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Direction des Programmes Espace

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Issue/ Rev.	Date	MODIFIED PAGES	Approval
Draft	13/2/87	First issue	
01	26/5/87	- Updated sections are identified in the right part of the dedicated pages - Rewording of § 3.3.8 - Definition of chap. 4 - Introduction of list of abbreviations	
02	02/2/88	- Updated sections are identified in the right part of the pages with vertical bars - Implementation of agreements reached during EMC meeting of 9/10 Sept. 87.	
03	20/6/88	- Implementation of agreements reached during the EMC meeting of 10/6/88 . deletion of ESD testing, low frequency RE.E testing . confirmation of test at satellite FM levels . definition of TBD in the TC frequency range . clarification of test conditions for PCS . relaxation of rise time for square wave tests . clarification of pulse width for transients . clarification of NB/BB requirements for TM . specific requirements for switch closure interface with instruments . clarification of test set-up (chap 6) - Updated sections are identified in the right part of the pages with vertical dotted lines	
Rev A	15/03/89	- Implementation of agreements reached during the EMC meeting of 15/12/88 with ESTEC . extension of H field testing up to 66 KHz . update of RE in the range 400-500 MHz . relaxation of CS testing . definition of CS TM/TC lines of instruments . clarification or correction - Modified pages are: 2, 9, 10, 11, 12, 13, 14, 15, 17, 18 20, 21, 22, 23, 24, 25, 26, 27, 31, 33, 34, 35, 36, 38 39, 40, 43, 46, 48, 52. - Updated sections are identified in the right part of the pages with a vertical stared line and the mark 3A	

ISO CHANGE RECORD

ISSUE	REV.	DATE	CHANGE DESCRIPTION	APPROVAL
03	B	09.0 .90	- Correction of clerical errors - Clarifications - Update (relaxaztion) of CS pulse width discrimination - definition of CE/CS : synchrolines and OTF - Modified pages are : 14,19,34,35,36,38,39, 24,37,37 bis added, 40,41,42,43 & 63. Nota : this issue has not been distributed, because not approved by ESA.	
03	C	18.04.90	Modified pages : 37 bis,38,39 and 40. All changes between issue 3/A and 3/C are indicated by vertical solid bar in the margin.	

SUMMARY

1. INTRODUCTION

1.1 PURPOSE

This specification defines the requirements applicable to the ISO satellite (including scientific instruments which are assessed to be the major driver for the susceptibility), as far as the various electromagnetic compatibilities (EMC) are concerned.

It further defines tests levels and test methods which have to be applied in the course of testing.

The cross reference between needs i.e tests and verifications necessary to fulfil the requirements is given in the EM/ES cleanliness control plan.

1.2 APPLICABILITY

This specification will cover the following areas:

- EMC with ground environment (PAD, EGSE, MGSE)
- EMC with launcher environment
- EMC with the flight environment encountered in orbit
- internal satellite EMC including EMC at sublevels
    - . module EMC (PLM and SVM)
    - . subsystem and equipment EMC.

Consequently, the present document is applicable to subsystem/unit, modules and system responsibles.

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents form a part of this specification, to the extent specified in the text of this specification. Their applicable issues are indicated in the "overall list of applicable documents", doc. n° ISO.AS.1200.LI.0415, annex 6 to the contract.

2.1.1 EID part B

- Doc. n° ISO.IF.WG.307
- Doc. n° ISO.IF.WF.304
- Doc. n° ISO.IF.WE.301
- Doc. n° ISO.IF.WH.310.

2.1.2 System specification, doc. n° ISO.AS.1400.SP.0090

2.1.3 ARIANE 4 User Manual

2.1.4 Design and construction requirements, doc. n° ISO.AS.14.SP.0028

2.1.5 EM/ES cleanliness control plan, doc. n° ISO.AS.14.PL.0176

2.2 REFERENCE DOCUMENTS

The documents used to prepare this specification have been:

2.2.1 ESA Standard

on "Electromagnetic Compatibility Requirements for Space Systems", SPS/Std/1/002, issue 1, Oct. 1980.

2.2.2 US, D.O.D Military Standard

on "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic interference" MIL-STD-461B, 1st April 1980.

2.2.3 US, D.O.D Military Standard

on " Electromagnetic Interference characteristics, Measurement of" MIL-STD-462, 9 Feb. 1971.

3. REQUIREMENTS

3.1 ISO SATELLITE REQUIREMENTS

3.1.1 General

During each phase of the satellite life, from equipment integration until its end of life, the satellite shall neither cause disturbances to other systems, nor suffer loss of performance due to other systems or to the orbit environment.

The ability of the satellite to perform its mission with the required performances will be demonstrated by test, analysis or similarity.

3.1.2 EMC with ground environment

The EGSE and MGSE used for satellite integration and ground testing will be designed in order to meet the EMC required by the satellite.

3.1.3 EMC with the launch system

The EMC requirements to be fulfilled by the satellite during the prelaunch and launch phases are described in the ARIANE user's manual.

These requirements are reproduced hereafter.

a. Radiation from the launch vehicle

The launch vehicle is equipped with the following transmission and reception systems:

A telemetry system with the transmitter in the VEB and an antenna system comprising two antennae located on the external section of the VEB Structure, having an omnidirectional radiation pattern and no special polarization.

The transmission frequency is in the 2200 - 2290 MHz band, and the transmitter power is 20 W. (Allocated frequencies to the Launch Vehicle are: 2203 MHz and 2218 MHz).

A telecommand destruct reception system, comprising two receivers operating in the 400 - 500 MHz band. Each receiver is coupled to a system of two antennae, located on the VEB, having an omnidirectional pattern and no special polarization.

A radar transponder system, comprising two identical transponders with a reception frequency of 5690 MHz, and transmission frequencies in the 5400 - 5900 MHz band.

The minimum pulsed (0.8 us) transmitting power of each transponder is 400 W peak. Each transponder is coupled to a system of two antennae, located on the VEB, with an omnidirectional pattern and clockwise circular polarization.

Spurious radiation interference levels from the launch vechicle will not exceed those given in:

- Figure 3.1.3.a.1 Spurious radiation by launch vehicle: narrow-band electrical field
- Figure 3.1.3.a.2 Spurious radiation by launch vehicle: wide-band electrical field (coherent noise)
- Figure 3.1.3.a.3 Spurious radiation by launch vehicle: narrow-band magnetic field.

These levels are measured at 1 m above the mounting plane of the VEB structure and do not take account of intentional transmissions by the launch vehicle.

Specific spurious radiations, emanating from the launch vehicle transmission systems, in particular from telemetry system, are lower than these levels (harmonics included).

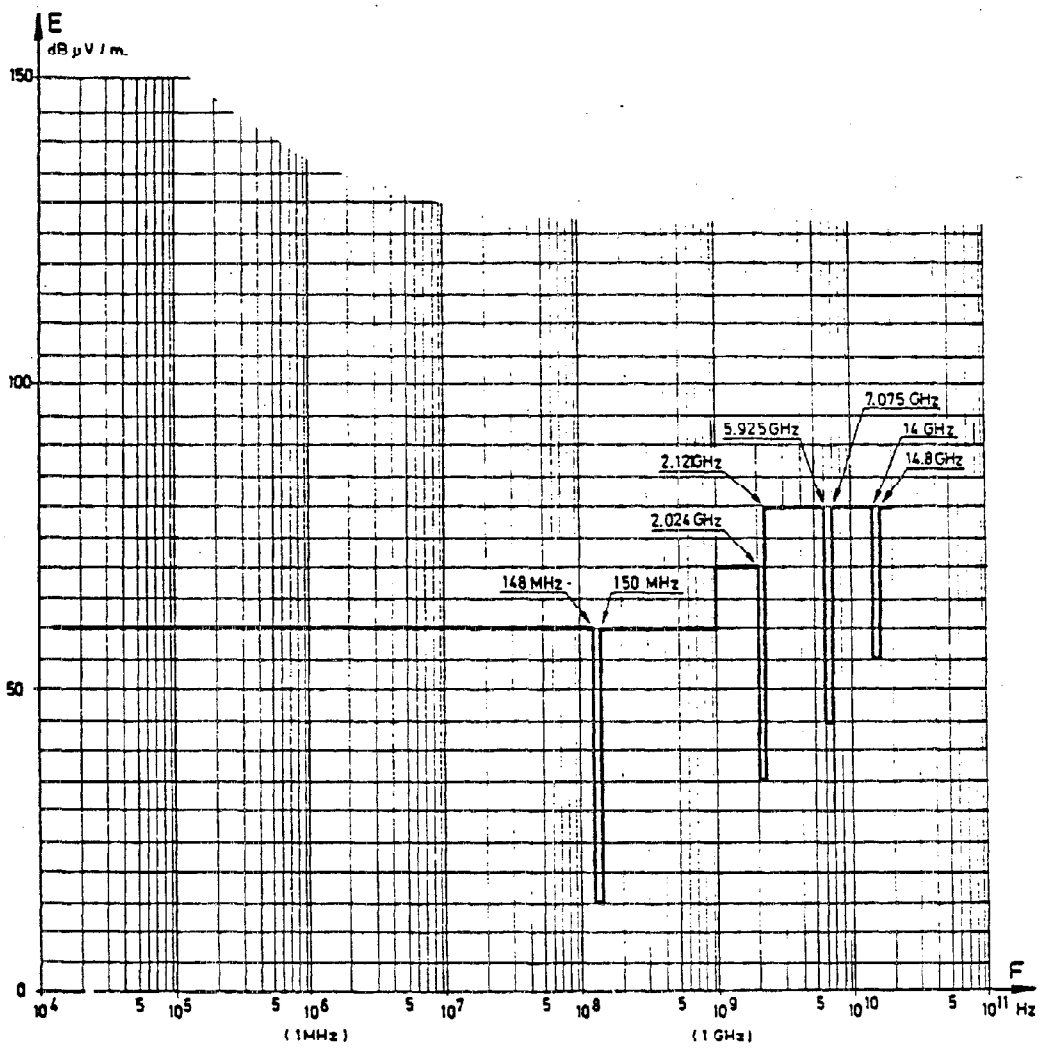


FIGURE 3.1.3.a.1 SPURIOUS RADIATION BY THE L.V. NB ELECTRICAL FIELD

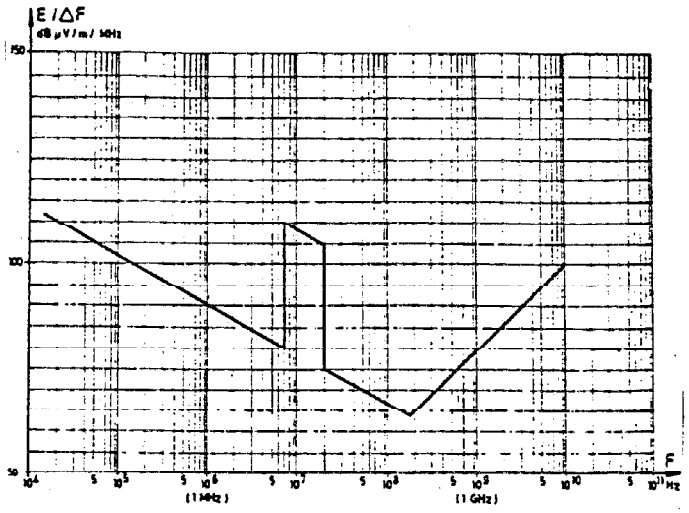


FIGURE 3.1.3.a.2 SPURIOUS RADIATION BY LAUNCH VEHICLE
WIDE-BAND ELECTRICAL FIELD (COHERENT NOISE)

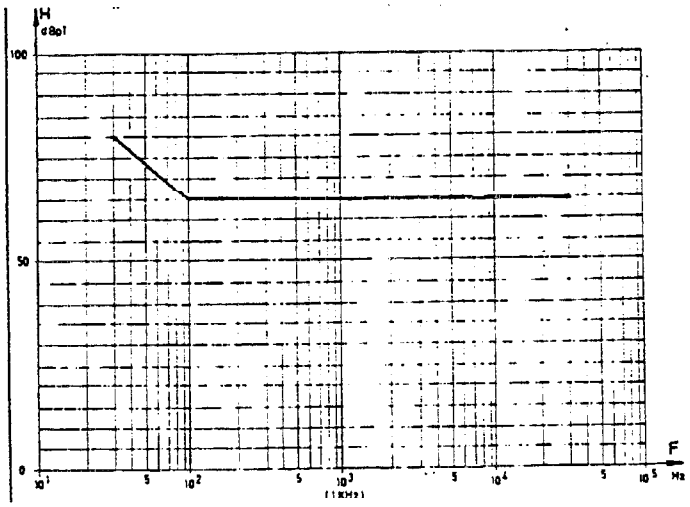


FIGURE 3.1.3.a.3 SPURIOUS RADIATION BY LAUNCH VEHICLE
NARROW-BAND MAGNETIC FIELD

b. Spurious radiation from the satellite

- The satellite shall not radiate a narrow-band electrical field at the level of the VEB exceeding the limit set in figure 3.1.3.b (including intentional transmission)

- A 20 dBuv/m level radiated by the satellite, in the launch vehicle telecommand receiver 400-500 MHz band, shall be considered as the worst case of the sum of spurious level over a 300 kHz bandwith

- Satellite transmitters have to meet general IRIG specifications.

c. Electrical and radio requirements

c1 Electrical requirements:

The satellite shall be so designed that during the final preparation phase leading up to actual launch, the umbilical cables are carrying only very low currents at the moment of lift-off, (i.e. less than 10 mA -50V for a resistive circuit). Satellite power shall be switched from external to internal and ground power supply must be switched off before lift-off.

In addition, the satellite surface fixed to the launcher adapter shall not be trented or protected in such a manner that the electrical resistance between the satellite reference point (location to be defined) and the adapter becomes higher than 10 milliohms (test under 10 mA D.C).

c2 Radio requirements:

. 135 - 139 MHz band: Satellite transmissions are not permitted during flight until separation time on orbit plus 20s

. In other bands there is a restriction on satellite transmissions up to 20 s after separation of the satellite. Waivers to allow transmission during the countdown phase and/or flight phase and/or at satellite separation will be considered on a case-by-case basis.

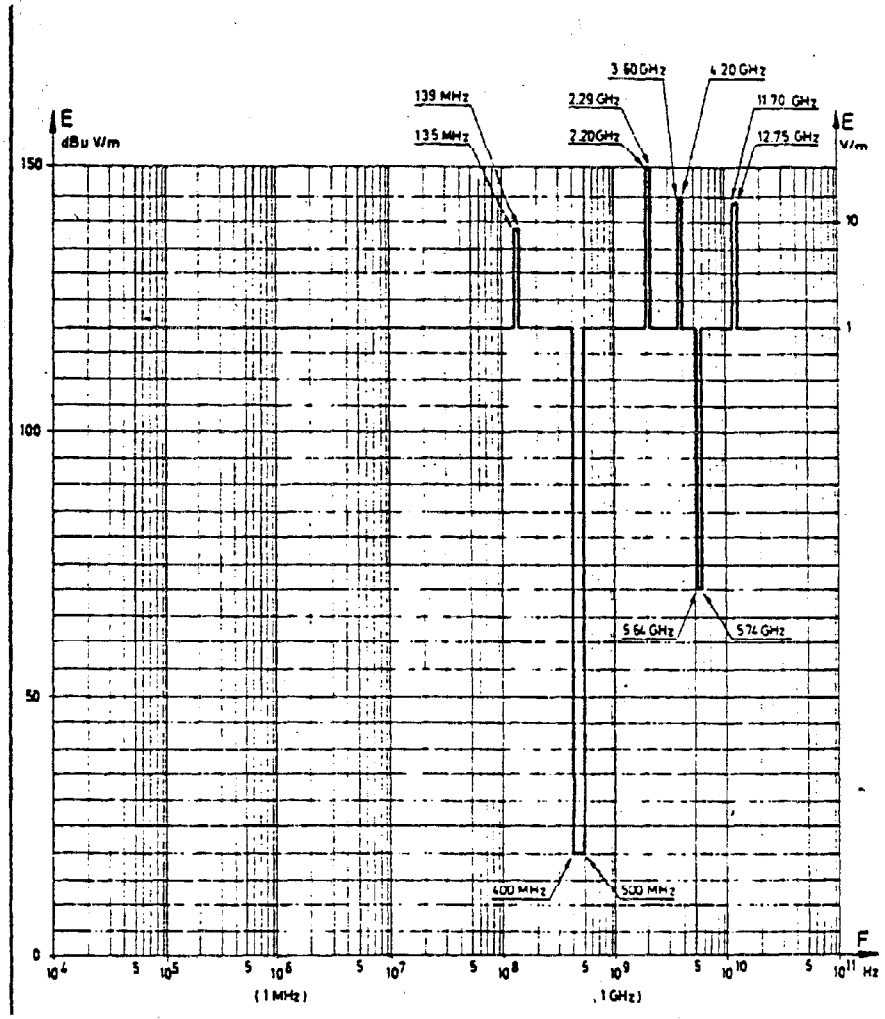


FIGURE 3.1.3.b SPURIOUS RADIATIONS ACCEPTABLE TO LAUNCH VEHICLE
NARROW-BAND ELECTRICAL FIELD

3.1.4 EMC with flight Environment

The satellite has to fulfil the requirements imposed by the environment during all orbital phases.

3.1.4.1 Electrostatic Requirements

Differential charging, occurrence of electrical discharge and degrading effects upon satellite nominal performances shall be minimized with the objective to prevent then via design and integration cautions.

The corresponding design requirements are requested in A.D.2.1.4 para. 4 & 6 and in AD 2.1.5 para 4.

3.1.4.2 Static Magnetic Field Requirements

The earth's magnetosphere and the satellite static magnetic field create mechanical torques which must be counteract by AOCS and RCS.

In order to make this possible and to minimize the propellant consumption, the magnetic dipole momentum of the satellite shall be less than: 10 Am^2

at B.O.L. and for all nominal configurations.

The allocation per module will be as follows:

- Sunshield: 2 Am^2 including the failure of one section
- PLM : 4 Am^2
- SVM : 4 Am^2

(This includes currents and material field effects).

3.2 SATELLITE TESTING REQUIREMENTS

3.2.1 General

The ability of the satellite to perform its mission with the required performance will be demonstrated. Particularly a 6dB margin shall be demonstrated between Emission & Susceptibility.

3.2.2 Satellite internal EMC

3.2.2.1 Radiated emission

a. Compliance with the LV requirements

In the VEB plane, narrowband e-field emission will be measured, using standard calibrated antennae and shall not be in excess to the limits given in figure 3.1.3b. Measurement shall be made in the frequency range 14 KHz to 18 GHz.

For this test the satellite will be launch configuration and the measurement will be made on the 2 conditions.

- satellite powered by external power supply (prelaunch)
- satellite powered by internal battery (launch).

b. Crysotat environment

At 4 differents points around crystoat (obtained by rotation of 90°), the narrow band E-field emission will be measured in the frequency range 14 KHz-10 GHz. Such measurements will be used to determine the compatibility of the overall platform with experiments.

3.2.2.2 Radiated susceptibility

a. E-field

Over the frequency range 14 KHz to 10 GHz, the ISO satellite shall not exhibit any mafunction, degradation of performance when subject to sine-wave electric field which level and characteristics are given in § 3.2.4.7.2 (identical to unit/PLM levels).

b. H-field

Over the frequency range 30 Hz to 66 KHz, the ISO satellite shall not exhibit any malfunction, degradation of performance when subjected to sinewave H-field which levels are given in § 3.2.4.7.2 (identical to unit/PLM levels).

c. Test conditions

Four directions, obtained by rotation around cryostat by 90° will be used for suceptibility threshold determination. Five payload configurations will be tested (one per instrument and parallel mode with the most sensitive instrument).

3.2.2.3 Conducted Emission

The conducted emission tests at system level will be made by using short EMC probes housed into the satellite harness itself or by standard current probes, or by direct voltage measurement at connector level provided that the test harness does not affect the measurement (a case by case analysis shall be achieved).

The probes will be constituted of two 60 cm parallel wires to allow a calibration of these means of measurement.

CE measurement will be confined to those areas not already tested at sublevel (module/subsystem) or for which test configurations were not fully representative.

They are 1) Conducted Emission on Primary Power Lines (28 V lines and K.AL) between PDU and upper platform units,

Two types of measurement will be performed:

- spectral analysis on a 30 Hz - 50 MHz frequency range

- RMS noise on a 10 MHz frequency bandwith (oscillascope with adequate BW).

2) And conducted emission on non standard link between SVM and PLM (at the time being, only the OTF signal is identified).

3.2.2.4 Conducted susceptibility

The ISO satellite shall not exhibit any malfunction, performance degradation when subjected to the following perturbation or the power lines between SVM and upper platform units.

- continuous sinewave from 30 Hz to 50 MHz (differential mode)

  . 28 Vlines : 1 Vrms
  . kAL : 1 Vrms.

Five payload configurations will be tested (one per instrument and parallel mode with the most sensitive instrument).

3.2.3 Module EMC

3.2.3.1 SVM requirements

3.2.3.1.1 Conducted emission

Conducted emission SVM will be made using calibrated probes. in areas not already tested at unit/subsystem level or for which test configuration were not fully flight representative.

These areas are:

a. Primary power lines (28 Vlines) between PDU and SVM users

Two types of measurement will be performed:

- spectral analysis or a 30 Hz - 50 MHz frequency range
- RMS noise on a 10 MHz frequency bandwidth (oscilloscope with adequate BW).

b. TM data lines between SVM users and RTU

Measurement shall be of broadband type (oscilloscope measuring at RTU inputs).

Results will be used to assess the margin w.r.t RTU susceptibility threshold.

c. Inter S/S links

A priori, measurements evidenced as being marginal during unit/subsystem testing (QM & FM).

3.2.3.1.2 Radiated emission

In the frequency range 14 KHz to 10 GHz, the radiated emission E-field of SVM towards PLM will be measured at 1 meter distance from the SVM lower platform.

Similar measurement will be made for H-field in the frequency range 30 Hz to 50 KHz.

These measurements will be assess the overall influence of SVM towards PLM.

3.2.3.2 PLM requirements

3.2.3.2.1 Conducted emission

a. On primary powerlines (28 Vlines) and on KAL

On each PLM units receiving primary power, the CE towards SVM (PCS) will be measured in the frequency range 30 Hz to 50 MHz. This will be a spectrum analyzer measurement (NB).

b. On secondary power lines

CE (spectral analysis of using NB BW) will be measured on the instruments preamps and detector secondary power lines at the source end (details will be part of the dedicated test procedures).

Measurements will be made in differential mode and common mode in the frequency range from 30 Hz to 50 MHz.

c. On TM data lines

CE on TM data lines from PLM users to RTU, the CE will be measured at RTU inputs. This could be of BB type (oscilloscope).

3.2.3.2.2 Conducted susceptibility

a. On primary power lines

For each payload configuration (one per instrument plus the parallel mode with the most sensitive instrument). the PLM (including instrument, Cryo-Elect QSS-E, and ELSE) shall not exhibit degradation of performance when subject to the following parasitic signals or power lines (28V and KAL lines).

- Differential mode
  - . sinewave
  - . transients
- common mode
  - . squarewave
  - . transients.

Levels and frequency range shall be those used at unit level (as per § 3.2.4.8.4).

b. On secondary power lines

In each of the above defined payload configurations (5), the opeating instruments shall keep nominal performances when subject to the following perturbating signal on secondary power lines.

- differential mode: sinewave (30 Hz to 50 MHz)
- common mode : squarewave (30 Hz to 50 MHz).

Levels will be at least 6 dB higher than those measured in CE.

Those tests shall also be performed on secondary power lines from QSS-E to QSS.

3.2.3.2.3 Radiated emission

On four locations (obtained by rotation around cryostat by 90°), the radiated emission E and H-field will be measured.

The measurement shall be a spectral analysis (NB type) and the frequency range shall be:

- E-field: 14 KHz to 10 GHz
- H-field: 30 Hz to 66 KHz.

3.2.3.2.4 Radiated susceptibility

a. E-field

Over the frequency range 14 KHz to 10 GHz, the PLM shall not exhibit degradation of performance when subject to sinewave E-field which levels and characteristics are given in § 3.2.4.7.2 (identical to unit level).

b. H-field

Over the frequency range 30 Hz to 66 KHz, the ISO satellite shall not exhibit any malfunction, degradation of performance when subjected to sinewave H-field which levels are given in § 3.2.4.7.2 (identical to unit level).

c. Test conditions

Four directions, obtained by rotation around cryostat by 90° will be used for susceptibility thereshold determination. Five payload configurations will be tested (one per instrument and parallel mode with the most sensitive instrument).

3.2.4 SUBSYSTEM AND EQUIPMENT REQUIREMENTS

3.2.4.1 General

Each equipment or subsystem shall be considered as a part of a whole system whose perfect running depends on the performance of each component.

Consequently, each equipment, subsystem or group of subsystem under the responsibility of a Subcontractor shall be designed in order to achieve the EMC with the others in the various operating modes.

The requirements stated in the present paragraph 3.2.4 are applicable at both subsystem and equipment levels and are derived from analysis: see EM/ES cleanliness control plan. Anyhow the subsystem responsible will be allowed to use the test results at equipment (or group of equipments) level to demonstrate the EMC of its subsystem with the requirements. In this way, the duplication of identical measurements will be avoided. However, this does not mean that no EMC test has to be performed at subsystem level. As a minimum, it is required that a functional test is performed at subsystem level to prove the EMC. The various equipments will be linked by the same type of wires as those used at S/C level (length, shielding, and as far as possible, layout).

EMC tests at equipment level shall be performed before EMC tests at subsystem level.

Compliance with this specification shall be demonstrated by the Subcontractor by tests, and/or analysis.

The choice of the analysis method shall be subject to PRIME approval and shall be supported by adequate justifications.

3.2.4.2 Qualification philosophy

EMC qualification shall be achieved on flight equivalent units.

It is then strongly recommended that first prototype or breadboard are tested will in advance of the qualification test on QM units in order to identify the potential problems and to assess the EMC performance of the unit.

3.2.4.3 Documentation

EMC test procedures for unit/subsystem tests shall be produced and shall:

- describe the different operating modes of the equipment or subsystem

- define for each kind of test (CE, CS, RE, RS), the different modes tested and the corresponding test configuration which have to be chosen to be as far as possible representative of the system configuration (including interconnecting cables)

- define the susceptibility criteria and the way of monitoring (test methods)

- define in detail the used test set-up (including the measurement accuracy).

3.2.4.4 Basic EMC Rules

The basic requirements to be followed by the design of the equipment to achieve the electromagnetic compatibility at equipment/subsystem and system levels (grounding, bonding, wiring, filtering, connectors...) are provided in the applicable documents 2.1.4 and 2.1.5 added to EID part A for instruments.

3.2.4.5 Narrowband and Broadband

The bandwidths of the receiver are as follows for narrowband (NB) and broadband (BB) recordings.

Type	Freq. Range	Bandwidth
NB	Up to 10 kHz	30 Hz or 50 Hz
NB	10 kHz - 2.5 MHz	300 Hz or 500 Hz
NB	2.5 MHz - 25 Mhz	3 kHz or 5 kHz
NB	25 Mhz - 1 GHz	30 kHz or 50 kHz
BB	10 kHz - 2.5 MHz	3 kHz or 5 kHz
BB	2.5 kHz - 25 MHz	30 kHz or 50 kHz
BB	25 MHz - 1 GHz	300 kHz or 500 kHz

For frequencies above 1 GHz each individual noise signal (N.B) is measured with a maximum band of 100 kHz. Deviation from this rule shall be subject to PRIME approval and clearly indicated in the relevant test procedures.

Distinction between NB and BB shall be made as follows:

1. NB requirement level shall be applied when the measured level increases less than 10 dB when the bandwidth of the receiver is switched from NB to BB as above.

2. BB required level shall be applied when the measured level increases more than 10 dB when the bandwidth of the receiver is switched from NB to BB as above.

It is understood that the bandwidth values are instrument dependant. Any deviation from what mentioned above, affect the requirements and then shall be approved by the Prime before being adopted. (+)

3.2.4.6 Amplitude

All the levels given in following requirements are peak amplitude unless otherwise mentioned.

3.2.4.7 Radiation requirements

3.2.4.7.1 Radiated Emission (RE)

3.2.4.7.1.1 RE E-field

a. General requirement

In the 14 kHz, - 18 GHz, the electric field emitted by the unit under test. including intentional and unintentional radiation from the test harness, shall be less than the hereafter defined limits:

- Narrowband - figure 3.2.4.7.1.1.a
- Broadband - figure 3.2.4.7.1.1.b.

The limits (NB & BB) in the frequency range 400- 500 MHz are applicable only to units operating during launch.

For the others the dotted lines limit is applicable.

b. Specific requirements

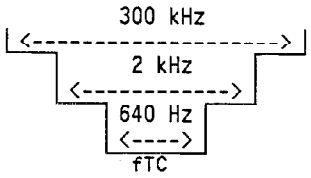
- Launcher receiving frequency range

In addition to the general requirements, every equipment operating before or during launch (until separation from the launcher) shall not perturbate the TC receiver of the launcher. In that aim, the requirements given in paragraph 3.1.3.b) apply.

- Satellite receiving frequency range

In addition to the general requirements, every equipment shall not perturbate the TC receivers.

In that aim, the RE-E shall be below the following limits.



42	dBuV/m	
20	dBuV/m	
15	dBuV/m	

fTC = 2,087 GHz

c. Test method

The measurements will be performed at 1 meter distance from unit under test.

Both vertical and horizontal polarization of the test antenna will be used for frequencies higher than 25 MHz.

The upper frequency range of the measurement shall be in accordance with the following table.

Highest operating frequency of equipment	Required upper limit
< 1 GHz	Tenth harmonic but never less than 1 GHz
1 - 10 GHz	Tenth harmonic or 18 GHz wichever is less

3.2.4.7.1.2 Radiated Emission H-Field

a. DC requirement

General requirement: 106 dBpt at 1 meter i.e 200 nanotesla.

That requirement is applicable at subsystem and unit level. Opportunity will be taken, as far as feasible of test at equipment level to demonstrate the compliance at S/S level taking into account, the satellite layout in all the operating modes.

The levels specified above shall be verified in accordance with procedure detailed in chapter 6 of this document.

The requirements shall be met both after deperming and reperming.

The measurement shall be performed after the CS test.

b. Narrow band H-field emission

In the 30 Hz - 66 kHz frequency range, the magnetic field radiated by the unit under test (including, intentional and unintentional radiation from the test harness) shall be less than the following levels at 1 m distance:

Narrow Band: see Fig. 3.2.4.7.1.2.b.

The test is applicable as unit level.

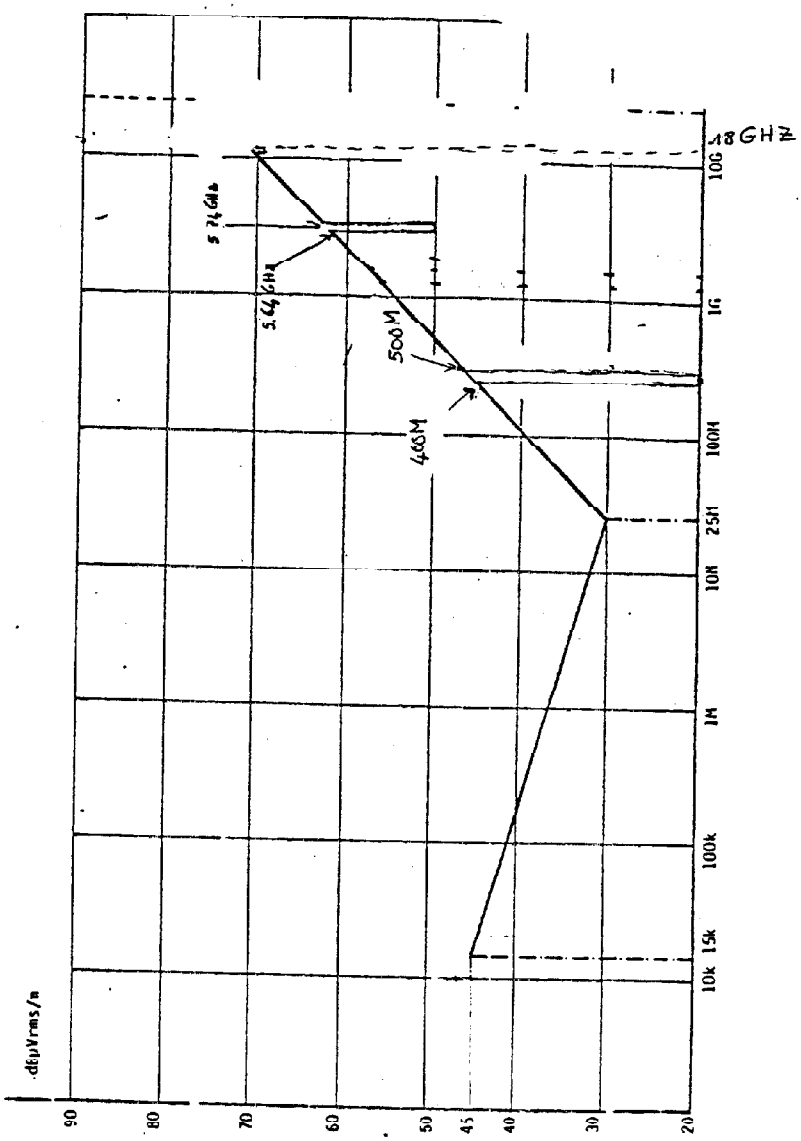


FIGURE 3.2.4.7.1.1.a RADIATED EMISSION, E-FIELD NARROW BAND

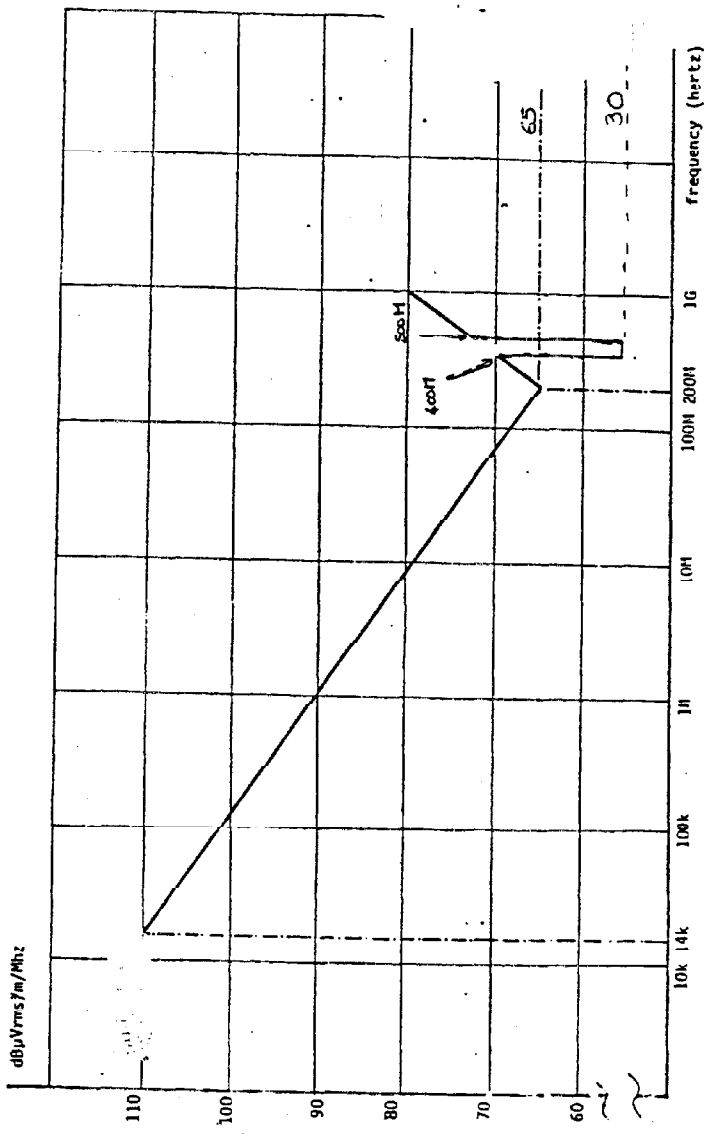


FIGURE 3.2.4.7.1.1.b RADIATED EMISSION, E-FIELD B.B

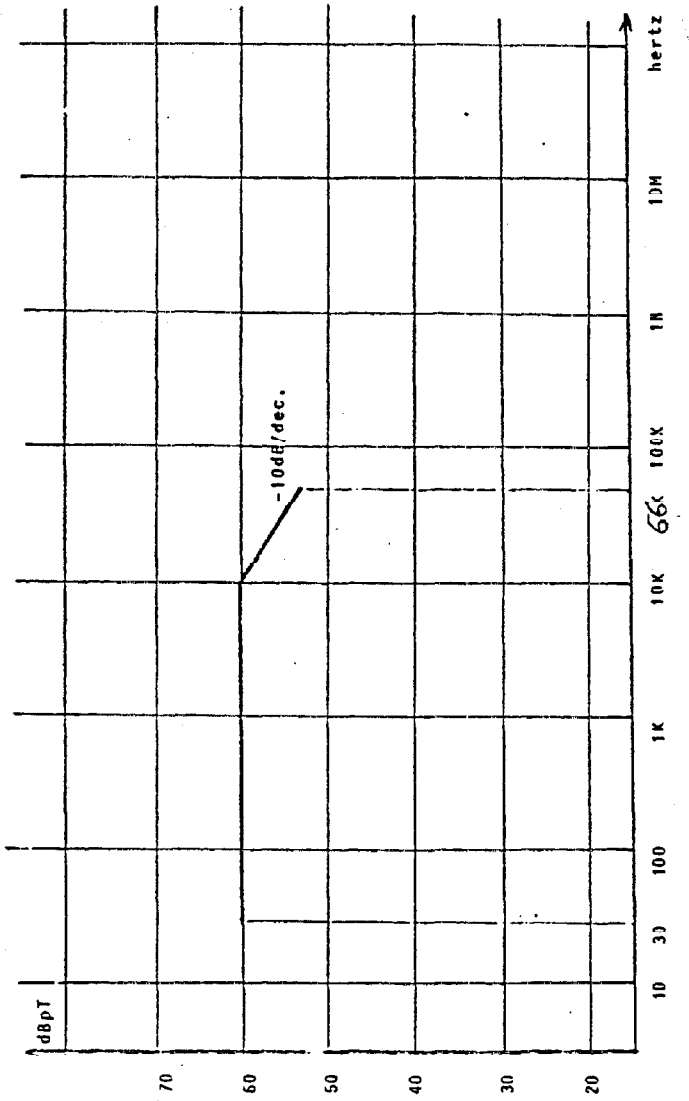


FIGURE 3.2.4.7.1.2.b RADIATED EMISSION, H-FIELD N.B

3.2.4.7.2 Radiated Susceptibility (RS)

3.2.4.7.2.1 Radiated susceptibility, E-field (see fig. 3.3.4.4)

Over the frequency range 14 kHz - 18 GHz (14 kHz - 10 GHz for instruments and units not operating during launch), the unit/subsystem fitted with its test harness shall not exhibit any malfunction, degradation of performance, deviation from specified susceptibility criteria given by the corresponding subsystem specification and test procedure when subjected to sinewave electric fields of:

1V/m in the whole frequency range

5V/m from 2.1 to 2.4 GHz (S-band TM)

(*) 5V/m from 5.4 to 5.9 GHz (radar).

The sweep speed for the test shall not be faster than 1 octave/minute and the sinewave signal shall be 30% amplitude modulated by 1 kHz squarewave (other amplitude modulation characteristics may be accepted by PRIME).

Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves.

The test shall be performed as per MIL.STD.462 (RS03).

(*) Valid only for equipment operating during launch and for RF receivers.

3.2.4.7.2.2 Radiated susceptibility, H-field over the frequency range DC to 66 kHz, the unit under test, fitted with its test harness, shall not exhibit any malfunction, degradation of performance, deviation from specified susceptibity criteria given by the corresponding subsystem specification and test procedures, when subjected to sinewave magnetic field which levels are given by fig. 3.2.4.7.2.2.

The sweep speed of the test shall not be faster than 1 octave/minute.

- DC: 170 dBpT (0.3 m Tesla or 3 Gauss)

- pulsed H-field (time domain)

Change of operation mode as realy coil, value coil or switch activation generate H-field emission in the form of transient pulse.
The unit under test shall not present any degradation of performance when submitted to the following H-field pulse train:

. amplitude: 5 uT
. duration : 13 ms
. rise time: 500 us
. rep.rate : 50 ms.

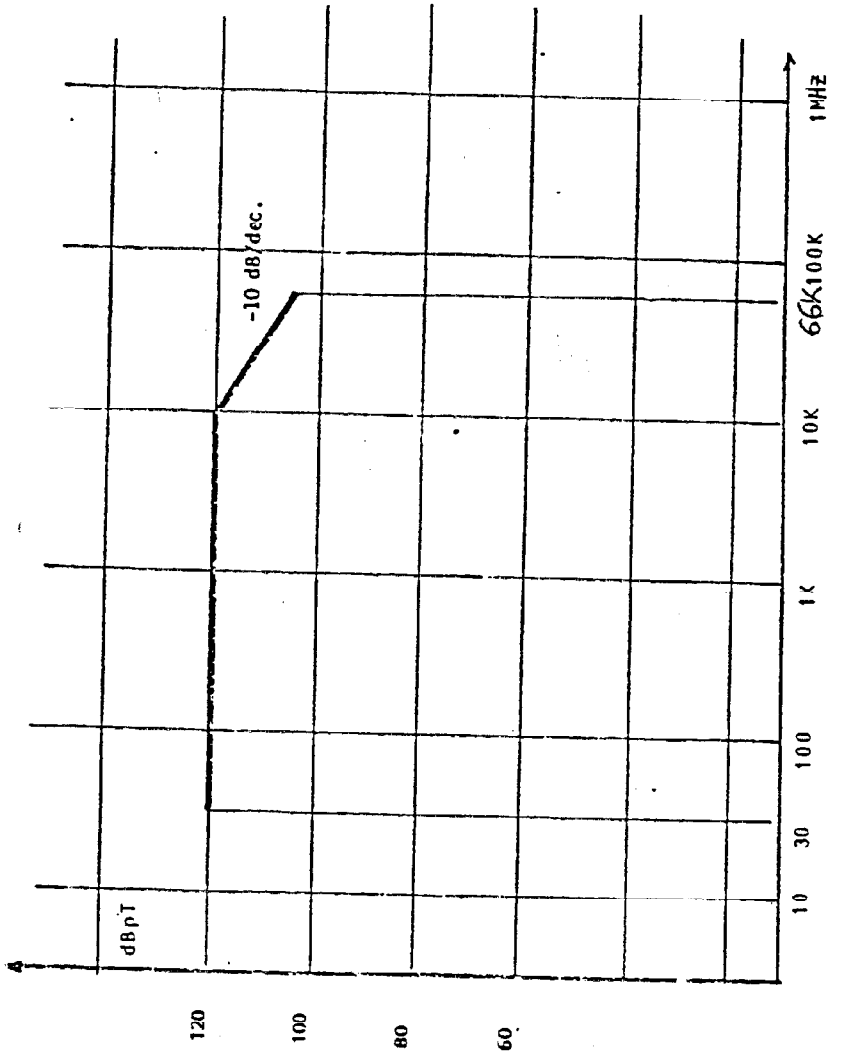


FIGURE 3.2.4.7.2.2 RADIATED SUSCEPTIBILITY H-FIELD

3.2.4.8 Conduction requirements (power lines)

3.2.4.8.1 Conduction requirements on PCS power lines

a. Broadband emission (differential mode)

In the frequency range 30 Hz to 50 MHz, the conducted emission shall be less than the herebelow given limits:

- 28V line - 300 mVpp
  - 50 mVrms

- Keep alive lines (5,5V):

  . 50 mVpp | > surimposed on steady state voltage which could
  . 10 mVrms | vary in the range 5,5V ± 10%

Those figures are valid whatever the operating mode.

The peak to peak value (including ripple and spikes) shall be measured with an oscilloscope, capable to detect peak to peak value, with an adequate bandwidth (50 MHz).

The RMS value shall be measured with a true RMS voltmeter up to 10 MHz

b. Transient single event (differential mode)

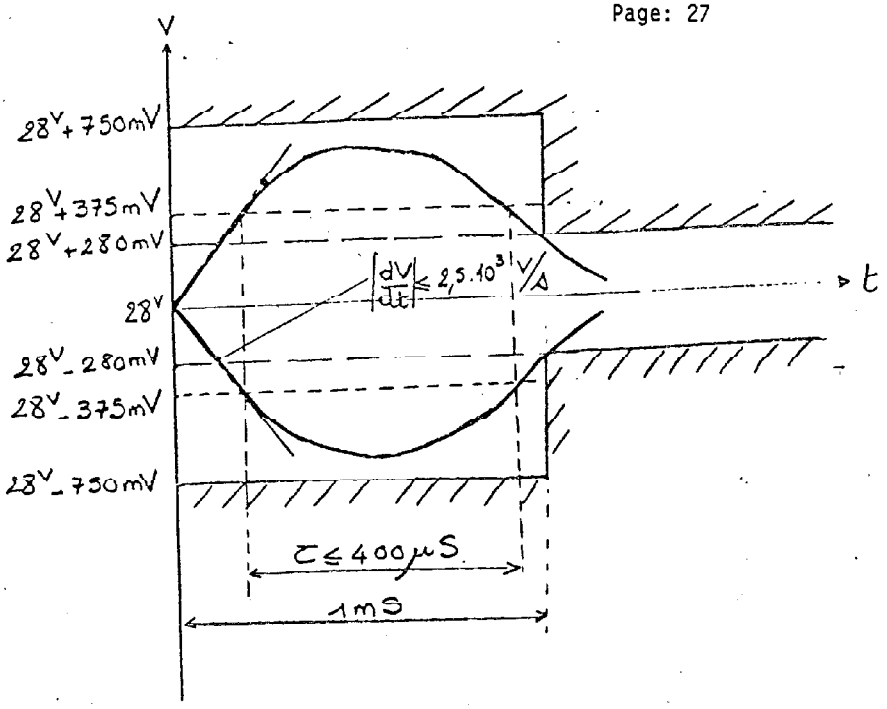
Voltage transient shall be contained within the enveloppes given in figures 3.2.4.8.1b.

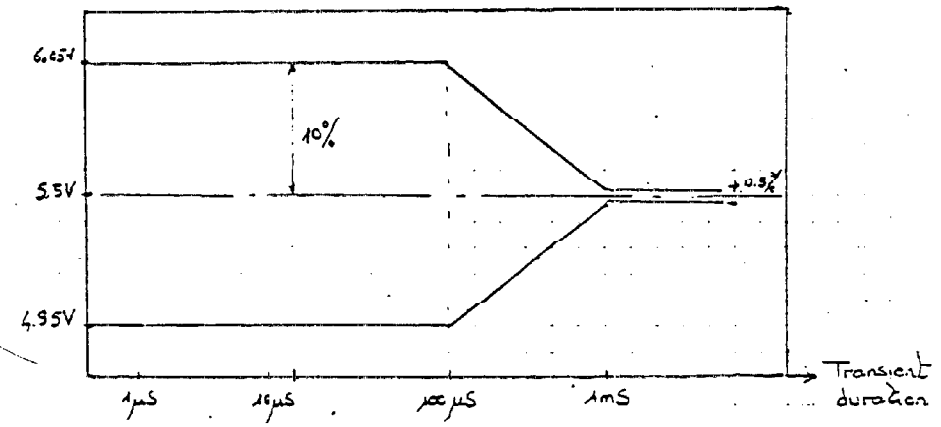
Transient occurrence conditions (load variation law) for test purpose shall be:

- step of load I: ± 4A peak (28 V) and ± 5 mA (KAL)

- current rate of change $\frac{dI}{dt}$ (imposed by the load): 10^6 A/s shall be experienced

Both polarities of step of load shall be experienced.





FIGURES 3.2.4.8.1b

c. Narrow band emissions (differential mode)

In the frequency range 30 Hz - 50 MHz, the conducted emission on power lines shall not appear in excess of the values shown in figure 3.2.4.8.1.c (narrow band measurement).

d. Conducted emission in common mode

CECM is the emission appearing as current in the power wire bundle, flowing back to the source in the structure and then in the source unit chassis and bonding strap.

Such current shall be limited as follows:

NB: 100 uAp from DC to 50 MHz (600 µ)

BB: 1 mAp/MHz from DC to 50 MHz.

e. Test conditions

the a.m differential mode limits shall be understood as those of the PCS connected to non inductive dummy loads leading to the following average DC currents:

- 28 V: 16 A
- KAL : 5 mA.

For the common mode limits, the specified values shall be understood as those generated by a current source.

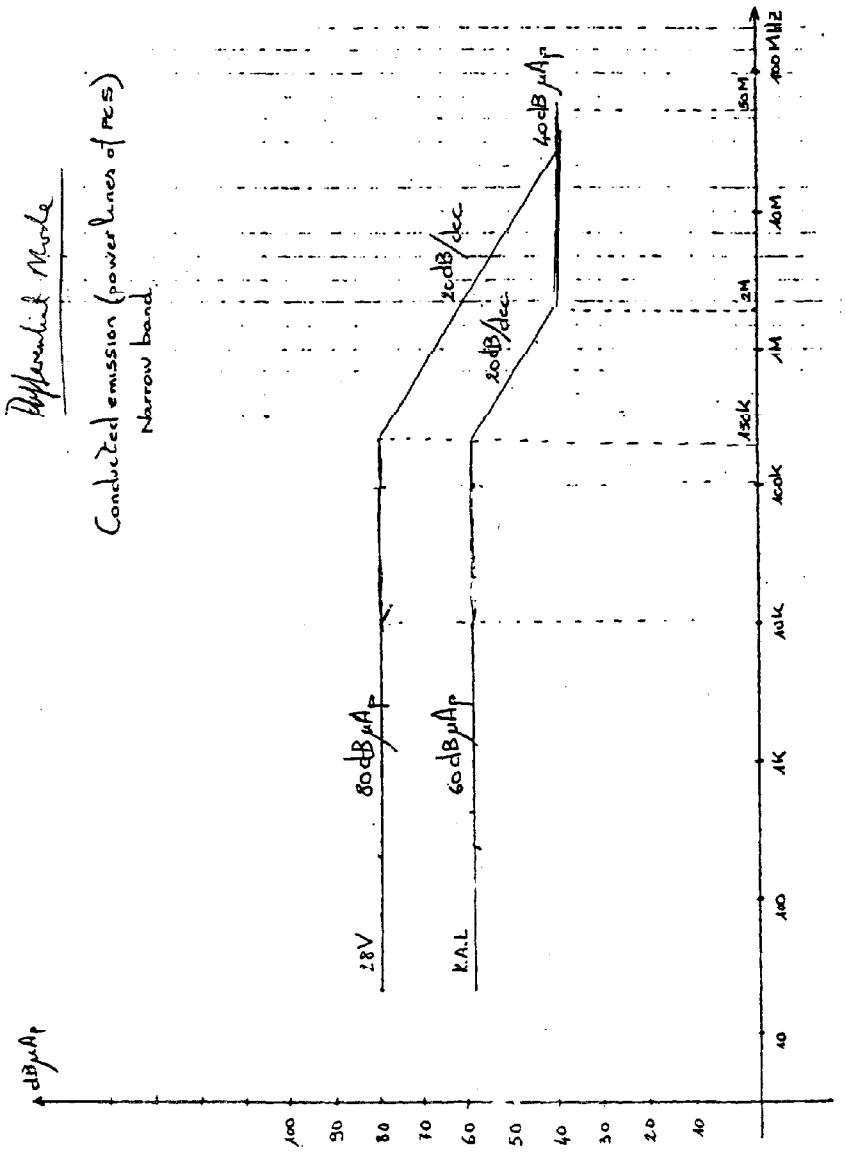


FIGURE 3.2.4.8.1.c

3.2.4.8.3 CE of users of P CS power lines

CE shall not appear in excess of the values shown in figure 3.2.4.8.2.

For test purpose, output impedance of power source in parallel to the 10 uF capacitor shall be lower than the actual PCS output impedance given in figure 6.1 with one meter cable. The current measurement will be made separately on both forward and return wires with the aim to demonstrate that the CM current is less than 100 uAp from dc to 50 MHz.

3.2.4.8.2 CS of PCS power lines

The PCS subsystem shall not exhibit any malfunction, degradation of performance, deviation from specified susceptibility criteria given by the corresponding subsystem specification and test procedure when subjected to a parasitic signal on the power lines whose characteristics are given in figure 3.2.4.8.3.

The test will be performed with the PCS loaded by non inductive resistors leading to the average total DC currents of:

- 28V lines : 16 A
- +5.5 V lines: 5 mA.

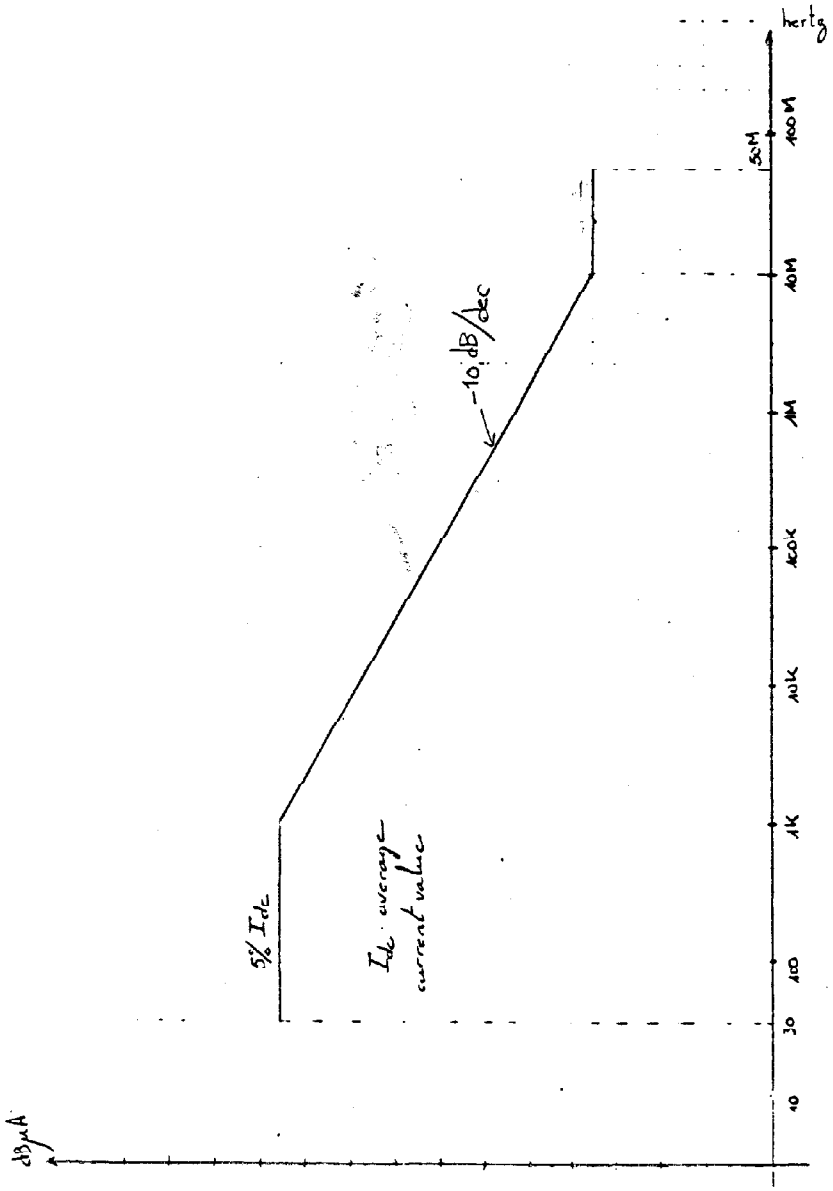


FIGURE 3.2.4.8.2 CE OF USERS OF POWER LINES

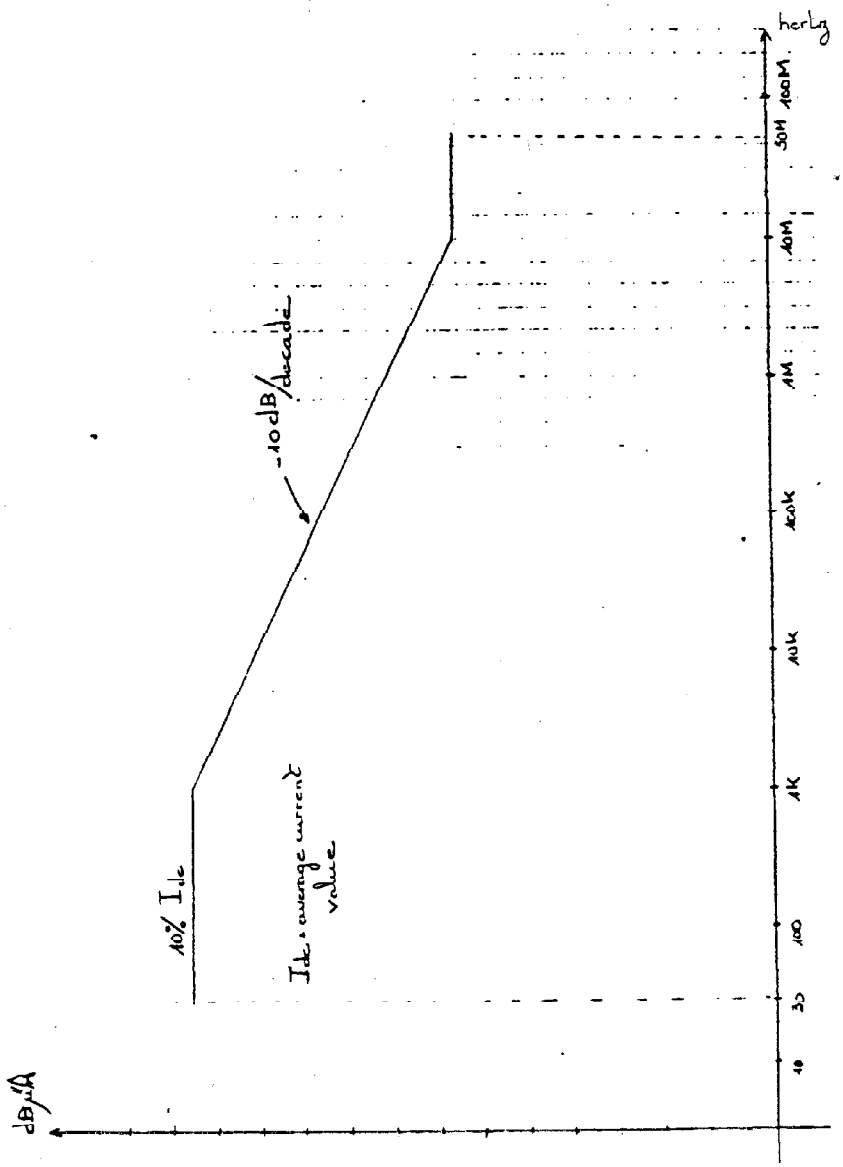


FIGURE 3.2.4.8.3 CS OF PCS POWER LINES

3.2.4.8.4 CS of users of PCS power lines

The unit or subsystem under test shall keep nominal performance as specified in the relevant equipment/subsystem specification when subjected to the following perturbation*. For continuous signals (sinewave, squarewave), the injected current shall be monitored and limited to 1 ampere peak, on their input power lines:

- Continuous sinewave from 30 Hz to 50 MHz (differential mode)

  . 28V lines: 1 Vrms

  . KA lines : 300 mVrms

- Squarewave from 30 Hz to 500 KHz (differential mode)

  . amplitude : 2 Vpp (for 28 V lines)
  0.6 Vpp (for KA lines)

  . risetime : $\leqslant$ 1 uS for f $\leqslant$ 50 kHz
  : $\leqslant$ 100 nS for f > 50 kHz

  . duty cycle: 50%

  The sweep speed of the sinewave and the squarewave tests shall be less than 1 octave/minute.

- Voltage surges (differential mode)

  . trapezoidal shape: rise time < 4 uS

Both polarities will be tested:

- a positive pulse at the highest allowed supply voltage
- a negative pulse at the lowest voltage limit.

The pulse characteristics shall be as follows:

. on 28V lines : E = 3V τ = 800 us

. on KAL line : E = 2V τ = 200 us.

(τ (tau)): duration at half amplitude.

A minimum of 10 pulses of each polarity shall be experienced, applied alternatively, with a repetition rate no greater than 10 Hz.

* For continous signals (sinewave, squarewave) the injected current shall be monitored and limited to one ampere peak.

- squarewave from 30 Hz to 1 MHz (common mode)

  . amplitude : 4 Vpp

  . risetime : < 5 % of the period

  . duty cycle: 50%

  . the sweep speed shall be less than 1 octave/minute

- transient single event: (common mode)

  . shape as for differential mode

  . amplitude E = 20 Volts

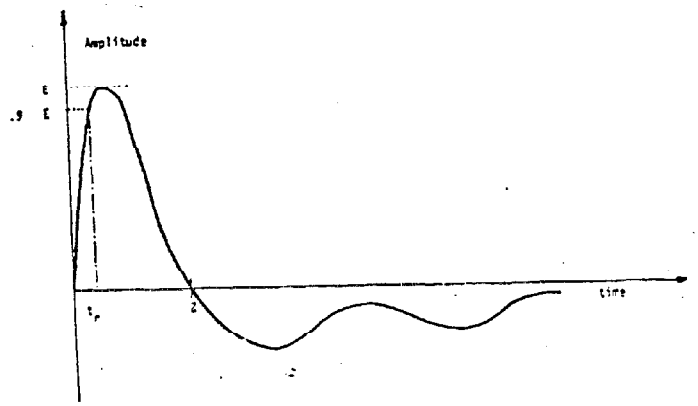
  . rise time: $\leq$ 10 ns (tr)

  . duration : $\geq$ 150 nS (Z).

  Both polarities shall be tested (10 pulses minimum).

* In common mode, the spurious signal is injected between the power return wire and the unit case (if not connected).

The shape of the transient shall be as follows:



3.2.4.9 Conduction requirements on TM/TC lines

By TM/TC lines, it is intended all the TM/TC signal lines interfacing with the OBDH subsystem.

3.2.4.9.1 CE/CS on analog TM lines

Analog TM lines (sigle ended):

(1) - Source conducted emission: 10 mVpp max. (load 10 Mohm, 150 pF)
BB Range DC to 100 kHz
4 mVpp max. (load 10 Mohm, 150 pF)
NB (spectrum analyser up to 100 kHz)

- TM encoder input CS : 20 mVpp min (NB): range: 1 Hz to 50 MHz

(1) - TM encoder CE : 4 uApp (load 5 kohm) BB range DC to 100 kHz
1 uApp (load 5 kohm) NB (range 1 Hz to 100 KHz)

- Source CS : 8 uApp (NB) range 1 Hz to 100 KHz

Analog TM lines (double ended) (range 1 Hz to 50 MHz)

(1) - Source CE : 10 mVpp max (load 10 Mohm, 150 pF) BB.BW [DC - 100 kHz]
4 mVpp max (load 10 Mohm, 150 pF) NB range 1 Hz to 100 kHz

- TM encoder inputs CS:

  . differential: 20 mVpp min (NB) range 1 Hz to 50 MHz

  . common mode: the encoding error shall be less than 5 mV for a common mode voltage of ± 5V (NB)

(1) - TM encoder CE : 4 uApp (load 5 kohm) BB BW [DC - 100 kHz]
1 uApp (load 5 kohm) NB range 1 Hz to 100 kHz

- Source CS : 8 uApp range 1 Hz to 100 kHz.

(1) The user is allowed not to perform NB test as soon as the BB one (peak to peak measurement of the noise will be an oscilloscope of 100 kHz bandwidth) is compliant with its dedicated requirement.

3.2.4.9.2 CE/CS on digital bilevel TM lines

The requirements apply from 1 Hz to 50 MHz

(1) - Source CE: 100 mVpp (on both logical level) BB (oscilloscope)
20 mVpp (on both logical level) NB (spectrum analyser)

load characteristic for test: 100 Kohm// 150 pF.

- TM encoder CS: "1" : 1 Vpp min surimposed on 3.5 Vdc NB
"0" : 1 Vpp min surimposed on 0.5 Vdc NB

- Source CS : 20 uApp min (NB)

(1) - TM encoder CE: 10 uApp (load 10 kΩ) BB (oscilloscope)
2 uApp (load 10 kΩ) NB

3.2.4.9.3 CE/CS on Digital serial TM lines

Data lines (from 1 Hz to 50 MHz)

(1) - Source CE: as for digital bilevel

load characteristic for test: 100 kΩ//150 pF

- TM encoder CS: "1" : 0.5 Vpp min: surimposed on 3.5 Vdc NB
"0" : 0.5 Vpp min: surimposed on 0.5 Vdc NB

(1) - TM encoder CE: "1" : 50 uApp (load 2 kΩ) NB or 250 uApp (BB)
"0" : 50 uApp (load 2 kΩ) NB or 250 uApp (BB)

- Source CS : "1" : 100 uApp NB
"0" : 200 uApp NB.

3.2.4.9.4 CE/CS: Switch closure

- User CS

a. Amplitude discrimination (applicable to all switch closure interface except for instruments)

"1" (+): switching from $r_{switch} > 100\ K\Omega$ to $r_{switch} = \frac{Rp^*}{2}(1 + \epsilon)$

"0" (-): switching from $r_{switch} < 10\Omega$ to $r_{switch} - 2\ Rp^*\ (1 - \epsilon)$

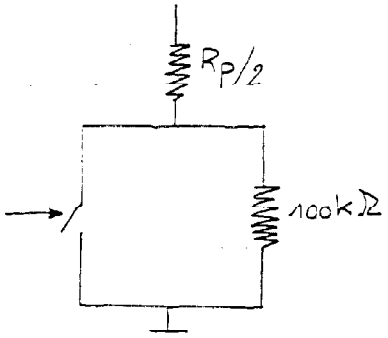
(1) The user is allowed not to perform this NB test as soon as the BB one (peak to peak measurement of the noise with an oscilloscope of 50 MHz bandwidth) is compliant with its dedicated requirement.

* Rp is the pull up resistor connecting the input circuit to the DC supply voltage on user's side.

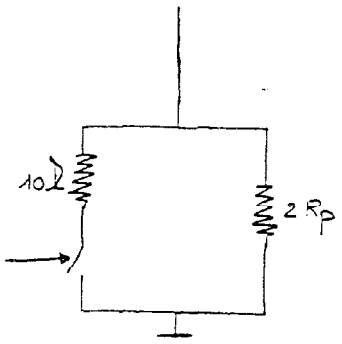
$\epsilon = 0.1$

Suggested test set-up is

"1" level



"0" level



- switching rate 1 Hz to 50 MHz - For pulses (TC address, TM sample, low level % cmd) DC testing is sufficient.

Suggested test set-up are:

Criteria of success shall be clearly identified in the relevant test procedure

- user CE: "0" (+): $\frac{(Vcc)}{(3)}$ Vpp when loaded by 10 Ohms from 1Hz to 50 MHz max.

"1" (+): $\frac{(Vcc)}{(3)}$ Vpp when loaded by 100 KOhms from1 Hz to 50 MHz

b. Amplitude discrimination for instruments (all switch closure interface

0.1 mA subject to 20 dB/dec increase from 10 kHz (limited to 2.4 mA).

c. Frequency/width discrimination

Interface circuits shall not respond to pulses corresponding in length to the rise or fall time of the signal source or 10 % of the respective signal pulse length, which ever is smaller.

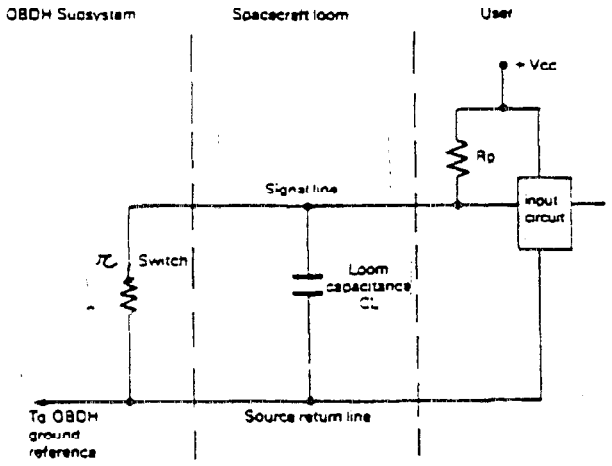
Accordingly, the following spurious pulses shall be experienced.

Signals	Tf	10 % of signal	Duration to be tested (1)	fall time during test (2)
Low level 0/0 cmd	0.6 µs	1.3 ms	≥ 0.6 µs	≤ 0.6 µs
MLC address	0.6 µs	23.6 µs	≥ 0.6 µs	≤ 0.6 µs
MLC data	0.6 µs	.76 µs	≥ 0.6 µs	≤ 0.6 µs
MLC clock	0.6 µs	.38 µs	≥ 0.38 µs	≤ 0.38 µs
DSTM sampling	0.6 µs	11.4 µs	≥ 0.6 µs	≤ 0.6 µs
DSTM clock	0.6 µs	.38 µs	≥ 0.38 µs	< 0.38 µs
High f. clock 262 kHz	0.3 µs	.19 µs	≥ 0.19 µs	≤ 0.19 µs
Word pulse	0.6 µs	11.4 µs	≥ 0.6 µs	≤ 0.6 µs
Frame pulse	0.6 µs	11.4 µs	≥ 0.6 µs	≤ 0.6 µs
Format pulse	0.6 µs	11.4 µs	≥ 0.6 µs	≤ 0.6 µs
2^3 format pulse	0.6 µs	11.4 µs	≥ 0.6 µs	≤ 0.6 µs

TABLE 3.2.4.9.4c

(1) The duration is defined at 50% amplitude of the signal.

(2) This is the fall time which shall be experienced during test



3.2.4.9.5 CE/CS: Sampling, acquisition clock (TM lines), special synchro lines

- user CS: a) as specified for switch closure (§ 3.2.4.9.4a); not applicable to instruments

b) pulse width discrimination, (on sampling lines)

"1": outside sampling period ; switching from $r_{switch} > 100\ k\Omega$ to $r_{switch} < 10\ \Omega$

. duration of pulse:)
) as specified in table 3.2.4.9-4c
. tf (fall time):)

. repetition rate: once per 64 us.

"0": during sampling period ; switching from $r_{switch} < 10\ \Omega$ to $r_{switch} > 100\ k\Omega$

. duration of pulse:)
) as specified in table 3.2.4.9-4c
. tf (fall time):)

. repetition rate: once per 64 µS

A minimum of 10 pulses shall be experienced.

c) TM clock, high frequency clock (262 kHz), word pulse, frame pulse, format pulse, 2^3 format pulse

. duration:) as specified in table 3.2.4.9.4c)
. Tf (fall time) "

- user CE: as specified for switch closure (not applicable to instruments).

3.2.4.9.6 CE/CS: low power O/O cmd

- user CS: a) as specified for switch closure (not applicable to instruments) exept that the value of r switch (closed) is increased from 10 ohms to 20 ohms (cf. § 3.2.4.9.4).

b) pulse duration (width) discrimination

"1" : switching from ⌜switch > 100 kΩ to ⌜switch < 10 Ω

. duration:)
. tf:)) as specified in table 3.2.4.9-4c

. repetition rate: once per 13 ms.

A minimum of 10 pulses shall be experienced.

- user CE: as specified for switch closure (not applicable to instruments).

3.2.4.9.7 CE/CS: high power O/O cmd

Requirements apply from 1 Hz to 50 MHz.

(1) - TC decoder output CE: 1 Vpp max. on both levels (BB)
: 100 mVpp max. on both levels (NB)

- user CS : a) 2 Vpp max on both levels

b) positive trainpulse:

. amplitude 16 V
. duration: 100 us (at 50% amplitude)
. repetition rate: 15 ms
a minimum of 10 pulsese shall be experienced

- user CE : 25 u App (load TBD)

- TC decoder output CS: 50 uApp.

3.2.4.9.8 CE/CS on MLC lines (address, clock, data)

- user CS: a) as specified for switch closure (§ 3.2.4.9.4a) (not applicable to instruments).

b) pulse width discrimination (address lines)

"1": outside addressing period ; switching from r_{switch} > 100 kΩ to r_{switch} < 10 Ω

. duration)
) as specified in table 3.2.4.9-4c
. tf (fall time)

. repetition rate: once per T ; T < 236 us

"0": during addressing period ; switching from r_{switch} from r_{switch} < 10 Ω to r_{switch} > 100 kΩ

. duration)
) as specified in table 3.2.4.9-4c
. tf (fall time)

. repetition rate: once per T ; T ≤ 236 us

shall not affect the intended operation.

A minimum of 10 pulses shall be experienced.

c) frequency discrimination (TC data)

. duration)
. tf (fall time) as specified in table 3.2.4.9-4c

d) frequency discrimination (TC clock)

. duration)
. tf (fall time) as specified in table 3.2.4.9-4c

- user CE: as specified for switch closure (not applicable to instruments).

(1) The OBDH supplier is allowed not to perform the NB test as soon as the BB one (oscilloscope 50 MHz BW) is compliant with its dedicated requirement.

3.2.4.9.9 Switch closure interface with instruments

Requirements apply from 10 KHz to 5 MHz

3.2.4.9.9.1 Low level % cmd

- User CS

  . Amplitude discrimination: see § 3.2.4.9.4b
  . Pulse width discrimination as for § 3.2.4.9.4c.

3.2.4.9.9.2 Sampling, acquisition clock TM lines

- User CS

  . Amplitude discrimination: as for § 3.2.4.9.9.1 . Pulse width discrimination (on sampling lines) as for § 3.2.4.9.4c
  . frequency discrimination (TM clock): as for § 3.2.4.9.4c.

3.2.4.9.9.3 MLC lines (address, clock, data)

- User CS

  . Amplitude discrimination: as for § 3.2.4.9.9.1 . Pulse width discrimination (address lines) as for § 3.2.4.9.4c
  . Frequency discrimination (TC clock + TC data): as for § 3.2.4.9.4c.

3.2.4.9.10 Test requirements

For the duration of the tests, the TM/TC lines will be loaded by resistor or resistor//capacitor as defined in the dedicated paragraph: e.g

- for digital TM lines: 100 kΩ //150 pF:

- for analog TM lines: 10 MΩ//150 pF

Attention shall be paid that the measurement device does not affect the load impedance.

The tests are applicable at each TM/TC inputs/outputs. In case of identical input/output circuits, the Contractor is allowed to limit to 2 the number of such tested circuits.

3.2.4.11 Conduction requirement on other lines

- By "other lines", it is intented all the:

  - subsystem intra links (e.g secondary power lines, internal bus...)

- subsystem links (e.g temperature sensor conditioned by PDU, flags from AOCMS to experiments...)

which are neither primary power lines delivered by PCS S/S nor TM/TC lines received/delivered by OBDH

- For the first kind of links (intra S/S links), the EMC is under the responsibility of the subsystem supplier. The suggested method to prove the EMC is to perform the tests at subsystem level, considering the whole subsystem as an single unit and then apply to the subsystem the requirements which are defined for units on standard interfaces (power lines, TM/TC lines)

- For the subsystems links, three have been identified:

. Temperature sensor conditioned by PDU

. DC/DC converters synchronization signals

. OTF from AOCS to instruments.

Requirements in terms of CE/CS are defined in § 3.2.4.12.

3.2.4.12 CE/CS on converters synchro.lines and OTF

a. Converter synchro.lines

a.1 User CS

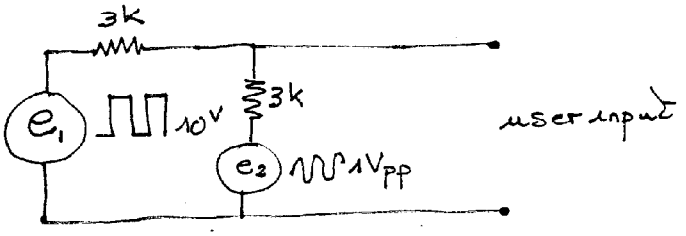
The unit under test shall keep nominal performances when a spurious signal is surimposed on the nominal square signal [0-5 V].

Spurious signal: sinewave 500 mV pp

frequency varying from 500 Hz to 30 MHz

Sweep speed lower than 1 octave per minute

A suggested test configuration is:



The rise and fall times of the 10V square signal shall be in that case equal to those of the nominal 5V square signal.

a.2 RTU output CE

Noise surimposed on the nominal 5^V square signal shall be lower than 100 mV pp on both level, BB measurement (oscilloscope BW ≥ 30 MHz).

b. OTF signals (applicable only to scientific instruments and DMU)

b.1 User CS

b.1.1 Amplitude discrimination

- As for § 3.2.4.9.9.1.

b.1.2 Pulse width discrimination

Pulses from "ON" to "OFF" or from "OFF" to "ON" of the flag, for less than 1.5 mS shall be rejected.

b.2 DMU CE

When loaded by:

- a resistor of 47 Ω in serie with a conducting diode on each of the 4 instruments, the leakage current in "OFF" state shall be less than 50 µA (BB) measured with an instrument of 50 MHz BW.

4. SATELLITE TESTING CONDITIONS REQUIREMENTS

4.1 TESTING FACILITIES

The satellite will be placed in a clean room (anechoïc clean room mandatory for radiated testing) where the ambient noise is at least 6 dB below the test level in all the required frequency ranges - however, few stable, predictable and widely spaced signals can be tolerated to be higher than this limit.

4.2 SATELLITE OPERATIONAL CONFIGURATION

For tested operational configurations, refer to EMC test plan as included in the EMC control plan.

4.3 RADIATED EMISSION

Narrowband, E-field emission shall be determined at 1 meter distance from the S/C for assessment of ambient field around cryostat, while determined in the VEB plane for L.V compatibility testing.

4.4 CONDUCTED EMISSION/SUSCEPTIBILITY

In case of probes wires (enbedded into harness) are used, they will have to be grounded to structure after tests.

4.5 SUSCEPTIBILITY TESTING

It is assumed that all monitoring of ISO, particularly concerning experiments aspects is performed via telemetry and practically near real time monitoring is required. If monitoring time becomes substantial (to be compared to sweep speed of about 1 octave/minute), only discrete frequencies will be tested.

5. MODULE TESTING CONDITIONS REQUIREMENTS

5.1 PLM TESTING CONDITIONS

The requirements stated in chapter 4 (satellite testing conditions requirements) are fully applicable to PLM, which the exception of LV requirements verification. For conducted tests on primary power lines, PCS impedance shall be simulated.

5.2 SVM TESTING CONDITIONS

Refer to ISO satellite testing.

6. EQUIPMENT/SUBSYSTEM TESTING CONDITIONS

6.1 TEST SET-UP REQUIREMENTS

6.1.1 General set-up requirements

a. The tests shall be performed in an ambient electromagnetic environment which is at least 6 dB below the performance levels required in Section 3.2.4. Included in the ambient level are also emissions from test equipment, including unit-testers (EGSE) with its harness.
Measuring antenna ends shall not be closer than 1.0 meter from any electrically conductive elements during the test.

b. The test harness length shall be as a minimum 3 meters of which 2 meters shall be exposed 5 cm from the edge of the ground plane at a 5 cm height. Breakout boxes which are used for the line measurements shall be carefully designed to fulfill the purpose of the test.

c. No shielding between the test set-up and measurement antennas is allowed

d. Grounding of interfaces shall be in accordance with flight installation.

e. Bonding of units - unit tester, etc... to the ground plane shall be verified by a bonding test. The unit bond shall be similar to that specified for the actual installation except for conducted common mode emission/susceptibility tests when a ground strap between the grounding lug and the ground plane shall be used

f. The tests shall be performed with test samples, unit-testers (EGSE) and harness placed on a conductive ground plane with a length greater than 2.5 meters and a width of more than 1 meter. If shielded room is used the groundplane shall be bonded to the room with low inductive bonds separated by less than 0.5 meter. This connection shall be verified by a resistance test. This connection of the groundplane is very important when the EGSE has to be located outside the shielded room because of emission or suceptibility exceedings

g. In the cases where real electrical/electronic loads cannot be used these shall be simulated by dummy loads with similar characteristcis. It is forbidden to take the interface wires to ground if not done in the actual installation.

The power sources used for the tests shall have a well defined impedance below 10 MHz: see fig. 6-1. Any variation from these impedance levels requires data correction as follows:

the correction formula is:

$$Icor = \frac{Z}{Zu} \times I_{NORM}$$

Where:

I_{COR} = new specification level

I_{NORM} = level given in para 3.2.4

Z = impedance as in figure 6-1

Z_U = used impedance

h. The test harness must be similar to flight condition: this applies also to the type of cables

Shielded wires shall not be used in the test set-ups unless they have been agreed by the Prime Contractor. The cable configuration, except the length, shall thus be in agreement with approved interface drawings. No overall cable shields are allowed unless used in the actual design.

i. Radiated susceptibility tests shall be performed such that regulations and laws at the test location are met.

Reflection effects shall be minimized by means of absorber materials.

All equipment used for emission and susceptibility tests shall be calibrated and wear calibration certificate.

Passive equipment, such an antennae, current probes, etc... must have calibration curves from the manufacturer.

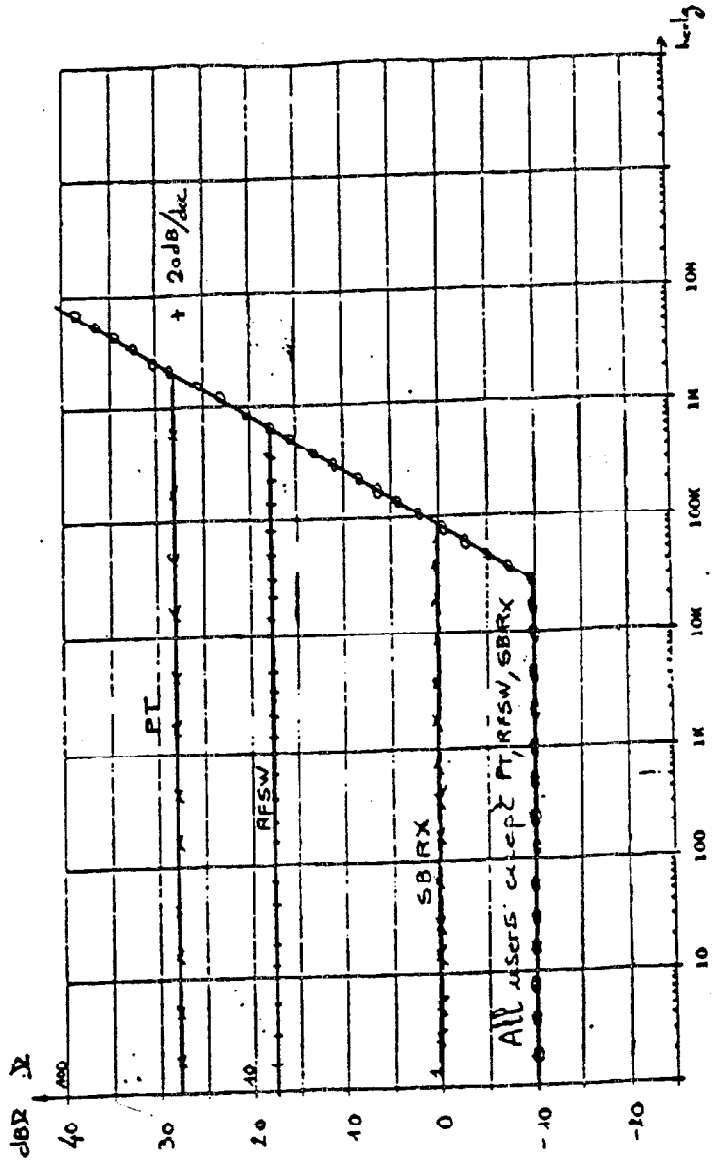


FIGURE 6-1 OUTPUT IMPEDANCE OF POWER SUPPLY (PDU OUTPUTS)
(For S/C or test equipment)

6.1.2 Test set-up for emission measurement

a. CEP conducted emission, power lines (for PCS loads)*

The suggested (1) test set-up is as shown in figure 6.1-2a. Any switch for ON/OFF test will be positioned berween to 10 uF capacitor and the unit under test. The transients are then measured on the power lines between the switch and the unit under test. For the Ac power line the 10 uF capacitor shall not be used.

b. RE-E radiated emission, E-field

The suggested (1) test set-up is as shown in figure 6.1-2c. The emission at the antenna at one meter distance from the test object which gives the highest reading shall be the RE-E level.

c. RE-H radiated emission, H-field (AC)

The suggested test set-up is as shown in figure 6.1.2d. The emission at the antenna at one meter distance from the test object which gives the highest reading shall be the RE-H level.

d. RE-H radiated emission, H-field (DC)

For DC magnetic field measurements, the following steps shall be performed.

1. The de-energised equipment shall first be depermed in a field of initial value 50 Oe, at a frequency in the range 3 Hz to 50 Hz. At 3 Hz, the field amplitude shall be reduced to zero over a period of 10 minutes. At 50 Hz this period may be reduced to 1 minute.

   Such deperming shall be performed in each of the 3 orthogonal axes.

2. The static field for the energised but quiescent equipement shall be measured along any of its orthogonal axis.

* NOTA: For PCS, CE measurement test set-up is defined in the EMC test plan.

(1) Alternative test set-up will have to be approved by the PRIME.

3. The de-energised equipment shall then be exposed to magnetising field of 3 Oe DC along each orthogonal axis.

4. The DC magnetic field of the re-energised equipment shall be measured along each of its orthogonal axes.

Measurements shall be taken at a distance r(m) which is not least 3 times the largest dimension of the equipment. Tests results shall be extrapoled to 1 meter using the equation

$$B \text{ (at 1 m)} = B \text{ (at r)} \times r^3$$

5. The unit shall be depermed as the end of this sequence

If meaningful results cannot be obtained at 3 times the largest equipment dimensions, the tests may be made at a shorter distance but in this case the field law shall be established, before extrapolating the results to 1 meter, by varying the measurement distance.

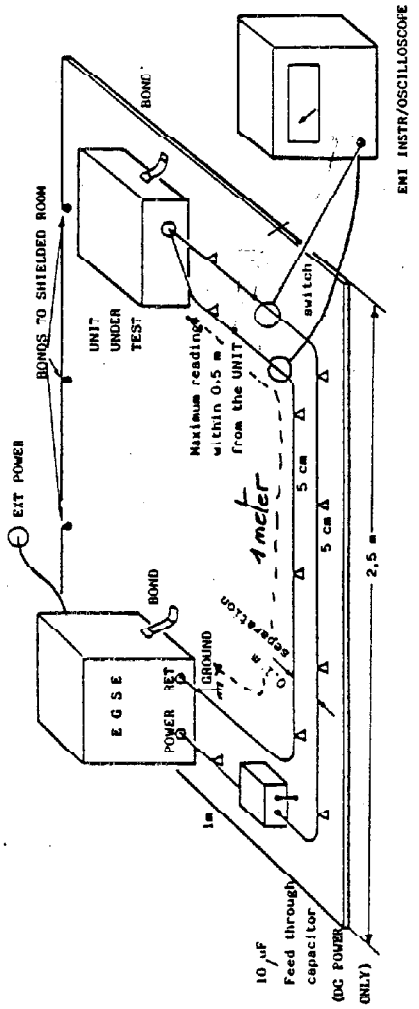


FIGURE 6.1-2a CONDUCTED EMISSION, TEST SET-UP (FOR PCS LOADS)

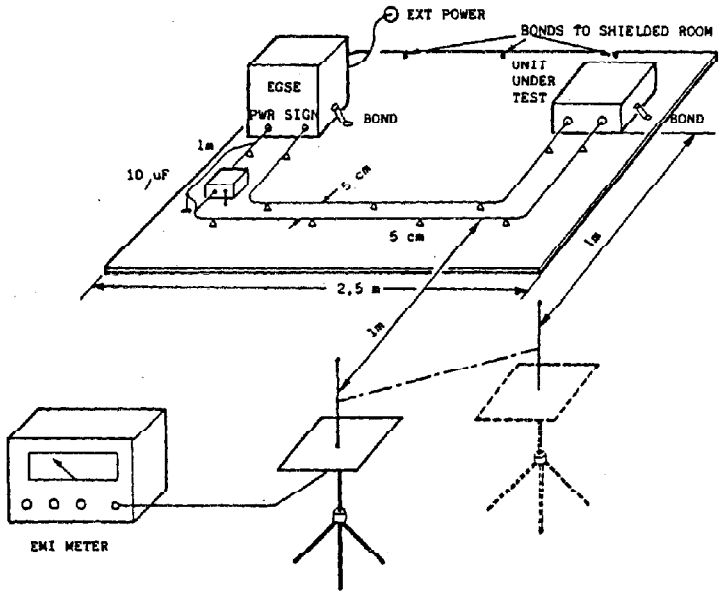


FIGURE 6.1-2.b RADIATED EMISSION, E-FIELD TEST SET-UP

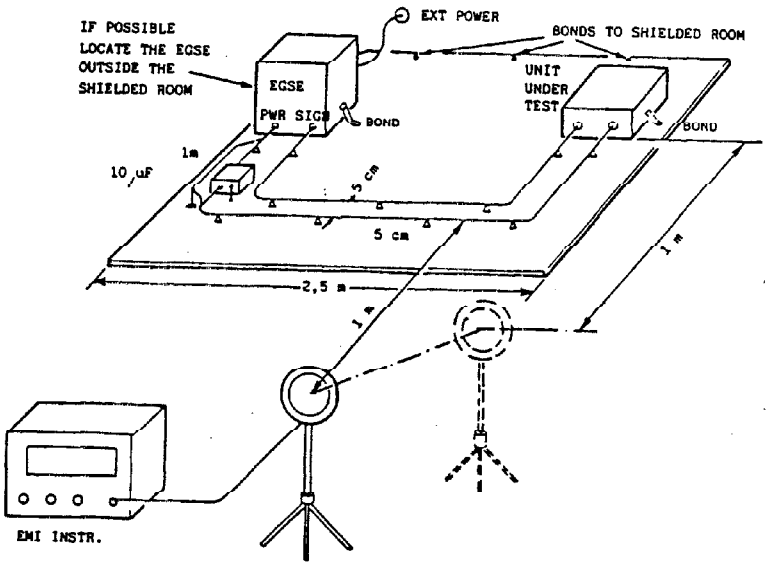


FIGURE G.1-2.c RADIATED EMISSION, H-FIELD TEST SET-UP

6.1.3 Test set-up for susceptibility tests

a. CSP conducted susceptibility, power lines

The test set-ups are shown in figures 6.1.3.a1 to 6.1.3.a4 for DC power only. The pulse tests shall be performed by switching the power source of the specified quantity in the specified time. The injected current relevant to the susceptibility threshold or to the voltage limit shall be monitored and recorded.

b. CSCM conducted susceptibility, common mode

The test set-up is shown in figure 6.1.3.b. The injected current relevant to the susceptibility threshold shall be monitored and recorded.

c. Common mode rejection test

Signal ground and the ground plane shall be disconnected and the signal shall be injected between them as indicated in the figure 6.1.3.c.

d. RS-E radiated susceptibility, E-field

The test set-up shall be as in figure 6.1.3d. The distance between the rdaiating antenna and the UUT shall be not less than 1 meter. In case, the specified field strength cannot be achieved a shorter distance is permitted as long as the test region against the field strength is measured and specified.

e. RS-H radiated susceptibility, H-field

The test set-up shall be as in figure 6.1-3.e. The distance between the radiating antenna and the UUT shall be the most suitable to achieve the specified level of field strength in the test region.

f. ES electrostatic discharge susceptibility

The test set-up shall be as in figure 6.1-3.f1 and 6.1-3.f2.

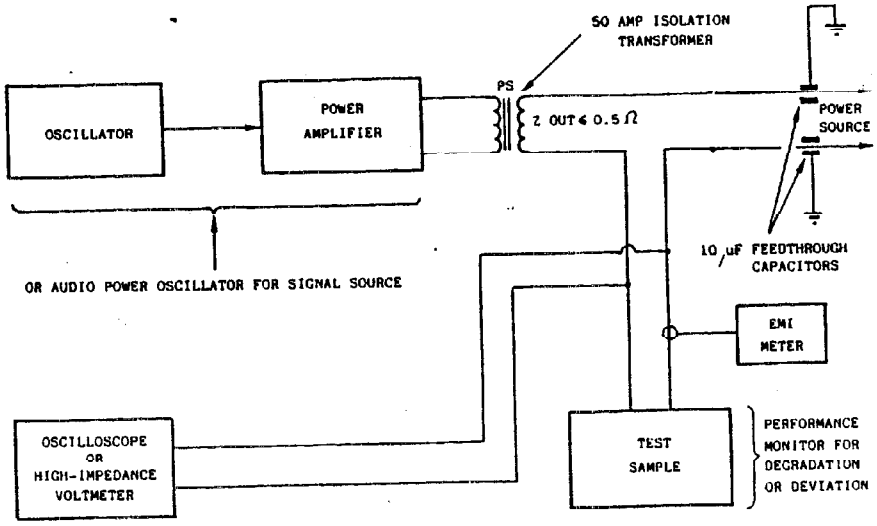


FIGURE 6.1-3a1 CONDUCTED SUSCEPTIBILITY (30 Hz - 50 KHz)
(FOR SINE INJECTION)

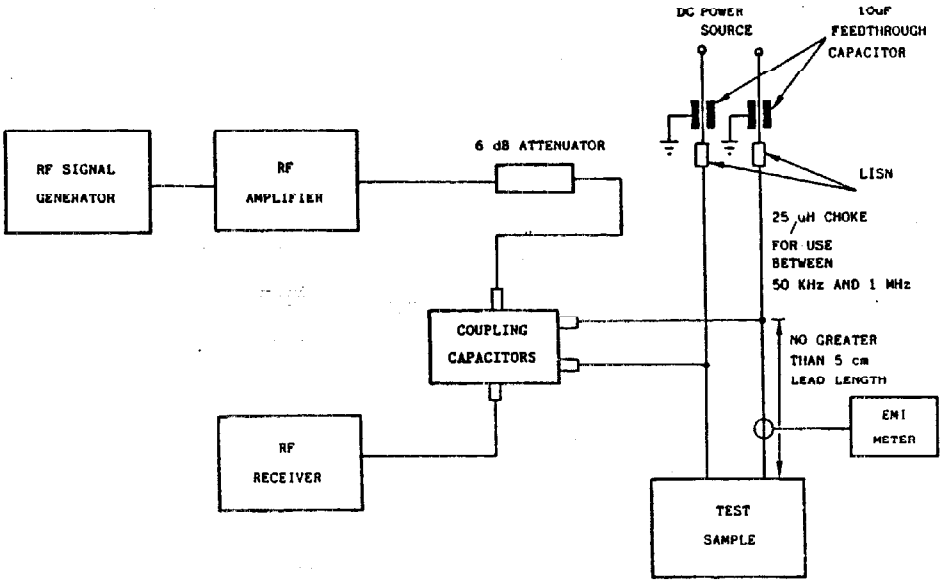


FIGURE 6.1-3a2 CONDUCTED SUSCEPTIBILITY (50 kHz - 50 MHz)
(FOR SINE INJECTION)

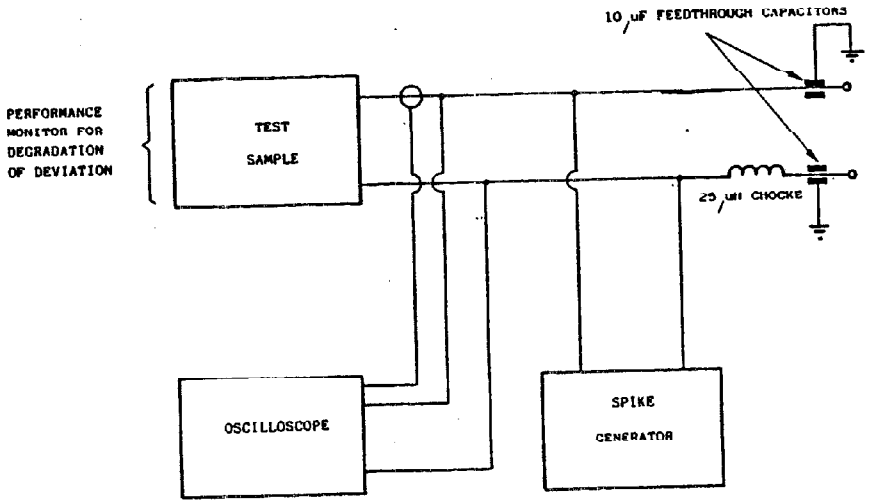


FIGURE 6.1-3a3 CONDUCTED SUSCEPTIBILITY
(TRANSIENTS PARALLEL INJECTION)

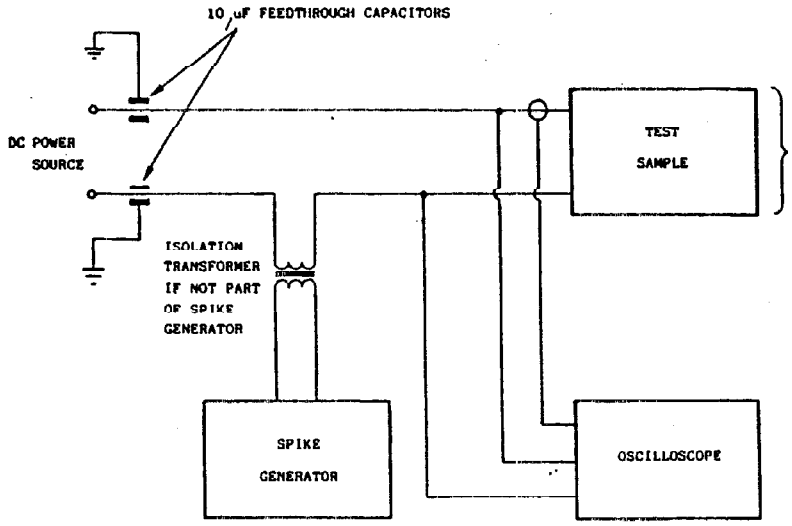


FIGURE 6.1-3a4 CONDUCTED SUSCEPTIBILITY
(TRANSIENT, SERIES INJECTION)

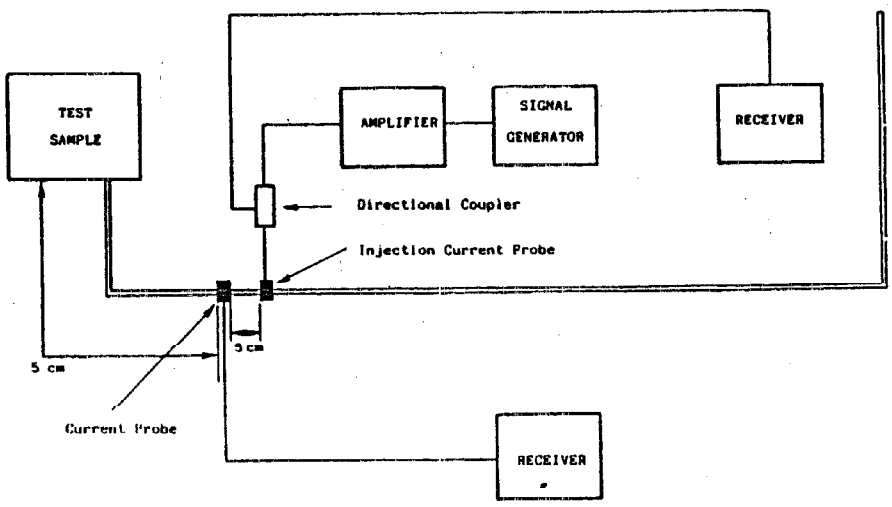
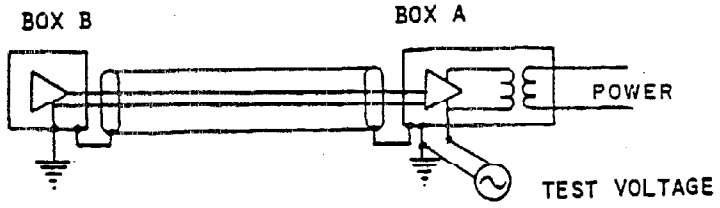
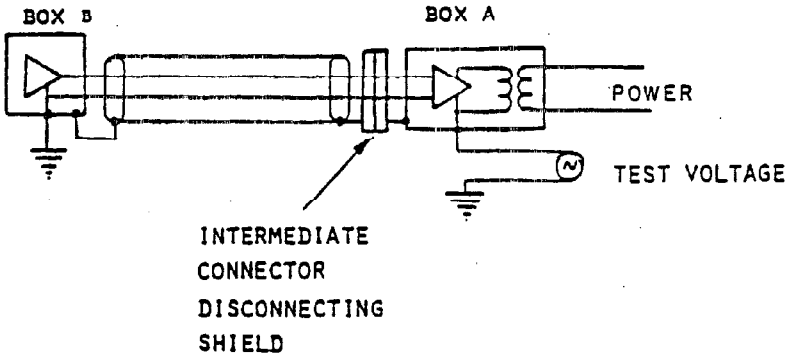


FIGURE 6.1-3b CONDUCTED SUSCEPTIBILITY
(COMMON MODE)



a. Test set-up for externally accessible ground wire



b. Test set-up when ground wire is not accessible. Box fitted from structure and shield disconnected.

FIGURE 6.1-3c COMMON MODE REJECTION TEST SET-UP

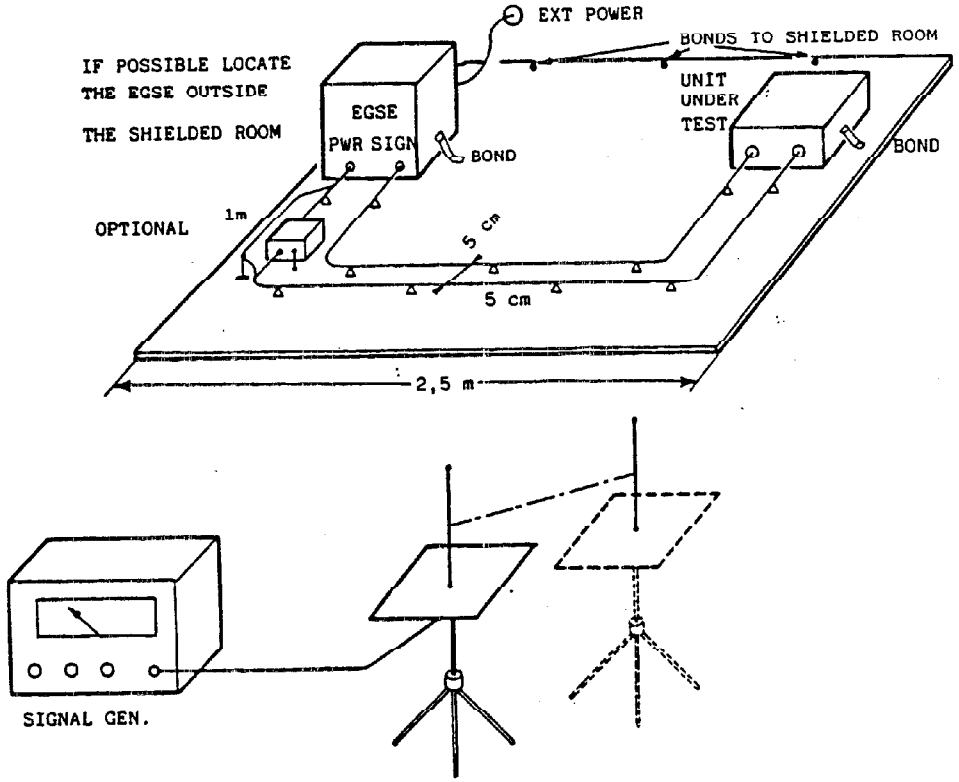


FIGURE 6.1-3d RADIATED SUSCEPTIBILITY E-FIELD TEST SET-UP

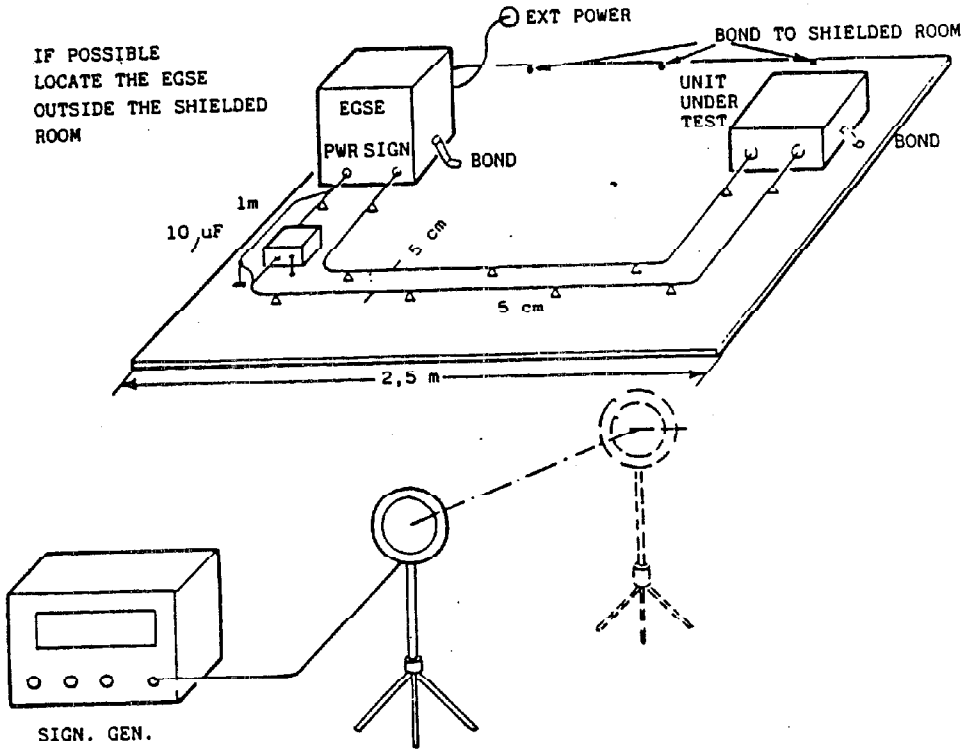


FIGURE 6.1-3e RADIATED SUSCEPTIBILITY H-FIELD TEST SET-UP

6.2 TEST SUPPORT EQUIPMENT GUIDELINES

a. Accessory equipment precaution

Care shall be taken to ensure that all accessory equipment used, such as spectrum monitors, oscilloscopes, earphones and other equipment used in conjunction with EMI analysers do not affect measurement integrity.

b. Excess personnel and equipment

The shielded enclosure of EMC test area shall be kept free of unnecessary equipment, cable racks and desks. Only the equipment essential to the test being performed shall be present. Personnel not actively involved shall not be permitted in the enclosure or test area.

c. Use of measuring equipment

All equipment used shall be operated as prescribed in the respective instruction manuals unless otherwise specified in the appropriate test procedure and approved by the Prime Contractor.

d. Grounding of measuring equipment

It is important that the grounding of equipment (EMI instrumentation) be accomplished in accordance with the following rules to avoid false data that may be introduced by ground loops. Shocks hazards will be minimised by adherence to these rules if care is taken to have the instruments bonded to ground plane at all times.

i. The antenna shall be remote from the measuring instruments

ii. The EMI measuring instruments shall be physically grounded with only one connection

iii. The EMI measuring instruments shall be connected to the AC line voltage (AC power source) through an isolation transformer. It is imperative that the chassis power ground be broken at this point to prevent the circulation of RF ground currents in the EMI test equipment.

e. Monitoring of EMI measuring instruments

The IF of RF output of the EMI measuring instruments shall have the capability of bieng monitored with a device that gives an amplitude versus frequency presentation on a cathode ray tube or on an X-Y recorder. This monitor shall be used to obtain information on the characteristics of the signals being measured.

f. Identification of spurious responses in measuring equipment

The measuring equipment shall be monitored first for spurious emissions. False data caused by such spurious emissions shall be identified on X-Y recordings or photos from cathode ray tubes.

g. Receiving equipment

Any commercially available receiving equipment such as spectrum analyser, EMI receivers may be used, provided the equipment has the necessary sensitivity and frequency range to perform the conducted and radiated tests specified in this procedure and having the following frequency and amplitude accuracies:

- frequency accuracy: ± 2 per cent
- amplitude accuracy: ± 2 dB

EMI receivers are preferred. The use of spectrum analysers shall be approved by the Prime Contractor.

h. Signal sources

Any commercially available signal source, pulse generator, power amplifier, capoable of supplying the necessary modulated and unmodulated power required to develop the susceptibility levels over the frequency range specified in this standard may be used provided the following requirements are met:

- frequency accuracy: ± 2 per cent
- harmonic content : minimum 30 dB below fundamental power.

i. Test antenna

The following antenna are recommanded for E and H-field. For susceptibility measurements any antenna can be used: the field strength shal be monitored in the test region in the vicinity of the unit under test. However, different antennas may be used provided calibration curves are available and the calibration has been performed as specified in the paragraph "Determination of Antenna Factors".

i. E-field antennas

- Frequency 10 KHz - 25 MHz

For emission measurements a 41 inch rod antenna with an electric length of 0.5 m and an appropriate matching network, as required, with a square counter poise of 60 x 60 cm shall be used.

For radiated susceptibility tests with a field strength up to 1 V/m the 41 inch antenna may be used with matching network. When fields greater than 1 V/m are required the antenna and procedure shall be described in the test plan.

- Frequency 20 MHz - 200 MHz

In the frequency range 20 MHz to 200 MHz the radiated emission and susceptibility tests shall be performed using a bi-conical antenna having the following specification:

- frequency range 20 to 200 MHz
- impedance matched to 50 Ohms

- Frequency range 200 MHz - 1 GHz

In the frequency range 200 MHz to 1 GHz the radiated emission and susceptibility tests shall be performed unsing the following two antennas:

- conical logarithmic spiral antennas (for emission and susceptibility tests) 1 - 10 GHz

- double ridged guide antennas (for susceptibility tests) 1 - 1 GHz.

ii. H-field antennas

For radiated emission tests as well as radiated susceptibility tests loop antennas shall be used having the following characteristics:

- radiated emission

The loop antenna together with the EMI receiving equipment shall be capable of measuring magnetic flux densities at least 20 dB below the applicable limits for this test

- radiated susceptibility

The loop antenna together with the signal source shall be capable of supplying sufficient current to produce magnetic flux densities 10 - 20 dB greater than the applicable limit at the test frequencies.

j. Current probes

Any current porbes capable of measuring to the limits and frequency range specified in this standard may be used. The transfer impedance curve of the probes used shall be included in the control plan as well as in the test report.

k. Ten microfarad capacitors

For the capacitors used to perform the measurements specified in this standard an insertion-loss or impedance curve be included in the control plan and test report.

7. ABBREVIATIONS

AC	Alternating Current/Alternating
BB	Broadband
CEP	Conducted Emission Power Lines
CECM	Conducted Emission Common Mode
CSP	Conducted Susceptibility Power Lines
DC	Direct Current/Steady State
EED	Electroexplosive Device
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EDS	Electrostatic Discharge Susceptibility
NB	Narrowband
RE-E	Radiated Emission E-field
RE-H	Radiated Emission H-field
RF	Radio Frequencies
RS-H	Radiated Susceptibility H-field
S/C	Spacecraft
STD	Standard
TBD	To be determined
UUT	Unit Under Test.