spark gap voltage : $V_{spark} = 6kV$

*

13. GENERAL TEST CONDITIONS

Tests conditions are based on MIL-STD-461E general requirements.

These general requirements are modified /completed to take into account SB4000 satellite design and dedicated EMC requirements.

13.1 Measurement tolerances

Reference **SBX-4CF-AD01-P3-REQ-121**

[FC Applicability: ALL CF (hardware)]

Unless otherwise stated for a particular measurement, the tolerance shall be as follows:

- Distance: $\pm 5\%$
- Frequency: $\pm 2\%$
- Amplitude, measurement receiver: ± 2 dB
- Amplitude, measurement system (includes measurement receivers, transducers, cables, and so forth): ± 3 dB
- Time (waveforms): $\pm 5\%$
- Resistors: $\pm 5\%$
- Capacitors: $\pm 20\%$

*

13.2 Ambient electromagnetic level

Reference **SBX-4CF-AD01-P3-REQ-122**

[FC Applicability: ALL CF (hardware)]

During CE & RE testing, the ambient electromagnetic level measured with the EUT 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.

*

13.3 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.

Reference SBX-4CF-AD01-P3-REQ-123

[FC Applicability: ALL CF (hardware)]

Shielded enclosures must have adequate attenuation such that the ambient requirements of paragraph "Ambient electromagnetic level" are satisfied.

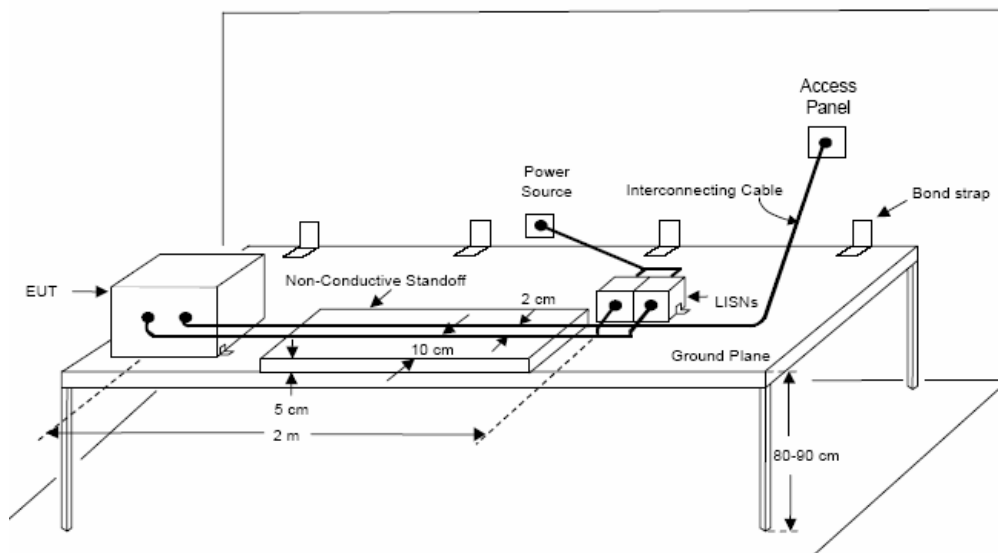
*

13.4 Ground plane

Reference SBX-4CF-AD01-P3-REQ-124

[FC Applicability: ALL CF (hardware)]

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



*

Reference SBX-4CF-AD01-P3-REQ-125

[FC Applicability: ALL CF (hardware)]

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.

*

Reference SBX-4CF-AD01-P3-REQ-126

[FC Applicability: ALL CF (hardware)]

The metallic ground plane shall be electrically bonded to the floor or wall of the basic shielded room structure at least once every 1 meter. The metallic bond straps shall be solid and maintain a five-to-one ratio or less in length to width.

13.5 EUT test configurations

13.5.1 Bonding of EUT

Reference SBX-4CF-AD01-P3-REQ-127

[FC Applicability: ALL CF (hardware)]

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. When bonding straps are required, they shall be identical to those specified in the installation drawings.

SB4000 satellite bonding requirements : DC resistance $\leq 5 \text{ m}\Omega$, inductance $\leq 100\text{nH}$.

*

13.5.2 Orientation of EUT

Reference SBX-4CF-AD01-P3-REQ-128

[FC Applicability: ALL CF (hardware)]

EUT shall be oriented such that surfaces which produce maximum radiated emissions face the measurement antennas.

*

Reference SBX-4CF-AD01-P3-REQ-129

[FC Applicability: ALL CF (hardware)]

EUT shall be oriented to maximize the sensitivity to susceptibility tests.

*

13.5.3 Construction and arrangement of EUT cables

Reference SBX-4CF-AD01-P3-REQ-130

[FC Applicability: ALL CF (hardware)]

The EUT shall be set up with following harness definition that simulates flight harness in shielding presence and terminations, twisting, ground and wiring properties. If no particular definition is given by the prime, the following general definition shall be considered :

- Shielded twisted pair with shield pig tail connection (length 3cm to 5cm) to the connector back shell for :
 - ◆ Memory load commands,
 - ◆ Digital serial telemetry,

-
- ◆ Umbilical telemetry compliant to TM video signal,
 - ◆ SMU- transceivers,
 - ◆ SMU - (STR,IRES,AOCSP,PROP) alarm,
 - ◆ SMU - (STR,AOCSP,PROP) synchronization (1Hz, 10Hz, 1KHz),
 - ◆ AOCSP - coarse sun sensor
 - ◆ OBDH & 1553 data bus
 - ◆ EED
 - nominal coaxial cables for RF interfaces
 - unshielded for others :
 - ◆ twisted pairs for differential interfaces
 - ◆ single wire for non differential interfaces

Refer to [AD1] section 2 for electrical design and interfaces requirements.

*

Reference **SBX-4CF-AD01-P3-REQ-131**

[FC Applicability: ALL CF (hardware)]

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

*

13.5.4 Interfaces of EUT

Reference **SBX-4CF-AD01-P3-REQ-132**

[FC Applicability: ALL CF (hardware)]

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.

Refer to AD1 section 2 for electrical design and interfaces requirements.

*

Reference **SBX-4CF-AD01-P3-REQ-133**

[FC Applicability: ALL CF (hardware)]

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.

*

Reference **SBX-4CF-AD01-P3-REQ-134**

[FC Applicability: REPEATER, TCR]

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

*

13.6 Operation of EUT

Reference **SBX-4CF-AD01-P3-REQ-135**

[FC Applicability: ALL CF (hardware)]

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.

*

13.7 Detector

Reference **SBX-4CF-AD01-P3-REQ-136**

[FC Applicability: ALL CF (hardware)]

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. When other measurement devices such as oscilloscopes, non-selective voltmeters, or broadband field strength sensors are used for susceptibility testing, correction factors shall be applied for test signals to adjust the reading to equivalent RMS values under the peak of the modulation envelope.

*

13.8 Emission testing

13.8.1 bandwidths

Reference **SBX-4CF-AD01-P3-REQ-137**

[FC Applicability: ALL CF (hardware)]

The measurement receiver bandwidths listed in table “Bandwidth and measurement time emissions” shall be used for emission testing. These bandwidths are specified at the 6 dB

down points for the overall selectivity curve of the receivers. Video filtering shall not be used to bandwidth limit the receiver response. If a controlled video bandwidth is available on the measurement receiver, it shall be set to its greatest value. 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	6 dB Bandwidth	Dwell Time	Minimum Measurement Time Analog Measurement Receiver
30 Hz - 1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz - 10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz - 150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz - 30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz - 1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
Above 1 GHz	1 MHz	0.015 sec	15 sec/GHz

*

13.8.2 Emission identification

Reference **SBX-4CF-AD01-P3-REQ-138**

[FC Applicability: ALL CF (hardware)]

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

*

13.8.3 Frequency scanning

Reference **SBX-4CF-AD01-P3-REQ-139**

[FC Applicability: ALL CF (hardware)]

For emission measurements, the entire frequency range for each applicable test shall be scanned. Minimum measurement time for analog measurement receivers during emission testing shall be as specified in table "Bandwidth and measurement time emissions". Synthesized measurement receivers shall step in one-half bandwidth increments or less, and the measurement dwell time shall be as specified in table "Bandwidth and measurement time emissions". For equipment that operates such that potential emissions are produced at only infrequent intervals, times for frequency scanning shall be increased as necessary to capture any emission.

*

13.8.4 Emission data presentation

Reference **SBX-4CF-AD01-P3-REQ-140**

[FC Applicability: ALL CF (hardware)]

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.

*

13.8.5 Time domain measurements using oscilloscope

Reference **SBX-4CF-AD01-P3-REQ-141**

[FC Applicability: ALL CF (hardware)]

A minimum bandwidth of 100MHz is required for oscilloscope and its associated current and voltage probe. 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 like spikes emission. The time base of the first plot shall be tuned to characterize the repetition time of the spike, and the time base of the second plot shall be tuned to characterize the spike (amplitude, duration, damped oscillation).

*

13.9 Susceptibility testing

13.9.1 Frequency scanning

Reference **SBX-4CF-AD01-P3-REQ-142**

[FC Applicability: ALL CF (hardware)]

The entire frequency range for each applicable susceptibility tests shall be scanned.

*

Reference **SBX-4CF-AD01-P3-REQ-143**

[FC Applicability: ALL CF (hardware)]

Stepped scans (for signal source sequentially tuned to discrete frequencies) shall dwell with a time duration longer than the response time of the unit under test. If continuously tuned signal source is used, scan rate (ΔF /second) shall be adapted to not have a significant frequency variation during the response time of the unit under test.

*

Reference **SBX-4CF-AD01-P3-REQ-144**

[FC Applicability: ALL CF (hardware)]

Step size shall be as short as possible and adapted to the frequency range tested (RS tests inside TX frequency slots, around eventual susceptibility zone of the unit, ...) to allow an accurate and confident observation of the unit behavior.

Minimum and Maximum recommended step size resolution are given hereinafter :

- Minimum resolution
 - 30Hz - 3KHz : 4 points / decade
 - 3kHz - 300KHz : 10 points / decade
 - 300kHz - 30MHz : 20 points /decade
 - 30MHz - 1000MHz : step size = 5MHz
 - 1000MHz - 22000MHz : step size = 100MHz
- Maximum resolution (MIL-STD 461-E recommendation)

Frequency Range	Analog Scans Maximum Scan Rates	Stepped Scans Maximum Step Size
30 Hz - 1 MHz	0.0333 f ₀ /s	0.05 f ₀
1 MHz – 30 MHz	0.00667 f ₀ /s	0.01 f ₀
30 MHz - 1 GHz	0.00333 f ₀ /s	0.005 f ₀
1 GHz - 8 GHz	0.000667 f ₀ /s	0.001 f ₀
8 GHz - 40 GHz	0.000333 f ₀ /s	0.0005 f ₀

*

Reference **SBX-4CF-AD01-P3-REQ-145**

[FC Applicability: ALL CF (hardware)]

The response shall be given in the test report for the entire frequency range or for at least 4 frequencies per decade.

*

13.9.2 Thresholds of susceptibility# Reference **SBX-4CF-AD01-P3-REQ-146**

[FC Applicability: ALL CF (hardware)]

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 EUT 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.

*

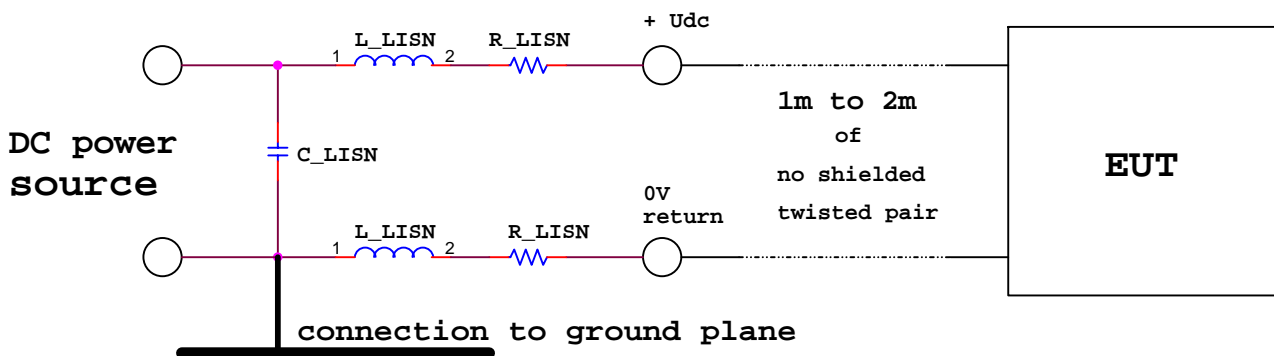
13.10 LISN specification

Reference **SBX-4CF-AD01-P3-REQ-147**

[FC Applicability: ALL CF (hardware)]

LISN definition :

2.5mF +/- 20%

 $L_{LISN} = 500nH \pm 20\%$ $R_{LISN} \leq 50m\Omega$ 

*

Reference **SBX-4CF-AD01-P3-REQ-148**

[FC Applicability: ALL CF (hardware)]

LISN shall be connected to EUT with a power lead harness : no shielded twisted pair, length in the range 1meter to 2 meter.

*

Reference **SBX-4CF-AD01-P3-REQ-149**

[FC Applicability: ALL CF (hardware)]

The power lead return line shall be connected to metallic ground plane on single point close as possible to C_{LISN} , the connection wire shall be as shorted as possible.

*

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
EUT	Equipment Under Test

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
OBDAH	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

Note: Applicability List

AIT	Assembly Integration & Test
ANTRACK	Antenna Tracking
AOCS	Attitude and Orbit Control Subsystem
DATAM	Data Management
FDIR	Failure Detection, Isolation and Recovery
HARNESS	-



MECHANISM	-
PAYLOAD	-
POWER	-
PROP	Propulsion Subsystem
STRUCTURE	-
TCR	Telemetry, Command and Ranging
THERM	Thermal Subsystem
ANTENNA	-
ALL CF	All Functional Chain

END OF DOCUMENT