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EMC-ESD DESIGN AND TEST REQUIREMENTS FOR @BUS UNITS

Written by	Responsabilité-Société	Signature/Date
M. SEVOZ	ASTRIUM EMC/ESD Specialist	5.10.05
Verified by		
C. ALLAUD	ASTRIUM Electrical Architect	05/10/2005
M. RITOUX	ASTRIUM JPT ALPHABUS Technical Manager	05/10/2005
B. JACQUE	ALCATEL JPT ALPHABUS Technical Manager	14/10/2005
Approved by		
J. COSTA	@Bus JPT Product Assurance Manager	18/10/05
M. VESPA	@Bus JPT Product Assurance Deputy	18/10/05
Released by		
M. ROUX	ASTRIUM JPT ALPHABUS Program Manager	
Ph. BERTHEUX	ALCATEL JPT ALPHABUS Program Manager	18/10/05

DOORS baseline :XXXX)
Code OT :
Entité émettrice : JPT
(détentrice de l'original)

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EADS ASTRIUM

ENREGISTREMENT DES EVOLUTIONS

ISSUE	DATE	§ : DESCRIPTION DES EVOLUTIONS	REDACTEUR
01 02	04/05/2004 04/10/2005	Original issue Update for HDR : All pages : wording improvement for clarification purpose (no change in requirements) §5.3.1.1 : Add of CE req for Source unit (PSR, SBVR) including TDMA for 100V bus : req 033 §5.3.1.1 : CE Primary user – TDMA spec in Time domain: req 035 §5.3.2.1 : CS Primary user – TDMA spec update to allow higher TDMA capability (2Vrms) and SBVR CS spec definition §5.3.1.1.3 : Inrush current spec for 100V and SBVR users	M. SEVOZ M. SEVOZ

TABLE DES MATIERES

LISTE DES FIGURES

1. SCOPE OF THE DOCUMENT

The scope of this document is to provide the EMC and ESD design and test requirements applicable to any unit of the @Bus product line.
These requirements are EMC-ESD inputs to RD1 (GDIE-E) and RD2 (UVVR)

2. DOCUMENTATION & TERMINOLOGY

2.1 Input Documents

The Input Documents are the input of the present document. If one of these documents is updated, relevant requirements in the present document may change accordingly.

Ref.	Document name	Doc. Ref.	Issue	Date

Table 1 : Input Documents

2.2 Reference Documents

The Reference Documents are not contractual but they may offer a better understanding of this document.

Ref.	Document name	Doc. Ref.	Issue	Date
RD01a	GDIE_E @bus Electrical General Design & Interface Environment (PartA)	ABU-JPT-SP-563	05 (PartA)	06/06/05
RD01b	GDIE_E @bus Electrical General Design & Interface Environment (PartE)	ABU-JPT-SP-563	01 (PartE)	06/06/05
RD02	@BUS units Verification and validation Requirement	ABU-JPT-SP-599		

Table 2 : Reference Documents

2.3 Applicable Documents

The Applicable Documents, applicable to the satellite, contain additional requirements to be used during product design, development, manufacturing, assembly, tests and delivery.

Ref.	Document name	Doc. Ref.	Issue	Date

Table 3 : Applicable Documents

2.4 Order of Precedence

In the event of conflict between the requirements of this specification and those of the documents here above, the requirements of this specification shall take precedence.

2.5 Terminology & abbreviations

Specific abbreviations used in the present document are given in the following table.

Abbrev.	Meaning
1553B	Military -Standard-1553B
ADC	Analog to Digital Conversion
ANA DE	Analog Acquisition Differential External
ANA DI	Analog Acquisition Differential Internal
ANA SE	Analog Acquisition Single ended External
ANA SI	Analog Acquisition Single ended Internal
ANA	ANAlog data acquisition (1553B)
APM	Antenna Pointing Mechanism
AS16	16 bits Serial digital Acquisition (1553B)
BC	Bus Coupler
BIL	digital BI Level acquisition (1553B)
CPS	Combined Propulsion Subsystem
CPSE TCE	Concatenation of CPSE & TCE, name of ADE4 board
CPSE	Combined Propulsion Subsystem Electronics

Abbrev.	Meaning
CSTA	Cross-Strapped Temperature Acquisition
CV	Power ConVerter
CVBCTC	CV Main &Bus Coupler & Telecommand Board
DAC	Digital-to-Analog Conversion
DTC	Direct TeleCommand (generated by SMU)
DTM	Direct TeleMetry (acquired by SMU)
EGR	Equipment Electrical Ground Reference
EOL	End Of Life
FCV	Flow Control Valve
FEV	Flow Enable Valve
FVV	Fill & Vent Valve
HFLV	High Flow Latching Valve
HLC DE	High Level Telecommand Differential External
HLC DI	High Level Telecommand Differential Internal
HLC	High Level Command
HPC	High Power on/off Command (1553B)
HPT	High Pressure Transducer
IPS	Ion Propulsion Subsystem
ITPM	Ion Thruster Pointing Mechanism
LAE	Liquid Apogee Engine
LFLV	Low Flow Latching Valve
LHLC	Long High Level on/off Command (1553B)
LHLCP	Long High Level on/off Command Payload (1553B)
LPT	Low Pressure Transducer
LSCC	Switch Closure on/off Command (1553B)
LSSBI	Low Speed Serial Bus Interface
LV	Latching Valve
MDE	Mechanism Drive Electronic
ML	Memory Load (1553B command)
MPIU	Modular Payload Interface Unit
MWX	Magnetic Momentum Wheels
NA	Not Applicable
P	Prime
PFIU	Platform Interface Unit
POT	Potentiometer acquisition
PPU	Power Processing Unit
PRE	Pressure Regulation Electronics
PRE	Pressure Regulation Electronic
PS	Program Specification
PT	Pressure Transducer
PTs	Pressure Transducers
R	Redundant
RCT	Reaction Control Thruster
RESA	RESistor Acquisition
RT	Remote Terminal
SADE PT TM	Concatenation of SADE & PT& Telemetry, name a board
SADE	Solar Array Drive Electronics
SADM	Solar Array Drive Mechanisms
SMU	Spacecraft Computer Unit
SW	software

Abbrev.	Meaning
TBC	To Be Confirmed
TBD	To Be Defined
TC	TeleCommand
TCE	Thermal Control Electronics
TEMA	TEMperature Acquisition
TEMA	ThErMistor Acquisition
TEMA1E	TEMperature Acquisition with 15K load at 25°C
TEMA1E	TEMA 15kW
TM	TeleMetry
TMBL DE	Telemesure BiLevel Differential External
TMBL DI	Telemesure BiLevel Differential Internal
TMBL NE	Telemesure BiLevel Normal External
TMBL NI	Telemesure BiLevel Normal Internal
TMBL SE	Telemesure BiLevel Single ended External
TMBL SI	Telemesure BiLevel Single ended Internal
TSE	Thruster Selection Electronic
TTI	Telecommand and Telemetry Interface
VHLC	Very High Level on/off Command (1553B)
WCA	Worst Case Analysis
WCE	Wheel Control Electronic
WPC	Concatenation of WCE & PRE & CSTA, name of ADE4 Board
XRFS	Xenon Regulator and Feed System

Table 4: Abbreviation Tables

3. ELECTROSTATIC CLEANLINESS REQUIREMENTS

3.1 Reduction of ESD occurrence risk

During and after launch, the spacecraft will be surrounded by low-density plasma of high-energy electrons and protons. On any spacecraft insulated surfaces the electrons will build up a charge that will discharge when the voltage breakdown of the insulating materials is reached.

Reference ABU-SUB-EMC-ESD-REQ-001

In order to minimize the effects of ESD, the general design principle is that all space facing surface shall be electrically conductive and reliably connected to spacecraft structure. Specific design requirements to satisfy the principles are as follows:

a. All external (fully exposed) surface above 5cm² shall be electrostatically conductive and grounded to the Spacecraft structure; the surface resistance shall be less than 1E+9 Ohm/sq.

b. the bulk resistance shall be less than :

   - 1E+11 Ohm.m for a max thickness of 6mm, when fully exposed to space environment (no shielding, corresponding to a max irradiation flux of 180pA/cm² at material level)
   - 1E+12 Ohm.m for a max thickness of 5mm, when only protected from space environment by a standard MLI (75µm shielding, corresponding to a max irradiation flux of 20pA/cm² at material level)
   - 1E+13 Ohm.m for a max thickness of 15mm, when protected from space environment by a minimum 1mm shielding (unit chassis + spacecraft structure), corresponding to a max irradiation flux of 0.72pA/cm² at material level.
   - In case of non-compliance to these requirements (Bulk Resistivity & thickness), the contractor shall assess by irradiation tests that there is no detrimental effect to the unit. Any deviation to this process shall be submitted to prime for approval, in case of prime refusal, the contractor shall replace the dielectric material by a compliant one.

c. All external/internal metallic parts whose surface is higher than 1cm² (even very small ones such as metallic labels, connector brackets, the EPC and heaters base plates (or doublers), the heat pipes, the tyraps) and intrinsically conductive parts

(like carbon) shall be grounded to the main spacecraft by a resistance much lower than 1MOhm and typically 100kOhm.

d. Blankets shall be grounded to the structure with at least 2 bonding straps and any point on a blanket shall be within 1 m of a bonding strap. The bonding strap shall be grounded to the structure by a proven technique such as a wire that is as short as possible . All external (on walls, Antennas, Battery, Fluid loop...) and internal (IMUX, OMUX, TWT, CPS, Battery...) Multi-layers Insulation shall be grounded to the structure by a resistance less than 100 Ohms. The area of individual thermal blankets shall not exceed 2 square meters. Adjacent blankets shall be separately grounded to structure (no daisy chain)

e. Optical Solar Reflectors shall be bonded using an electrical conductive adhesive.

*

White PCBZ & PSG120/121FD, black ELECTRODAG 501 and conductive BLACK AEROGLAZE Z306/307 paints have demonstrated good performance in order to dissipate the electrostatic charges.

3.2 External materials submitted to Prime approval

ESD occurrence risks will be encountered in the situation of highly resistive and thick dielectrics as here below :
Perforated Aluminised Teflon (SSM) and standard Teflon
Uncoated Kapton (or Aluminized Kapton thickness > 25µm) is generally unacceptable due to high resistivity. (*However, In continuous sunlight application, if less than 130 µm thick, Kapton is sufficiently photoconductive for use.)*
Use of epoxy glass,
Silica cloth,
Metallic floating parts (wire, connector, strap, metallic part on non-conductive Velcro).

Reference ABU-SUB-EMC-ESD-REQ-002

Triple junction point (triple contact point between dielectric, vacuum & metal; ex uncoated conductors) shall be avoided (except solar cells interconnectors): metallic conductors shall be isolated by a dielectric film thickness <25µm or qualified coating/varnish.

#

Reference ABU-SUB-EMC-ESD-REQ-003

The use of non-compliant materials shall be submitted to Prime EMC/ESD authority for approval (System analysis shall be performed, taking into account with Spacecraft shielding, exposed surface, insulator thickness, in order to assess max transmitted flux)

#

Reference ABU-SUB-EMC-ESD-REQ-004

If compliance with the above ESD requirements (§3.1& §3.2) cannot be achieved due to conflicting design requirements then tests shall be performed on a representative sample of the concerned surface material. Details of the procedure and the test results shall be submitted to Prime Contractor EMC authority for approval.

#

3.3 Reduction of ESD effects

Reference ABU-SUB-EMC-ESD-REQ-005

The following general principles shall be applied in addition to any specific circuitry techniques:

- circuit bandwidths shall be restricted to the functional use,
- loop areas of circuits using structure return shall be minimized by routing the wires of these circuits close to the structure,
- harness shieldings shall be grounded to the Electrical Ground Reference Plane by a wire (pigtail) of 5cm length max ,
- all external harness not routed through filter connector shall be overshielded.
- external Top-floor harness and units protected by an ESD Screen.

#

3.4 Deep Dielectric Charging mitigation requirements

Electrostatic discharge can result from charging of dielectric and floating conductors within a spacecraft by energetic electrons (E>2MeV).

Reference ABU-SUB-EMC-ESD-REQ-006

In order to minimise the charging risk, the general design principle is that all metallic parts shall be electrically conductive and reliably connected to spacecraft structure, and dielectric materials resistivity and thickness selected to mitigate deep charging risk.

#

Reference ABU-SUB-EMC-ESD-REQ-007

Specific design requirements to satisfy the principles are as follows :

The Subcontractor shall identify in its equipment, all the metallic >20mm² surfaces which are not always referenced to a fixed potential (track of floating PCB tracks, unused pins, cabling).

In case of non-compliance DDC analyses have to be performed to demonstrate design compliance to the REQ-001 §3.1requirements (dielectric materials selection versus bulk resistivity & thickness requirements)

#

4. MAGNETIC REQUIREMENTS

Reference ABU-SUB-EMC-ESD-REQ-008

The magnetic momentum of any fully operational equipment, electronic or others, shall not exceed 0.5 Am2 in any direction. Analysis will be acceptable for demonstration of compliance except for equipments with permanent magnetic field (eg: TWT, Solenoïd magnetic actuators), where test is required.

#

5. EMC/ESD TESTS

5.1 General

An EMC test matrix is given in hereafter table, with the EMC test requirements applicable to each type of equipment.
Compliance with these requirements for each equipment design must be demonstrated by submitting flight representative model to a test programme to be agreed upon with the Prime Contractor.

Reference ABU-SUB-EMC-ESD-REQ-009

The sample to be tested shall be in general the protoflight model. The use of an Engineering and Qualification model may be accepted provided that it is electrically and mechanically identical to the flight standard design. In addition, Subcontractor supplying equipment of a new design are reminded that it is necessary to check the EMC performance (at least for conducted parameters) at the "breadboard" stage of development to avoid the need for costly, late modifications.

#

Reference ABU-SUB-EMC-ESD-REQ-010

In any case, every RF flight unit must be tested in R.E (radiated emission) and R.S (radiated susceptibility), at useful mission frequency range, in order to detect any workmanship defect. Limited radiated tests to be performed for acceptance testing has to be described in the equipment specification.

For existing equipment or equipments derived from a previous design with modifications which do not affect the EMC behaviour, the use of tests performed for a previous programme may be accepted to demonstrate compliance with EMC requirements, after Prime Contractor approval at EQSR. Applications for exemption from EMC testing shall be submitted by Subcontractors in their bids.

#

The following Test matrix summarises the EMC-ESD requirements tests, detailed in §5.3 :

Tests performed	Measured / Injected value	Frequency range
Conducted Emission (CE)	Voltage/Current ripples	50Hz - 10MHz
	Inrush Current	(Time Domain)
	Common Mode Current (Only in Wire Return configuration)	10 kHz - 30 MHz
Conducted Susceptibility (CS)	Sine wave signal (1V rms)	50Hz - 10MHz
	Voltage/Current Transients	(Time Domain)
	Common mode for signal interfaces	Cf. RD01 for the requirements
	Voltage Drop out	Cf. RD01 for the requirements
Radiated Emission (RE)	Electric field	1MHz - 31GHz
Radiated Susceptibility (RS)	Electric field	1MHz - 22 GHz
Electrostatic Discharge (ESD)	Triangular shape Current	(Time Domain)

5.2 Test conditions

5.2.1 Test sample loading and stimulus

Reference ABU-SUB-EMC-ESD-REQ-011

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 :

maximise the measured ripples for the Emission tests,

maximize the sensitivity of the Unit under test for Susceptibility tests

However, all power supplies shall use Line Impedance Stabilisation Network (LISN), given in figure 5.2.9/1.

#

Typical devices for the impedance simulation of loads current measurements could be for example, bypass capacitors whose reactance value is lower than the value seen in the flight installation. Similarly for voltage measurements, the impedance increasing device could consist of a series inductance whose reactance value is larger than flight loads.

5.2.2 General conditions

Reference ABU-SUB-EMC-ESD-REQ-012

The test sample shall be set up with harness that simulates flight harness in shielding presence and terminations, twisting, ground and wiring properties. The EMC test plan shall include a test harness description and shall be submitted to Prime approval.

#

Reference ABU-SUB-EMC-ESD-REQ-013

The tests shall be performed in an ambient electromagnetic environment which is at least 6 dB below the lowest level to be measured. Emissions from the attendant test equipment and harnesses are included in the ambient levels.

#

Reference ABU-SUB-EMC-ESD-REQ-014

The tests shall be performed with the test sample, appropriate unit test equipment (UTE) and flight representative harness elements, on an electrically conductive ground plane. This ground plane shall have a length of a least 2.5 metres and a width greater than 0.5 metres.

#

Reference ABU-SUB-EMC-ESD-REQ-015

If a shielded room is used, the ground plane shall be bonded to the room by bonds whose resistance is less than 2.5 mOhm and separated by no more than 2.5 metres.

#

This connection of the ground plane is very important when the UTE has to be located outside the shielded room because of emission in excess of, or susceptibility below, the specified limits.

Reference ABU-SUB-EMC-ESD-REQ-016

Interconnecting cable assemblies, in the vicinity of the ground plane test area, shall be flight representative in construction and content.

#

Reference ABU-SUB-EMC-ESD-REQ-017

Shielded wires or Aluminium tape overshielding shall not be used in the test set-ups unless that have been specified in the intended installation.

#

Reference ABU-SUB-EMC-ESD-REQ-018

No overall cable shields shall be used in the vicinity of the ground plane test area unless these are representative of the flight design.

#

5.2.3 Measuring equipment grounding

Reference ABU-SUB-EMC-ESD-REQ-019

The grounding of the EMC measuring equipment shall be implemented in accordance with the details of this section in order to avoid false data introduced by ground loops and minimise the likelihood of shock hazards.

a) The measuring instruments shall be remote from the antenna

b) The measuring instruments shall be physically grounded by only one connection to the ground plane.

c) The measuring instruments shall be connected to their power supply through an isolation transformer.

#

5.2.4 Receiving equipment

Reference ABU-SUB-EMC-ESD-REQ-020

Any receiving equipment used shall be capable of measuring sine wave signals with an accuracy of ± 2 dB and broadband (impulse) signals with an accuracy of ± 3 dB. Its frequency accuracy shall be better than ± 2 %.

#

5.2.5 Bandwidth and Measurement time

Reference ABU-SUB-EMC-ESD-REQ-021

(as per MIL-STD-461E)

Frequency Range	Resolution Bandwidth	Minimum Measurement Time
50Hz-1KHz	10Hz	0.015 sec/Hz
1KHz-10KHz	100Hz	0.15 sec/kHz
10KHz-150KHz	1KHz	0.015 sec/kHz
150KHz-30MHz	10KHz	1.5 sec/MHz
30MHz-1GHz	100KHz	0.15 sec/MHz
Above 1GHz	1MHz	15 sec /GHz

Video bandwidth shall be set to its greatest value

#

5.2.6 Signals sources

Any signal source such as signal generator, pulse generator, or power amplifier, may be used provided that it is capable of supplying the necessary modulated and unmodulated power required to develop the susceptibility levels over the frequency range specified.

Reference ABU-SUB-EMC-ESD-REQ-022

The following requirements shall be applicable :

a) Absolute frequency measurement accuracy ± 0.01 %

b) Harmonic content a minimum of 30 dB below fundamental signal level.

#

5.2.7 E-Fields, Tests antennas

The following antennas are recommended for E field test, although different antennas may be used if more suitable, provided that calibration curves are available.

10 kHz to 30 MHz	1 metre matched rod
30 MHz to 200 MHz	Biconical antenna (H&V polarization)
200 MHz to 1 GHz	Log spiral antenna
1 GHz to 10 GHz	Aperture type horns, log spiral etc. (H&V polarizations)
10 GHz to 47 GHz	Horns, ridged guide

Reference ABU-SUB-EMC-ESD-REQ-023

The emission level shall be measured at a distance of **one meter from the equipment/harness.**

#

5.2.8 Power bus user

Reference ABU-SUB-EMC-ESD-REQ-024

The user shall be powered at 100V nominal voltage from simulated power supplies routed via the LISN specified in figure 5.2.8/1.

#

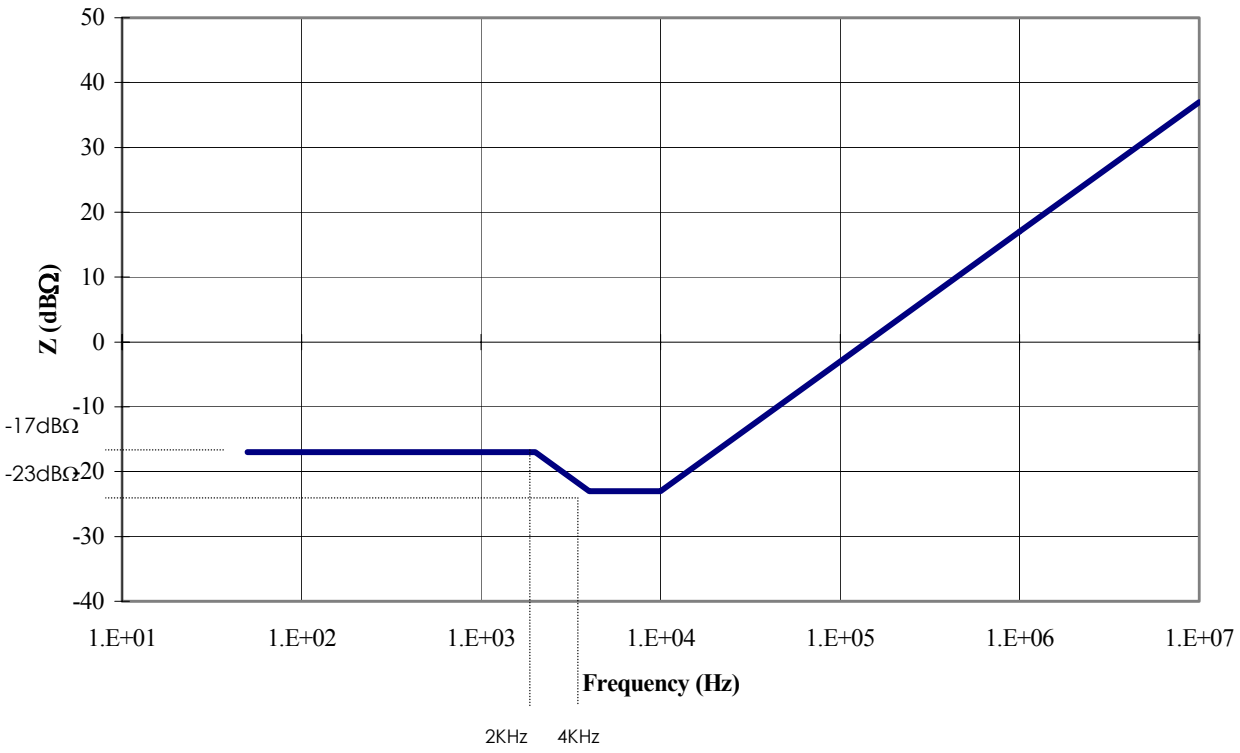
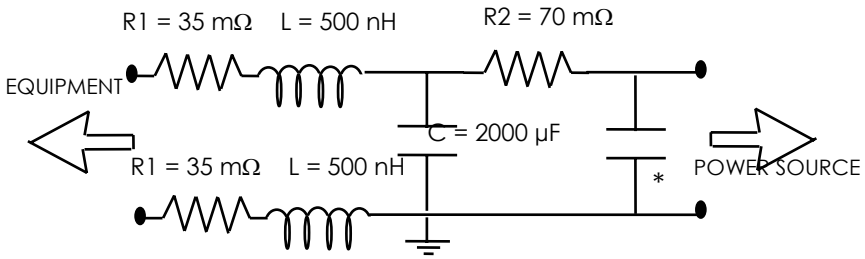
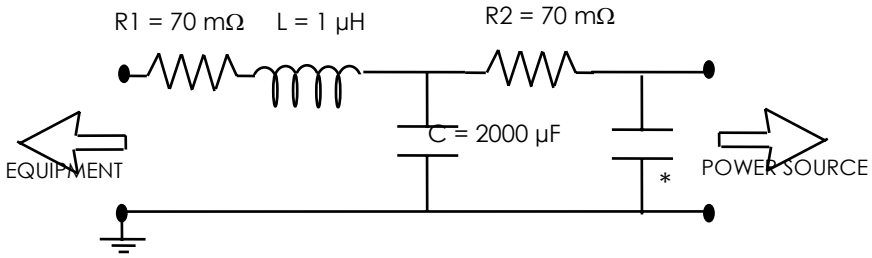


FIGURE 5.2.8/1- LINE IMPEDANCE STABILIZATION NETWORK

Case A : Wire Primary Return (Option A Wire return)
(*) only if the power source has no output capacitance (10000µF)



Case B : Structure Primary Return (Option A Structure Return or Option B)
(*) only if the power source has no output capacitance (10000µF)



For the 2000µF capacitance : ESR ≤ 10 mΩ and ESL ≤ 100 nH
For equipment power ≤ 125 W : case A or B is applicable
For equipment power > 125 W : LISN to be defined with Prime Contractor agreement.

Aim of this network is to simulate the power bus source impedance expected at spacecraft level, and thus to standardize the measurements in Conducted mode (Repeatability)

Reference ABU-SUB-EMC-ESD-REQ-025

The user shall be loaded with representative loads simulating ripple current demand.

#

5.2.9 Frequency scanning for susceptibility tests

Reference ABU-SUB-EMC-ESD-REQ-026

(as per MIL-STD-461E)

During Conducted and Radiated Susceptibility tests, the stimuli sweeping rate shall be defined as follows:

The measurement time at each tuned frequency shall not be less than the time necessary for the equipment to be exercised and to be able to respond, but not greater than 5s.

The frequency step size of the signal source shall not exceed the following frequency ratio of the injected signal f0 :

Frequency range	Max Step size
50Hz-1MHz	0.05 f0
1MHz-30MHz	0.01 f0
30MHz-1GHz	0.005 f0
1GHz-8GHz	0.001 f0
8GHz- 22GHz	0.0005 f0

#

5.3 EMC tests

Reference ABU-SUB-EMC-ESD-REQ-027

Generally, all the tests shall be performed at equipment level.

Nevertheless the EMC tests could be performed at the level of group equipments if all the equipments of the group are manufactured by the same Subcontractor or under his responsibility.

#

Reference ABU-SUB-EMC-ESD-REQ-028

The decision to conduct the EMC tests at such level shall be agreed by the Prime Contractor.

#

Reference ABU-SUB-EMC-ESD-REQ-029

EMC tests shall be performed with representative protection (same type and same rating) on primary power bus (including external fuse).

#

Reference ABU-SUB-EMC-ESD-REQ-030

The current limitation of the lab supply shall be set at 2 times the fuse rating current at the supply voltage.

#

5.3.1 Conducted Emission (CE)

5.3.1.1 Primary user (CE)

5.3.1.1.1 Differential mode

Applicability :

Reference ABU-SUB-EMC-ESD-REQ-031

Equipments in Option A structure return, Option A wire return and Option B, supplied by 100V power bus (PSR) and 50V power bus (SBVR)

#

Reference ABU-SUB-EMC-ESD-REQ-032

Conducted Emissions shall be measured into the impedance defined in figure 5.2.8/1. Depending on the configuration (wire return and structure return), a different LISN is used. For units with several power converters, this required measurement is applicable on each main power wire of each converter.

#

Frequency domain :

Reference ABU-SUB-EMC-ESD-REQ-033

Current ripples shall be measured in narrowband detection in the 50 Hz - 10 MHz frequency range. Under these conditions, the current re-injected on the main bus shall be less than the limits given in figure 5.3.1-1.

Power < 30W : These limits apply directly to users demanding up to 30 W.

Power > 30W : the limits shall be scaled proportionally to demanded power (Increase in dB given by 20 log P/30).

For the particular case of power source units supplying primary power bus (100V PSR, 50V SBVR) :

- 100V bus voltage ripples shall be less than 1Vrms from 50Hz to 5KHz (under TDMA squarewave modulation), decreasing in -20dB/decade down to 0,5Vrms at 10KHz, then 0,5Vrms from 10KHz to 10MHz
- 50V bus voltage ripples shall be less 0,5Vrms from 50Hz to 10MHz

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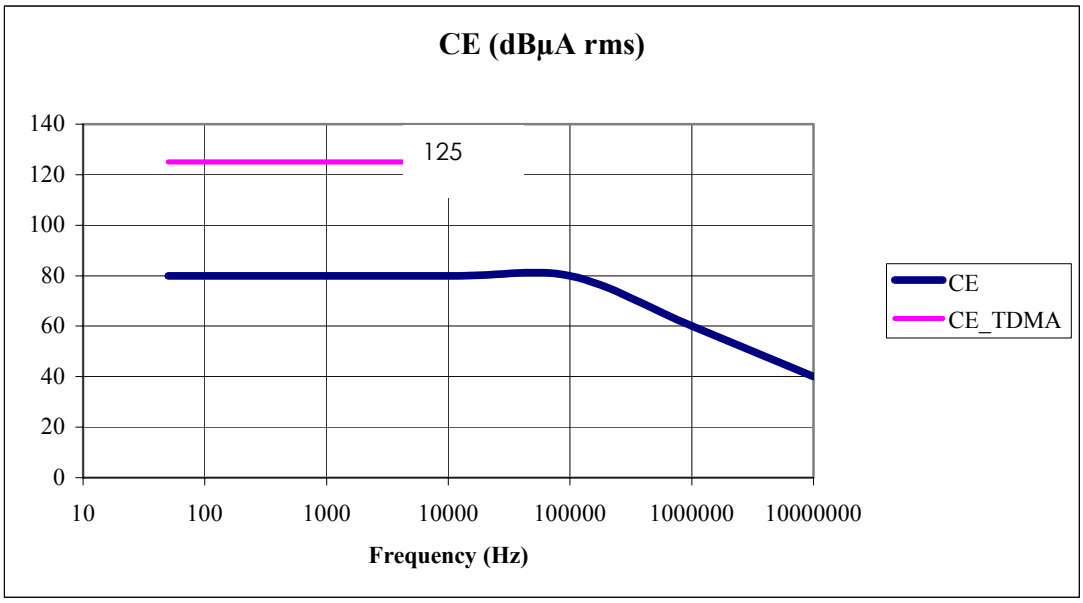


FIGURE 5.3.1/1 : CONDUCTED EMISSIONS - PRIMARY BUS EQUIPMENT NARROW-BAND

Reference ABU-SUB-EMC-ESD-REQ-034

For units operable in TDMA mode (cf. EPC/SSPA equipment specification), the relaxation factor shall not be applicable (max level = 125dBµA rms from 50Hz to 5KHz)

#

Time domain :

Reference ABU-SUB-EMC-ESD-REQ-035

Only for units operable in TDMA, the voltage and current ripples shall be measured on main supply line in the time domain with a measuring bandwidth of at least 10 MHz. Under these conditions, the current re-injected on the main bus shall be less than 4 App.

#

Reference ABU-SUB-EMC-ESD-REQ-036

For units providing secondary supplies, voltage ripples shall be measured on secondary supply output in the time domain with a measuring bandwidth of at least 10 MHz (no specified limit : only reference for CS test on secondary user)

#

5.3.1.1.2 Common mode(CE)

Applicability :

Reference ABU-SUB-EMC-ESD-REQ-037

Equipments in Option A only (whatever final use in wire or structure return) supplied by 100V power bus (PSR) and 50V power bus (SBVR)

#

Reference ABU-SUB-EMC-ESD-REQ-038

The equipment shall be configured in primary wire return, operating with representative interfaces, and shall be representative of a flight configuration.

#

Frequency domain :

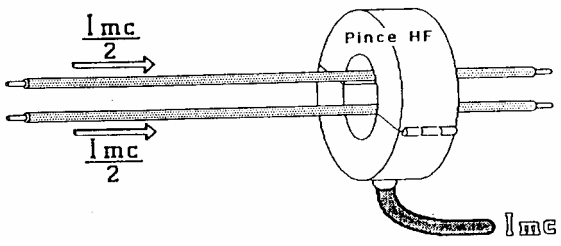
Reference ABU-SUB-EMC-ESD-REQ-039

Current ripples shall be measured in narrowband detection in the 10KHz - 30 MHz frequency range.

Under these conditions, the current re-injected on the main bus shall be less than 100 dBµA rms at 10 kHz, decreasing with frequency with a -20 dB/decade slope up to 30 MHz.

The measurement shall be performed with both the positive and negative wires inside a current probe, as illustrated below :

#



5.3.1.1.3 Inrush current

Reference ABU-SUB-EMC-ESD-REQ-040

The inrush current transient into the impedance defined in figure 5.2.8/1 shall not exceed the following limits as defined in figure 5.3.1/2 for SBVR 50V bus user and 5.3.1/3 for PSR 100V bus user :

- X is the current integral over the first 100µsec

- At fuse clearing recovery with possibly uncharged input filter capacitors and when the bus voltage starts from 0V to nominal voltage with dV/dt >1V/µs : X<3000µC for SBVR user and X<4500µC for 100V user

- In normal operation, at equipment level switch-on with the power bus steady at its nominal voltage 100V, the switch on shall not exceed X ≤ 3000 µC for SBVR user and X≤ 4500µC for 100V user

- The I step mean value during the plateau of 50ms maximum shall not exceed respectively 10A for SBVR user, and 15A for 100V user . The worst case inrush current on any unit power line shall be taken into account in the fuse sizing or protection sizing (Cf RD01).

#

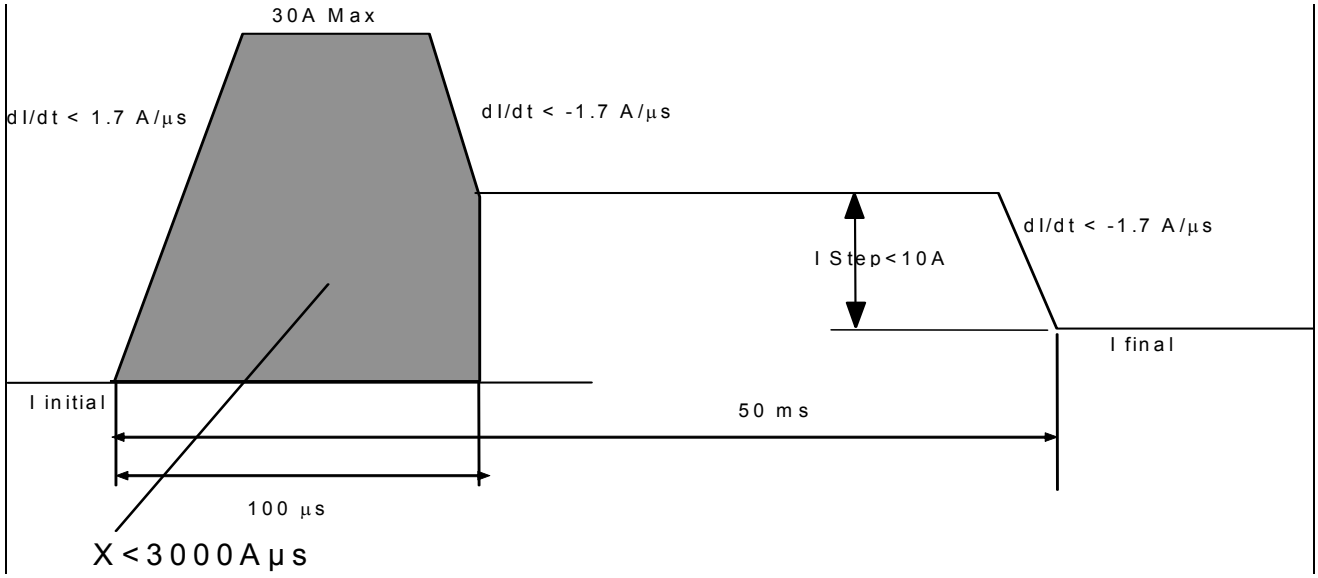


FIGURE 5.3.1/2 - 50V PRIMARY BUS USER INRUSH CURRENT

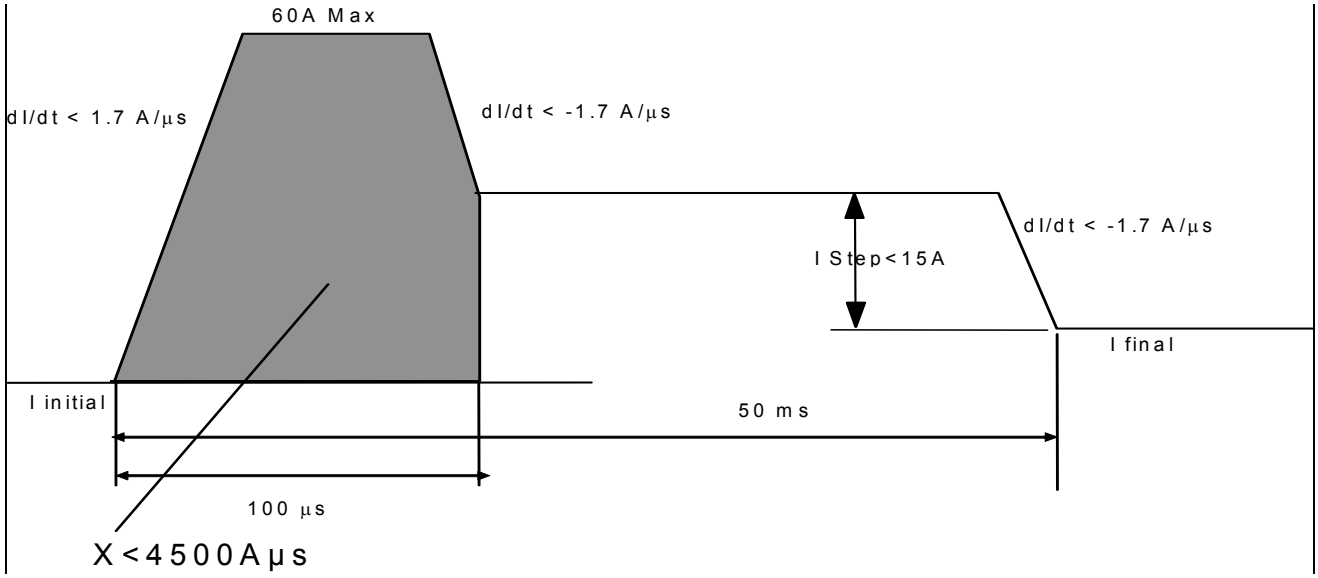


FIGURE 5.3.1/3 - 100V PRIMARY BUS USER INRUSH CURRENT

The limits on the current integral ("X") are valid assuming that the loads switching ON are separated in time by at least 5ms (nominal case if the SMU is the only unit able to switch ON equipments). A dedicated approval by the Prime Contractor is necessary, for units having the capability to switch ON other equipments or functions, asynchronously with respect to the SMU computer.

5.3.1.2 Secondary user (CE)

Reference ABU-SUB-EMC-ESD-REQ-041

The ripple current generated by an equipment supplied by a secondary supply voltage in the range 50 Hz to 10 MHz shall not be greater than those defined in Figure 5.3.1/1.

#

5.3.2 Conducted Susceptibility (CS)

Reference ABU-SUB-EMC-ESD-REQ-042

For all Conducted Susceptibility (except for REQ-046) tests specified in this section : in case of encountered unit susceptibility, the injected interference level at susceptibility frequency shall be reduced until the unit recovers its nominal performances. The new injected level shall be recorded.

#

5.3.2.1 Primary users (CS)

Reference ABU-SUB-EMC-ESD-REQ-043

The equipment shall continue to operate in accordance with the relevant equipment performance specification when the interferences (Sine wave signal) defined here after are applied to the power supply in differential mode.

100V POWER BUS USER: 2Vrms from 50Hz to 5KHz, decreasing in -20dB/decade down to 1Vrms at 10KHz, then 1Vrms from 10KHz to 10MHz,

50V POWER BUS USER (PLIU, TMTC) : 1Vrms from 50Hz to 10MHz

Corresponding injected current shall be measured on main supply line.

#

Reference ABU-SUB-EMC-ESD-REQ-044

Any notching shall be submitted to prime approval.

#

Reference ABU-SUB-EMC-ESD-REQ-045

TRANSIENTS (AS PER MIL-STD-461E CS06 TEST METHOD): The signal defined in figure 4.3.2 shall be applied with a positive and a negative polarity, the DC level being within the 100V range. The transient level is increased until one of the following limits is reached:

- Transient voltage = 100 % of the DC supply voltage
- Transient current = 100 % of the DC supply current.

#

Reference ABU-SUB-EMC-ESD-REQ-046

This transient shall be applied with frequency of 1 Hz and the total duration of the test shall not exceed 5 minutes.

#

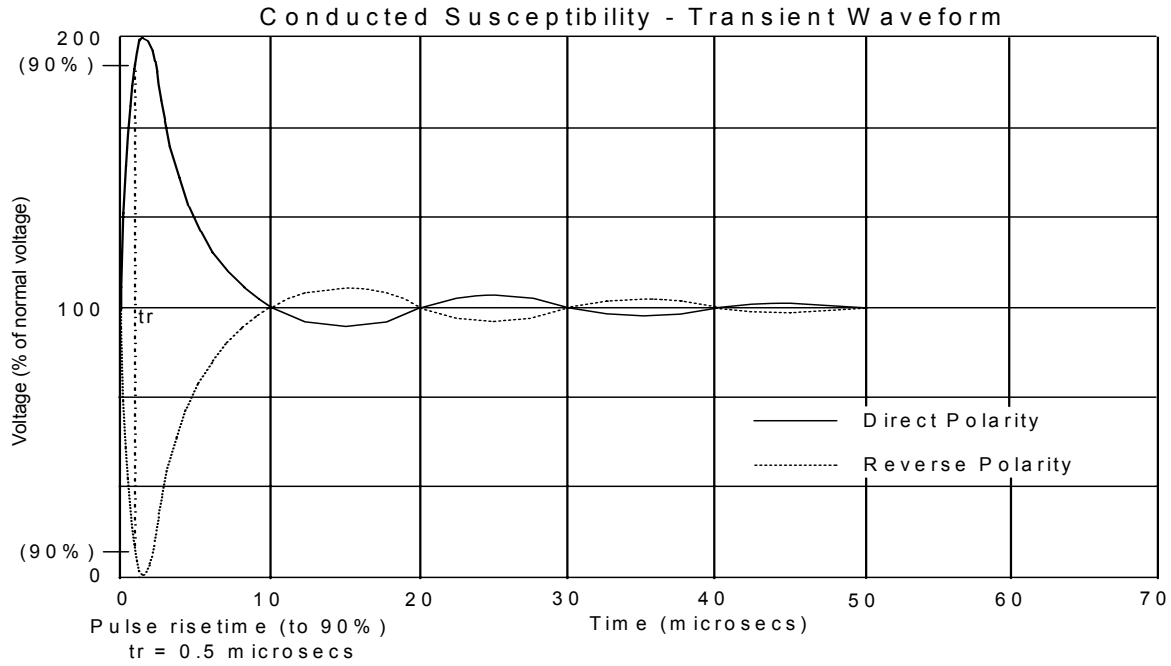


FIGURE 4.3.2 EQUIPMENT - SUSCEPTIBILITY TO TRANSIENTS PRIMARY POWER LINES

Reference ABU-SUB-EMC-ESD-REQ-047

TRANSIENTS DUE TO LOAD SWITCHING & FUSE CLEARING EVENT :

Compliance to §5.2.1.3 requirements of RD01 (REQ 117, 118, 119 & 120) shall be demonstrated by test..

#

5.3.2.2 Secondary users (CS)

Reference ABU-SUB-EMC-ESD-REQ-048

Equipments supplied by a secondary power supply shall continue to operate in accordance with their relevant equipment performances when the voltage ripples injected on these supplies are twice (= +6dB) max voltage ripples emitted by the supply equipment in differential mode (converter switching frequency)

#

Reference ABU-SUB-EMC-ESD-REQ-049

The ripple voltage shall be determined by the Sub-contractor to represent the ripple arising from the generator equipment., as measured in REQ-036, Time domain.

#

5.3.3 Radiated Emission (RE)

Reference ABU-SUB-EMC-ESD-REQ-050

The electric field, measured at 1m, radiated by the equipments in the range 1MHz - 31GHz shall not be greater than the limits defined herebelow.

Radiated levels are limited to :

E = 70dBµV/m from 1MHz up to 100MHz, then +20dB/decade from 100MHz up to 31GHz

Except in the following slots (corresponding to Telecoms Payload Uplinks bands),

L-Band : 1626.5MHz – 1675MHz

S-Band : 2025MHz - 2110MHz

C-Band : 5725MHz – 7075 MHz

X-Band : 7900MHz – 8400MHz

Ku-Band : 12750MHz – 14800MHz & 17300MHz – 18100MHz

Ka-Band : 27000MHz – 31000MHz

where E field strengths are requested to be lower than :

E = 20dBµV/m (rms)

#

Reference ABU-SUB-EMC-ESD-REQ-051

FOR THE UNITS 'ON' DURING LAUNCH, in the following slots (corresponding to Launch Vehicles main Uplinks bands), E field strengths are requested to be lower than :

E = 35dBµV/m (rms) in the 408MHz-480MHz band (AR5 & Delta Receivers),

E = 20dBµV/m (rms) in the 762MHz-776MHz band (Sea Launch Receivers),

E = 45dBµV/m (rms) in the 1570MHz-1620MHz band (Proton M Receivers),

E = 60dBµV/m (rms) in the 2720MHz-2730MHz band (Proton M Receivers),

E = 30dBµV/m (rms) in the 5450MHz-5725MHz (Proton M, Delta & AR5 Receivers)

#

Reference ABU-SUB-EMC-ESD-REQ-052

For what regards non RF equipments, the radiated emissions shall be imperatively measured up to 1 GHz .

#

Reference ABU-SUB-EMC-ESD-REQ-053

For non RF equipments, the measurements from 1GHz up to 31 GHz shall be only performed in the specified hereabove slots (Uplink bands), if the levels measured between 500 MHz and 1 GHz are at 10 dB, or less, below the limits specified in the same frequency range.

#

Reference ABU-SUB-EMC-ESD-REQ-054

The emission from the RF equipments outside their operating bandwidth (for which no limitation is required) shall be measured up to 31GHz.

#

Reference ABU-SUB-EMC-ESD-REQ-055

The radiated emission test shall be performed under the following conditions :

- the measurement shall be recorded in a worst case localisation (by detecting the most emissive face) and a worst case polarisation of the antenna
- distance between the antenna and the equipment : 1m

#

Reference ABU-SUB-EMC-ESD-REQ-056

Before beginning of this test, a leakage detection of the RF connections, cables and test set-up inside the EMC chamber shall be performed to ensure that the Equipment Radiated Emissions measurement will not be affected by the test set-up : a background measurement (unit OFF, EGSE ON) shall be necessarily performed to discriminate unit noise levels from set up/ambiant noise.

#

Reference ABU-SUB-EMC-ESD-REQ-057

This background measurement shall be at least 6dB below the test limits.

#

5.3.4 Radiated Susceptibility (RS)

Reference ABU-SUB-EMC-ESD-REQ-058

The equipment shall continue to operate without degradation of its performances when the specified electric field shall be applied on it. This figure can be summarised as :

From 1 MHz to 1 GHz : **E(V/m) = 1V/m (rms)** = 120dBµV/m (rms)

From 1GHz to 22GHz : **E(V/m) = 5V/m (rms)** = 134 dBµV/m (rms)

Except in the following slots (corresponding to Telecoms Payload Downlink bands),

L-Band : 1518MHz – 1559MHz

S-Band : 2200MHz - 2290MHz & 2520MHz – 2670MHz

C-Band : 3400MHz – 4200MHz & 4500MHz – 4800MHz

X-Band : 7250MHz – 7750MHz

Ku-Band : 10700MHz – 12750MHz

Ka-Band : 17300MHz – 22000MHz

where hereafter E field strengths are requested :

E(V/m) = 25V/m (rms) = 148dBµV/m (rms), for all internal units (*) (in the structure or below MLI and ESD shield).

E(V/m) = 89V/m (rms) = 159dBµV/m (rms), for all external units (earth, sun or star sensors)

(*) for receivers at Rx frequency, dedicated levels shall be determined and submitted to EMC Prime authority.

#

Reference ABU-SUB-EMC-ESD-REQ-059

The Radiated Susceptibility test shall be performed on the most sensitive face of the equipment (harness, connectors).

Reference ABU-SUB-EMC-ESD-REQ-060

If a susceptibility occurs, the injected electric field at susceptibility frequency shall be reduced until the requirement is met. The new injected level shall be recorded.

#

5.3.5 ESD tests

The demonstration of ESD resistance by test apply to any unit that is deemed by prime contractor as particularly susceptible to ESD threat due to its location in the Spacecraft or particularities in its design.

Units that should be submitted to ESD tests will be identified in the unit and/or subsystem URD specifications.
When such demonstration has been already performed in a previous qualification program on the proposed design and might be applicable to @Bus, demonstration that deviations and departures from the original test article to the proposed design are within the envelope of the qualification shall be provided. Acceptability of similarity is upon Prime Contractor approval at EQSR . Applications for exemption from ESD testing should be submitted by Subcontractors in their proposals.

Reference ABU-SUB-EMC-ESD-REQ-061

The adequacy of the spacecraft design to survive electrostatic discharge threats shall be demonstrated by a set of tests and analysis to be performed on the qualification model only (no ESD test authorized on Flight model)

#

The use of an engineering model may be accepted provided that it is electrically and mechanically identical to the flight standard design.

Reference ABU-SUB-EMC-ESD-REQ-062

The equipment shall continue to operate in accordance with its performance specification when it is submitted to the following conditions :

- equipment mounted on a plane structure of the same nature of that used in the spacecraft
- bonding and grounding representative of the flight conditions.
- same harness than in the spacecraft (nature - technology - height above structure= 1cm - separate bundle...). The EMC test plan shall include a test harness description and shall be submitted to ASTRIUM approval.
- Injected current in the plane structure of test (cf. figure 5.3.5/1) :
  - triangular shape of 20ns min to 50 ns max mid-height duration, 50A-peak in amplitude and di/dt > 3.10^9 A/s for the front edge.
  - triangular shape of 300ns min to 500 ns max mid height duration, 100A-peak in amplitude and 10^9 A/s < di/dt < 2.10^9 A/s for the front edge.
- Each shape of injected current shall not be applied more than 10 times.
- Current transient coupled on the victim cables shall be monitored for information only.

#

Test set-up dimensions (figure 5.3.5/1) should be respected in order to achieve specified current shapes within the structure (accuracy of +/- 1cm). RC components are typical values given for information, which can be adjusted to achieve specified levels. In case where distances/current shapes can not be achieved, cable coupling method (figure 5.3.5/2) can be used on each specified victim bundle.

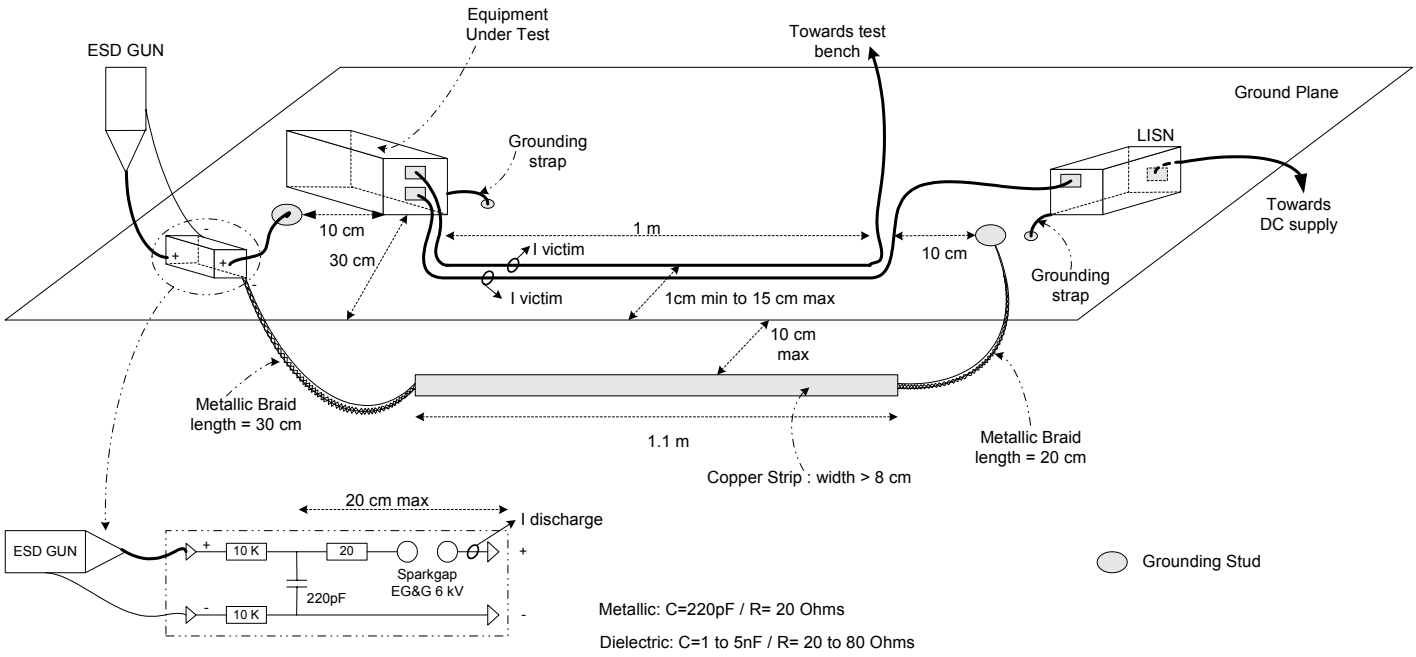


Figure 5.3.5/1 : ESD injection in the structure plane

Reference ABU-SUB-EMC-ESD-REQ-063

In case of susceptibility during injection into the structure, ESD cable coupling test (cf. figure 5.3.5/2) shall be performed (with metallic discharge waveform of 20A min to 30A max amplitude), for investigation to discriminate the coupling.

#

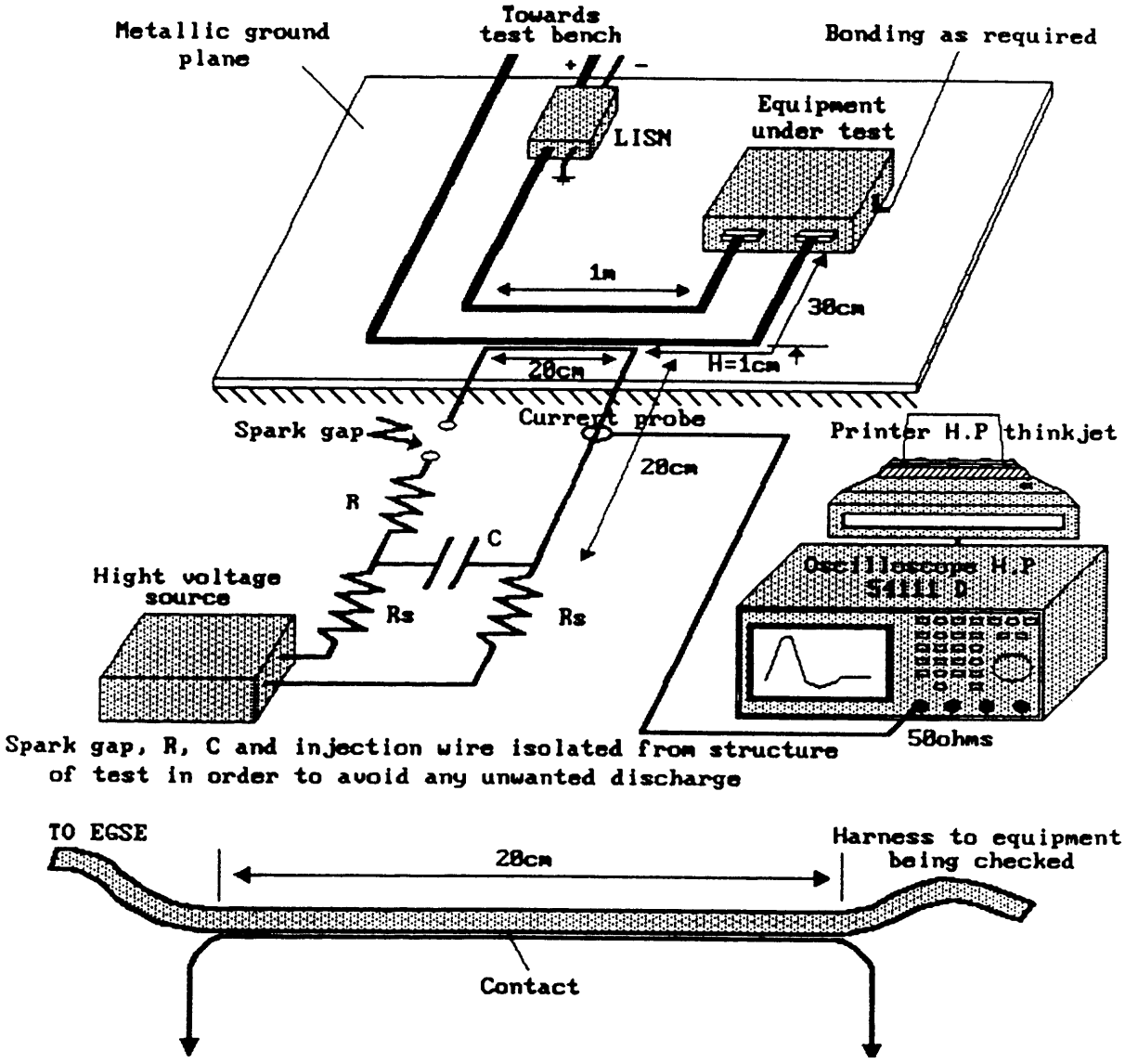


Figure 5.3.5/2 : ESD injection by cable coupling

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