Chapter 6 : Payload verification and test requirements

CHANGE TRACEABILITY Chapter 6

Here below are listed the changes between issue N-2 and the issue N-1:

N°§	PUID	Change Status	Reason of Change	Change Reference	Doc Issue
§6.1.2.1		New in	Aims of the validation tests	PUM.6.1.EJ.29	6.2
§6.1.5.1		New in	§ at a different level: Electrical Functional Verification	PUM.6.1.CG.31_25	6.2
§6.1.5.1	**[PL - 6.1.5 -4]**	New in	Kinds of payload reference test	PUM.6.1.CG.31_25	6.2
§6.1.5.1	**[PL - 6.1.5 -5]**	New in	Duration of the tets	PUM.6.1.CG.31_25	6.2
§6.1.5.2		New in	§ Electrical Interface Validation	PUM.6.1.CG.31_25	6.2
§6.1.6.1	**[PL - 6.1.6 -3 a]**	Modified in	Table replace by Section	PUM.6.1.CG.31_26	6.2
§6.1.6.4	**[PL - 6.1.6 -8 a]**	Modified in	Handling: additional sentence	PUM.6.1.CG.31_27	6.2
§6.2		Modified in	Figure 6.2-1 updated	PUM.6.1.CG.31_28	6.2
§6.2.5.1		New in	§ 6.2.5.1 updated	PUM.6.1.CG.31_30	6.2
§6.2.5.2		Modified in	§ 6.2.5.2 updated	PUM.6.1.CG.31_30	6.2

Here below are listed the changes from the previous issue N-1:

N°§	PUID	Change Status	Reason of Change	Change Reference	Doc Issue
§6.1.5.2.1		Deleted in	Sentence deleted	PUM.6.1.CG.31_25a	6.3
§6.1.5.2.1	**[PL - 6.1.5 -7]**	Modified in	One sentence added	PUM.6.1.CG.31_25a	6.3
§6.1.6.3.4.4	**[PL - 6.1.8 -29]**	New in	Text becomes a requirement	PUM.6.2.E.J.21	6.3
§6.2.5.1		Modified in	Figure updated	PUM.6.1.CG.31_30a	6.3
§6.2.5.2		Modified in	RF launcher required bands ranges specified in section 3.5.7.2.1	PUM.6.2.EJ.33	6.3
§6.2.5.2		Modified	RF Susceptibility defined in Section	PUM.6.2.EJ.33	6.3

N°§	PUID	Change Status	Reason of Change	Change Reference	Doc Issue
		in	3.5.7.2.2		
§6.2.5.2		Deleted in	Launcher TM band deleted	PUM.6.2.EJ.33	6.3

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§ N°	Sentence	Planned Resolution
§6.2.5.2	**S/C EMC Radiated Emission and Susceptibility with launcher TBD:**	
§6.2.5.3	Test sequence TBD.	

Chapter 6: Payload verification and test requirements

The first section details the "rules of the art" and provides preliminary requirements to qualify the payload before delivery and consequently ensure the best compatibility with the satellite (especially for EMC). The second section describes the main tests and verifications (instrument inspection, functional tests) at satellite level in order to give a rough idea of the satellite tests sequence for the User.

6.1 PAYLOAD DESIGN VERIFICATION REQUIREMENTS

6.1.1 General

PL - 6.1.1 -1

The demonstration of the qualification status shall be given to the Satellite Contractor through the Development, Design and Verification (DD&V) documents and through the Payload End Item Data Package as defined in the Deliverable Items List.

PL - 6.1.1 -2

The Payload shall be delivered to the Satellite Contractor fully qualified. Required tests are given in Table 6.1-1.

Kind of tests		Required	Comments
Functional	PVT	X	For reference test purpose.
	HCT	X	For reference test purpose.
	AT	X	For reference test purpose.
Mechanical	Sine	X	
	Acoustic or random	X	Depending on payload shape
	Shock	X	At payload or payload sub-system level
Thermal	Thermal balance	X	
	Thermal cycling	X	
EMC	CE/CS	X	Test set-up described in section 6.1.8.7
	RE/RS	X	Test set-up described in section 6.1.8.7
ESD	ESD	X	
Mass properties	Mass properties	X	Mass and inertia

Table 6.1-1 : Tests required at payload level before payload delivery

The payload development and verification philosophy shall contain, at least, these required tests. Full test campaign and test levels and duration (qualification and/or acceptance) shall be determined by the Payload Supplier depending on the payload maturity and agreed by the Satellite Contractor.

The Payload Supplier shall deliver to the Satellite Supplier the Payload Flight Model and the Spare Model (if applicable).

6.1.2 Payload Model Build Standard

The payload level of assembly and build standard shall comply with the System verification concept selected for the PROTEUS based mission Program.

Provisions for payload models have to be made according to the Deliverable Items List.

PL - 6.1.2 -1

The payload model philosophy and its related payload qualification/acceptance program shall be defined by the Payload Supplier in his Payload Development and Validation Plan.

Hereafter are defined the payload models usually assembled and built to check the payload concept and performances. With this information, the User can estimate the need to build or not all these models according to his mission.

6.1.2.1 Payload Functional Model definition (TBC)

The Payload Functional Model shall be representative of the Flight Model for the following aspects:

Electrical interface parameters

All interface hardware shall be electrically and functionally representative of the flight standard (excluding use of high reliability parts).

Command control interface

All interface hardware and software equipment shall be representative of the flight standard.

Connectors interface

The interface connectors shall be flight representative. In the event the connectors interface with flight hardware or EGSE that also interfaces with flight hardware, gold plated hi-rel type or connector savers shall be used.

This model will be used for functional tests at satellite level on satellite validation bench. Requirements for this model are given in document reference «PIC-P0.3-NT-224-CNES».

Main aims of these validation tests are:

Test of the PF-PL communications for the mission:

- 1553 dialog:
  1553 TCs: Payload Controller Commands, Payload Software
  PLTM
  broadcast command: PPS UTC date message
- discrete acquisition lines from the Payload (OBDH addressing)
- discrete commands from the Platform to the Payload (OBDH addressing)
- Payload software loading through the Platform

FDIR testing

- For example: - Following to 3 consecutive out of range current values acquisitions on line n°X of the Payload, opening by the Platform of the Payload power lines relays according to a predefined order.
- Following to 3 consecutive out of range PLC temperature value acquisitions, opening by the Platform of the Payload power lines relays according to a predefined order.

Payload interface level tests

- For example: - closure of the power lines relays according to a predefined order with a fixed timing
- \- discrete command sensivity and observation of PL status change

System level tests

- All the functional chains together, with the modes chaining simulation according to real time performances.

6.1.2.2 Qualification and Flight Spares (QFS) definition

The objective is to qualify Payload off-line of the system qualification program.
This Payload shall be used as flight spare. Refurbishment of Payloads shall therefore be considered.

6.1.2.3 ProtoFlight Model (PFM) definition

The ProtoFlight Model shall be of a standard compliant with all the requirements of the applicable Payload Design Interface Specification (PDIS) last issue and shall have successfully undergone a full program of qualification testing (with acceptance duration) and verification prior to delivery.

6.1.2.4 Flight Model (FM) definition

The Flight Model shall be of a standard compliant with all the requirements of the applicable PDIS last issue and shall have successfully undergone a full program of acceptance testing and verification prior to delivery.

6.1.3 Design Verification Methods and Types - Definition

The Payload Development and Validation plan must be based on a development qualification and acceptance scheme compatible with the overall system program concept.

6.1.3.1 Verification Methods

Qualification and Acceptance Verification shall be accomplished by test wherever possible and by assessment as support or as an alternative should testing be prohibitive:

a) Test
. Functional Tests,
. Environmental Tests,
b) Assessment
. Similarity,
. Analysis,
. Inspection,
. Demonstration,
. Validation of Records.

6.1.3.1.1 Functional Tests

Functional testing is a series of electrical or mechanical performance tests conducted on flight or flight configured hardware at conditions equal or less than design specifications. Its purpose is to establish that the hardware performs satisfactorily in accordance with the design specifications. Depending on the situation, there are functional tests of various complication or degrees of depth.

6.1.3.1.2 Environmental Tests

An environmental test is a test conducted on flight or flight configured hardware to assure that the flight hardware will perform satisfactorily in one or more of its flight environments. Example are acoustic, thermal vacuum and EMC. Environmental testing is normally combined with functional testing to a degree which depends on the objectives of the test.

6.1.3.1.3 Verification by Similarity

Verification by similarity is the process of assessing by review that the article is similar or identical in design and manufacture to another article that has previously been qualified to equivalent or more stringent conditions.

6.1.3.1.4 Verification by Analysis

Verification by analysis is a process where compliance of an article to specification is proven by analytical methods. The typical technique used is mathematical modeling (e.g. by finite elements method, simulation, statistics, etc.). Mathematical models may be supplemented or supported by hardware simulations. Verification by analysis is normally given lower importance than direct testing, but is applicable where:

Analysis is rigorous and accurate enough to provide reliable results,
Tests are not cost effective,
Similarity is not available.

6.1.3.1.5 Verification by Inspection

Verification by inspection may typically be applied where an article consists of well known and proven manufacturing methods. The verification process consists in assuring strict adherence to these specified methods during the article production (i.e. exclusion of deviations and mistakes) by rigorous supervision and inspection (e.g. wire coding, materials selection, mechanical and electrical connections, correct screw torquing, etc.). Depending on the specific case, inspection may reduce or omit later testing of the article in various aspects. Like analysis, inspection in general is given lower priority than direct testing, but may be applied where other verification methods are not cost effective.

6.1.3.1.6 Verification by Demonstration

Verification by demonstration primarily applies to activities of a handling, servicing, safety and logistics nature, e.g. easy replaceability of a critical Payload unit, lifting a container with fork-lift, mounting a Payload on a vibrator, etc.

The process consists in demonstrating that the activity in question is possible within the specified time, manpower, safety and other constraints.

6.1.3.1.7 Verification by Validation of Records

Verification by validation of records is a process where on the basis of manufacturing records (which have to be complete and comprehensive, and may not contain any new unproved processes), compliance with performance specifications of an article can be proven. This process is of the same nature as inspection, it being an inspection of (reliable) records "after the event". Again, this verification method is considered lower priority and applies if direct testing is not feasible.

6.1.3.2 Verification Types

6.1.3.2.1 Development Verification

Development Verification is a process to verify the feasibility of a design approach and to provide confidence in the ability of the hardware to comply with the performance criteria.

6.1.3.2.2 Qualification Verification

Qualification Verification is an individual test or a series of functional and environmental tests conducted on flight hardware at conditions normally more severe than acceptance test conditions, to establish that the hardware will perform satisfactorily in the flight environments with sufficient margins. The purpose is to uncover deficiencies in design and method of manufacture. It is not intended to exceed design safety margins or to introduce unrealistic modes of failure.

6.1.3.2.3 Acceptance Verification

Acceptance Verification is an individual test or a series of functional and environmental tests conducted on flight hardware at conditions equal to design specifications plus acceptance level margin to establish that the hardware performs satisfactorily.

6.1.4 General Requirements for measurements and tests

6.1.4.1 Environmental Conditions

PL - 6.1.4 -1

All measurements and tests shall be conducted within the following environmental conditions:

- Pressure: ambient
- Temperature: 22°C $\pm$ 3°C
- Relative Humidity: $\leq$ 60 %.

PL - 6.1.4 -2

Actual ambient test conditions shall be recorded regularly during the tests. In case of ambient conditions exceeding the allowable limits, the decision not to test or to halt any test in progress shall lie with the responsible Test Manager who must have adequate evidence that there will be no adverse influences on component performance.

6.1.4.2 Tolerance levels

PL - 6.1.4 -3

The accuracy of instruments and test equipment used to control or monitor the test parameters shall be better than one tenth of the tolerance of the variable to be measured.
The accuracy of the measuring instruments and test equipment shall be verified periodically by calibration.
The maximum environmental tolerances (except instrumentation tolerances) on test conditions during environmental testing shall be as specified in Table 6.1-2 unless otherwise specified.

Parameter	Measurement Range	Tolerances
Mass		± 0.010 kg or 0.15% whichever is greater
Volume		± 0.06 dm^3
Temperature	maximum temperature minimum temperature	+ 3°C - 3°C
Pressures	system pressure p > 1bar p ≤ 1 bar barometric pressure: p > 0.1 mbar p < 0.1 mbar Measured pressure above 60% of full scale.	± 1 % full scale ± 2 % full scale ± 5 % ± 50 %
Relative Humidity		± 3 % RH
Acceleration		± 10 %
Vibration	sinusoidal random PSD 20 - 300 Hz 300 - 2000 Hz random rms	± 10 % g-peak ± 1.5 dB ± 3 dB ± 10 %
Frequencies	≤ 20 Hz > 20 Hz	± 0.5 Hz ± 5 %
Time		± 1 %
Sweep Rate		± 5 %
Acoustic Pressure		± 3dB per octave band, ±1.5dB OASPL
Force	static tests	+ 5% / - 0 %
Force and Moments	dynamic tests	± 10 %
Leakage Rate		± 50 %
Mass Flow		± 10 %
Graduated Cylinder		± 1 %
Electrical Conditioning	Voltage ≤ 5 Volt > 5 Volt	± 0.2 % ± 0.5 %
	Current	± 0.1 %
	Resistance high low	± 10 % ± 2 %
Centre of Mass	Deviation from nominal centre	± 0.5 mm
Moments of Inertia	Measurements, if MOI > 0.1 kgm2 Calculations, if MOI ≤ 0.1 kgm2	± 10% ± 10%

Table 6.1-2 : Measurement requirements

6.1.4.3 Cleanliness of test equipment

PL - 6.1.4 -4

The inner cleanliness of the test equipment as far as it can affect the cleanliness of the Payload shall be checked and minimum cleanliness level shall be assured before, during and after each test.

6.1.4.4 Measurements

PL - 6.1.4 -5

During all tests to be performed, the test data and parameter values shall be continuously recorded.

PL - 6.1.4 -6

Prior to conducting any of the tests, the test item shall be operated under ambient conditions, and a record shall be made of all data necessary to determine compliance with the required performance in the subsequent performance tests conducted before, during and after the environmental exposure. The only exceptions to this requirement are for those items which cannot be tested realistically in ambient conditions. In such cases, initial testing shall be designed to prove compliance as far as possible without causing damage to the test item.

6.1.5 Electrical Verification

6.1.5.1 Electrical Functional Verification

PL - 6.1.5 -4

Three kinds of payload reference tests shall be defined and conducted during payload functional tests and before payload delivery
These tests will serve as a baseline against which all later results can be compared. The results obtained during the satellite tests shall be similar to the ones obtained during payload acceptance. These tests are:

- Payload Performance Verification Test (PPVT)
- Payload Health Check Test (PHCT
- Payload Aliveness Test (PAT)

PL - 6.1.5 -5

The duration of these tests defined in following sections shall be optimised to the strict necessary. All the operations shall be individually justified.

6.1.5.1.1 Payload Performance Verification Test (PPVT)

PL - 6.1.5 -1

A reference Payload Performance Verification Test shall be conducted at payload level before payload delivery. This reference PPVT shall be a part of the total PPVT and will serve as a baseline against which all later results can be compared. The results obtained during this part of PPVT shall be similar to the ones obtained during Payload acceptance. The duration of this part of the PPVT shall be lower than 5 days (i.e. 5 x 8 hours).
The total PPVT shall be a detailed demonstration that the hardware and software meet all their performance requirements within allowable tolerances. It shall exercise all Payload modes, science operations and calibration measurements (where applicable). It shall also demonstrate operation of all prime and redundant components and hardware (where applicable) and shall be performed for each Payload side (where applicable).

6.1.5.1.2 Payload Health Check Test (PHCT)

The Payload Health Check Test is a subset of the PPVT.

PL - 6.1.5 -2

The Payload HCT shall exercise major Payload modes, limited science operations and calibration measurements (where applicable).
The Payload HCT shall demonstrate for each Payload side operation of all prime and redundant components and hardware (where applicable).
The HCT is a part of the PPVT.

6.1.5.1.3 Payload Aliveness Test (PAT)

PL - 6.1.5 -3

The Payload Aliveness Test shall test engineering housekeeping functions only; no Payload science testing will be performed.
The Payload AT shall be performed during short duration to check the communication between the DHU and the Payload.
The duration of PAT shall be lower than 1 day (i.e. 8 hours).

6.1.5.2 Electrical Interfaces Validation

The Payload Supplier is in charge of demonstrating the payload compliance with regard to all I/F requirements by analyses, similarity or tests. When tests are proposed, the payload responsible shall detail the configuration, the way how the test is intended to be performed and the success criteria.
In order to somehow clarify the satellite contractor needs, the following sections give some requirements for this validation.

6.1.5.2.1 Platform interfaces simulation

PL - 6.1.5 -6

If an EGSE is specifically developed to simulate electrical I/F, it shall be fully representative (in term of electrical characteristics and grounding) of the platform interfaces as described in the section 3.5.

~~Moreover, implementation in the EGSE of PF I/F electrical schematics & layouts as defined in Appendix E is strongly recommended.~~

PL - 6.1.5 -7

~~The length and the type of harness used between EGSE and payload shall be representative of the platform harness~~. Demonstration of the EGSE representativeness shall be provided by the payload responsible (compliance matrix with regard to platform characteristics shall be provided.

PL - 6.1.5 -8

The electrical validation shall be performed in configuration representative of the flight hardware configuration. In particular, the EGSE/payload overall grounding network shall be fully representative of the satellite grounding. Demonstration of the representativeness of the grounding network shall be provided by the payload responsible.

6.1.5.2.2 Electrical interface validation

PL - 6.1.5 -9

Tests shall be done with the payload fully integrated. The measurements shall be done at connector/bracket levels.

PL - 6.1.5 -10

All signals shall be tested.

6.1.5.2.2.1 Pin allocation/signal addressing

PL - 6.1.5 -11

All signals shall be addressed during payload test.

6.1.5.2.2.2 Continuity/Isolation

PL - 6.1.5 -12

The following isolation or continuity shall be checked:

- Isolation between each primary power line & P/L structure.
- Isolation between each heater line & P/L structure.
- Isolation between each pyro line & P/L structure (real pyro initiator replaced by dummy).
- Isolation between each DR line & P/L structure.
- Isolation between each TH line & P/L structure.
- Isolation between each HLC line & P/L structure
- Isolation between each LLC line & P/L structure
- Isolation between each 1553 line & P/L structure (long stub case).
- Continuity between each signal line connected to secondary zero-volt line (inside a unit) e.g. ANA/DB return and P/L structure.

6.1.5.2.2.3 Primary Power lines

PL - 6.1.5 -13

The following measurements shall be performed:

- In-rush current measurement (covered by payload EMC test)
- permanent current measurement for each functional mode (P/L power consumption budget consolidation),
- other tests for PF to PL electrical interfaces validation are covered by payload EMC test, isolation and pin out verification.

6.1.5.2.2.4 Heater lines

Heater lines interfaces validation are covered by payload EMC test, isolation and pin out verification.

6.1.5.2.2.5 Other lines

PL - 6.1.5 -14

For other electrical lines, the requirements for validation are provided in the following table.

Signal type	Voltage level	Timing	Waveform (Tr, Tf, pulse duration, …)	Impedance		Triggering Threshold /Hysteresis	Comments
				DM	CM		
ANA	X			X	*		
DB	X			X	*		
DR				X	**		Open circuit & Close circuit to be checked
Th				X	**		Measurement at ambient temperature
HLC				X	**	X	Functionality to be validated over the EGSE active voltage level range and over Tr and Tf pulse range
LLC				X	**	X	Functionality to be validated over the EGSE active voltage level range and over Tr and Tf pulse range
PPS					X		
ML16 C/E/D & DS16 C/E	X	X	X	X	X		ML16 & DS16 differential receivers
DS16 D	X	X	X	X	X		DS16 data transmitter
1553	X	X	X	X	**		

X : to be measured * : covered by continuity test ** : covered by isolation test

Table 6.1-2b: Payload electrical interface verification matrix

Nota : the compliance the fault tolerance requirements of Payload interface shall be demonstrated by analysis for instance.

6.1.6 Structural and Mechanical Verification

6.1.6.1 Sinusoidal Vibrations

The sinusoidal vibrations test aims at demonstrating the capability of the test item to withstand and properly function after the sine vibration environment encountered during launch and of the test item primary structure to withstand the quasi-static loads encountered during launch.
This test may also reveal defects in design, parts, and workmanship, if any.
And finally, this test allows to demonstrate that the structural design of the test item shows the proper response to sine excitation. In particular, it identifies the critical lowest resonance frequency of the item.

PL - 6.1.6 -1

The Payload shall undergo a Sinusoidal Vibrations Test before payload delivery.

PL - 6.1.6 -2

The levels given in Table 5.1-2 shall be used for sine vibration design qualification (levels are 0-to-peak).
Acceptance levels are 1.25 times lower (launch vehicle dependent).
Qualification testing shall be with a sweep rate of 2 octaves per minute, one sweep up.
Acceptance testing shall be with a sweep rate of 4 octaves per minute, one sweep up.

For Protoflight testing, see PFM definition section 6.1.2.3.
Notching philosophy at payload level is defined in section 4.2.5.3.
For information, notching at any instrument vibration frequency will not be allowed.

PL - 6.1.6 -3 a

Before and after sine test along each axis at the qualification levels required in Section 5.1.2, a low level sine test (0.5 g from 5 to 2000 Hz, 2 octaves/min, 1 sweep up) shall be performed with the objective to demonstrate that the unit has not been damaged by the qualification test.

The sine vibrations tests are usually performed on a shaker along all three axes in sequence.

6.1.6.2 Acoustic/Random Vibrations

These tests aim at demonstrating its ability to survive mechanical stresses arising during pre-launch and launch environments.
They will also reveal defects in design, parts, and workmanship, if any.
As a general rule, acoustic test applies to big size payload whereas random vibrations test applies to smaller one.

PL - 6.1.6 -4

The Payload shall undergo an Acoustic or Random Vibrations Test before payload delivery.

PL - 6.1.6 -5

The levels given in Table 5.1-3 or Table 5.1-4 shall be used respectively for random and acoustic vibrations design qualification.
Qualification testing shall be through a test duration of 120 s on each axis.
Acceptance testing shall be through a test duration of 60 s on each axis.
Test Tolerances for the sound pressure levels are given Table 6.1-3.

Octave Band Center Frequency (Hz)	Test Tolerances (dB)
31.5	-2/+2
63	-1/+2
125	-1/+2
250	-1/+2
500	-1/+2
1000	-1/+2
2000	-1/+2
4000	-3/+3
8000	-4/+4
Overall	-1/+3

Table 6.1-3 : Acoustic test tolerances

The random vibrations tests are usually performed on a shaker along all three axes in sequence.

6.1.6.3 Shocks

Shock tests aim at demonstrating the capability of the test item to withstand and properly function after the shock environment encountered during and after launch (satellite separation, solar arrays deployment).
They will also reveal defects in design, parts, and workmanship, if any.
As a general rule, shock testing is not required for structural components.

PL - 6.1.6 -6

The Payload shall undergo a Shock Test at payload or payload sub-system level (payload dependent) before payload delivery.
The shock response spectrum is specified in section 5.1.5.

PL - 6.1.6 -7

The Payload shall verify by test that it does not generate shock levels higher than those given in section 3.1.5.2.

6.1.6.4 Handling

PL - 6.1.6 -8 a

Tests at payload level shall be performed in order to demonstrate the possibility of handling the payload at ALCATEL SPACE facilities. These tests shall be performed before delivery and with additional masses in order to represent the maximal payload masses (see § 4.2.2.4).
The maximum load encountered during nominal handling shall be tested on the flight hardware.
The maximum load encountered during degraded case (fail-safe for instance) shall be tested on a representative sample.
For safety reasons, related test reports shall be provided with the payload for its acceptance.

6.1.7 Thermal Verification

PL - 6.1.7 -1

> The thermal active control of the payload (including the lines provided by the platform) shall be qualified at payload level before delivery to the satellite (thermal balance test).
> The regulation parameters (C1, C2 and T_{ref}) shall also be adjusted before payload delivery.

That involves that only minor modifications of the regulation parameters will be authorised during satellite thermal tests.

6.1.7.1 Thermal Balance Test definition

A test conducted to verify the adequacy of the thermal model, the adequacy of the thermal design, and the capability of the thermal control system to maintain thermal conditions within established mission limits.

6.1.7.2 Thermal Vacuum Test (Thermal Cycling) definition

A test to demonstrate the capability of the test item to operate satisfactorily in vacuum at extreme temperatures based on those expected for the mission with adequate margin. The test can also uncover latent defects in design, parts, and workmanship.

6.1.8 EMC verification

The test sequence applies to the unit level tests, which are to be analysed for earliest possible prediction of whatever problems may arise. Prediction of the units test results, prior to the tests, shall form the input for writing the Test Plan, with a view to prevent any potential incompatibility between the units and evidence shortcomings, if any, in the compatibility margins.
These tests aim at demonstrating the capability of the test item to operate satisfactorily under the electromagnetic environment encountered during the mission. The test also demonstrates that the test item does not generate more electromagnetic interference than specified.

6.1.8.1 Test Configuration

The tested hardware, whether at overall satellite or at Payload level, shall be confronted with all operational modes for which it was originally designed, with each synchronizable converter operating in synchronized mode.

PL - 6.1.8 -1

> The complete EMC tests could be run on one single model of the Payload if several replicas are built. This test article shall be fully representative of the Flight Model (if not, the full test sequence shall be run on the FM). Furthermore, where a change has occurred from Engineering Model (EM) or Qualification Model (QM) to Flight Model (FM), the EMC tests shall be performed again following the same approach.

PL - 6.1.8 -2

> A reduced EMC tests sequence will be done with the FM in case the complete EMC tests have been performed on another model.

PL - 6.1.8 -3

> In all operating modes, the aim of the EMC tests shall be a worst-case assessment of both emission and susceptibility.

6.1.8.2 Test Requirements

6.1.8.2.1 Units and harness/wiring configuration

PL - 6.1.8 -4

The units and harness configuration shall be as

- the lay-out of units is the nominal lay-out,
- actual (flight-standard) inter-unit or inter-connector harness/wiring at final positions,
- interface connectors linked to simulators or to dummy loads.

6.1.8.2.2 Test operating conditions

PL - 6.1.8 -5

Test harness/wiring and Payload units shall not create any grounding loops.

PL - 6.1.8 -6

If some radiated perturbations are measured in an anechoic test room, the simulators and EGSEs shall be located outside, and the level of ambient perturbations shall be at least 6 dB below the required level.

PL - 6.1.8 -7

The test-operation and parameter-measuring procedures shall be that applicable to the system to be tested.

PL - 6.1.8 -8

Should, in any test sequence, an operating mode appear as the most unfavorable in terms of EMC, that mode shall be selected.

6.1.8.2.3 Band analyses

PL - 6.1.8 -9

The analysis bandwidth to be used for Narrow band (NB) and Broadband (BB) recordings shall be as follows:

TYPE	FREQUENCY RANGE	BANDWIDTH
NB	up to 10 kHz	< 50 Hz
NB	10 kHz - 2.5 MHz	< 500 Hz
NB	2.5 MHz - 25 MHz	< 5 kHz
NB	25 MHz - 1GHz	< 50 kHz
NB	1GHz - 10 GHz	<100 kHz
NB	10 GHz - 18 GHz	< 500 kHz
BB	10 kHz - 2.5 MHz	< 5 kHz
BB	2.5 MHz - 25 MHz	< 50 kHz
BB	25 MHz - 50 MHz	< 50 kHz
BB	50 MHz - 1 GHz	< 100 kHz
BB	1GHz - 10 GHz	< 500 kHz
BB	10 GHz - 18 GHz	< 1 MHz

Table 6.1-4: Analysis bandwidth for NB and BB recordings

PL - 6.1.8 -10

The Narrow band/ Broadband distinction is established as follows:

- Narrow band requirements shall apply if the measured levels growth is less than 10 dB when the receiver bandwidth grows by a factor of 10.
- Broadband requirements shall apply if the measured levels growth exceeds 10 dB when the receiver bandwidth grows by a factor of 10.

6.1.8.2.4 Amplitude

All values per requirements thereunder are peak to peak amplitudes unless otherwise stated.

6.1.8.3 Responsibilities

Each test is under the responsibility of the authority in charge of the tested hardware. Selection of the test laboratory, as well as preparation and conduction of the test shall be subject to approval by the authority responsible for the overall system to be tested.

6.1.8.4 Test Site

PL - 6.1.8 -28

The Payload shall be placed within an anechoic chamber whose walls are coated with absorbing panels, to achieve a reflecting coefficient less than -20 dB in the 100 MHz to 18 GHz frequency band. Use of such anechoic chamber may not be required if the following conditions are demonstrated for the selected test site:

- - 20 dB reflection coefficient achieved, at the Payload transmission frequencies, by other means,
- ambient noise level less than 6 dB below the levels defined herein; ambient noise may locally exceed the limits set if occurring as predictable, stable, discrete frequencies sufficiently spaced throughout the frequency band.

6.1.8.4.1 Facility requirements

PL - 6.1.8 -11

Unless from out-of-control impossibility, the tests shall be run within an anechoic chamber, which shall comply with the following prescriptions:

- dimensions shall be such that antennas always stand at a distance not less than 1 m to any of the test chamber walls, except for the dipole and whip antenna, for which the minimal distance can be reduced to 30 cm.
- filtering of the power sources shall curb residual perturbations to less than the limits set hereby by at least 6 dB, with the ambient electric fields lower by at least 6 dB than the limits set hereby; for the purpose of those measurements, the power source shall be closed on a charge at least equal to the tested unit, with the measuring Payloads and test devices ON.
- However, should the global level, i.e. ambient perturbations added to the perturbations on the tested unit, lie within the limits set, the equipment shall be ruled satisfactorily.
- The chamber shall feature a grounding plane as per MIL.STD.462, at least 2 m^2 in size and 0.75 m in width, which may be formed by a copper, brass, or lightweight alloy plate of a minimal thickness of 0.70 mm; the plate connections to the chamber, preferably made up of 0.7 mm thick copper strips whose width equals at least 20% of their length, shall be spaced by no more than 1 m.

Use of absorbing materials with anechoic properties is recommended.

6.1.8.4.2 Tests outside an anechoic chamber

The selected test site shall be a clear area, free from rough/uneven features, preferably located near an earthling/grounding outlet linking up to the grounding plane, which may consist of a copper, brass or lightweight alloy not less than 2 m^2 in size, with ambient EMC perturbation control identical to that defined here before.

6.1.8.4.3 Measuring instrument

6.1.8.4.3.1 Measuring receiver

The minimal characteristics required of measuring receivers are as listed below:
input impedance: 50 Ω
input TOS:
< 1.5 up to 200 MHz
< 2 from 200 MHz to 18 GHz
recommended analysis bands:
see 6.1.8.2.3 (If needed, the analysis bands shall be reduced to decrease measurement noise).
types of detection recommended:
. peak, efficient, mean
accuracy of frequency measurement: 1%
accuracy of voltage: 2 dB

6.1.8.4.3.2 Spectrum analyser

The spectrum analyser may be used as a measurement receiver, using analysis bands similar to those specified for the receiver.

6.1.8.4.3.3 Electric field measurement antennas

Depending on measuring frequencies, the following antennas may be used:

- below 30 MHz: whip antenna, 1 m in length.
- from 20 MHz to 200 MHz: dipole antenna; biconical antenna
- from 200 MHz to 1 GHz: dipole antenna; 'log spiral' conical antenna; so-called 'ridged guide' antenna
- from 1 GHz to 12.4 GHz: 'log spiral' conical antenna; so-called 'ridged guide' antenna
- beyond 10 GHz: horn- shaped, parabolic-shaped antennas.

This list is not restrictive: any other antenna may be used, provided its "antenna factor" at receive/transmit stage is known from calibration or from the manufacturer's diagrams.

6.1.8.4.3.4 Calibration

PL - 6.1.8 -29

The last-calibration date for the measuring instruments used in the EMC tests shall be less than one year old. This requirement does not apply to the passive (current probe-type) instruments, as those shall exhibit a calibration curve.

6.1.8.4.4 Test set-ups

PL - 6.1.8 -12

Generally speaking, the test conditions and set-ups shall comply with standard MIL.STD.462 where applicable.

PL - 6.1.8 -13

Moreover, the Payload to be tested shall be installed in conditions that best reproduce the normal conditions of use, particularly at unit level:

- grounding, shielding and backshell identical to conditions of use
- harness/wiring of same nature and immunity as at unit installation
- accurate definition of Payload-associated harness/wiring shall be provided
- the antenna of every tested receiver or transmitter shall be replaced with a dummy antenna or with a shielded charge of equivalent impedance to that of the actual antenna.

PL - 6.1.8 -14

Both test conditions and test set-ups shall be described in the Test Plan.

6.1.8.5 TESTS

6.1.8.5.1 Conducted test requirements

PL - 6.1.8 -15

The requirements given in section 3.5.7 shall be verified at a power supply voltage of 37 V for conducted emission and 23 V for conducted susceptibility.

PL - 6.1.8 -16

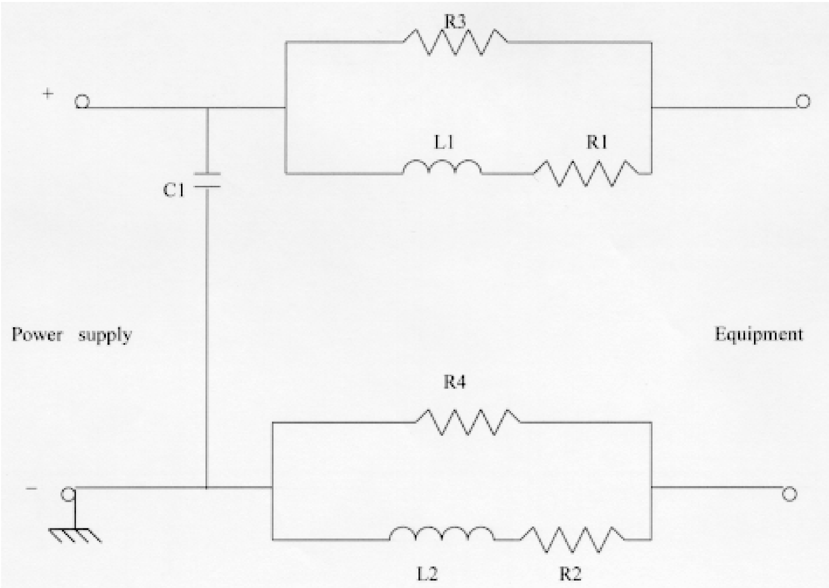
A Line Impedance Stabilised Network (LISN, Figure 6.1-1) shall be used to simulate impedance of primary power supply. The wound, unshielded test connections shall be with the negative power supply point on LISN input grounded.

PL - 6.1.8 -17

The LISN shall be used in each EMC test except if mentioned . Its characteristics shall be measured by the Instrument Contractor and delivered with the EMC test report.

PL - 6.1.8 -18

The star point of the test set up shall be in the LISN, on the return link.



R1, R2 < 20 mOhm (inductance parasistic resistors)
R3, R4 = 50 Ohms
L1, L2 = 4 µH
C1 = 19 mF

Figure 6.1-1: Schematic representation of a LISN

PL - 6.1.8 -19

As far as possible, Payload shall be tested within a shielded chamber. The test requirements shall be as follows:

- Conducted emission and susceptibility to be tested on Engineering or Qualification model (EM or QM) equipment.
- Need for partial or full tests at Flight Model (FM) level to be analysed in case of changes and where components technology or manufacturer are not identical for EM or QM and FM.

Flight Model (FM) tests consist in:

measuring inrush current at time-domain on switching,

measuring conducted emissions in both common and differential modes.

All the above involve both the nominal and the redundant channels.

Identification	Measuring range	Section N°
Conducted emissions (CE) Power supply bus Wave Transients Emissions from transmitter units/devices	10 Hz - 50 MHz 10 kHz - 18 GHz	3.5.7.1.1
Conducted susceptibility (CS) Power supply bus Sine wave Modulated wave Transients Receiver units/devices	10 Hz - 50 MHz 10 kHz - 18 GHz	3.5.7.1.2

Table 6.1-5: Measuring range and section for CE and CS tests

6.1.8.5.2 Radiated test requirements

Identification	measuring range	Section N°
Radiated emissions (RE) Non-RF equipment RF equipment	 10 kHz - 1 GHz 10 kHz - 18 GHz	 3.5.7.2.1
Radiated susceptibilities (RS) Sine Modulation	 10 kHz - 1 GHz 10 kHz - 18 GHz	 3.5.7.2.2

Table 6.1-6: Measuring range and section for RE and RS tests

6.1.8.5.3 Electrical Ground Support Equipment (EGSE)

Regarding EGSE, the requirements here before are applicable only to those EGSE to be co-located with the Payload during radiated emission/susceptibility tests.

PL - 6.1.8 -20

Such EGSE, complemented with the dedicated harness/wiring interfacing the tested unit, shall be subjected to the following measurements:

- Narrowband radiated emissions over the 10 kHz to 18 GHz range (up to 1Ghz for all units except RF units),
- Susceptibility to the Payload transmit frequencies.

6.1.8.6 Tests organization

6.1.8.6.1 Test Plan

PL - 6.1.8 -21

Each electromagnetic compatibility test shall be defined in a dedicated document drawn up by the Payload Supplier. This document, which constitutes the Test Plan, contains the specific data to be used in writing the test procedure. The following pieces of information shall be provided in the Test Plan: a) Specimen operational configuration during test, b) Duly justified choice of a measuring method, c) The bare descriptive modicum for environmental and operational conditions, d) Specimen operating modes and points to be watched (susceptibility criteria), e) Description of injected signals for measuring susceptibility or the compatibility margin.

6.1.8.6.2 Test procedure

The unit development, qualification or verification EMC tests follow a test procedure that details how tests must be run to verify compliance with the EMC requirements.

PL - 6.1.8 -22

The procedure shall be made available to the Satellite Contractor for approval one month at least before test inception, and shall contain at least the following sections, in sequential order: a) contents, b) applicable documents, c) purpose of tests, d) general test conditions (electromagnetic environment, grounding plan, measuring precautions, authorized personnel, power supply characteristics), e) specimen detailed mechanical and electrical configuration (operating mode, power supply voltage, input signals, stimuli, dummy charge power levels, points to be watched, detailed description of interface harness/wiring, overall layout on test site, grounding connection), f) for each type of test: • required test instrumentation, • antenna calibration data sheets, • measurement set-up, accuracy over the specific precautions for each type of test, • test limits and levels, • frequency ranges or discrete frequencies for the test, • susceptibility criterion.

6.1.8.6.3 Test execution

PL - 6.1.8 -23

Test execution shall be documented by the proceedings from the test sequence as actually experienced, which state the facts as observed in real time:
a) calibration of the actually used instruments,
b) recording of measurements (photos, plots, graphs, tables, etc.),
c) deviations from procedures, or changes required by real conditions.

PL - 6.1.8 -24

Assessment of the specimen compliance with the specifications shall be acquired during tests, with a clear identification of non-conformance, e.g.:
a) measurement of emitted level, should the emission limit be exceeded
b) measurement of susceptibility threshold, if actual threshold is less than specified,
c) measurement of real compatibility margin, if found less than specified.

The above elements are critical to obtaining a waiver for not meeting a specified requirement.

6.1.8.6.4 Presentation of results

6.1.8.6.4.1 General

The rough results shall be of the following form:
XY recording with sufficient resolution to ease out data analysis,
photos of oscilloscope or spectrum analyser.
The data recorded in emission tests shall be read in continuous frequency-scanning mode.
For a quick assessment of results, the test data and the maximum levels allowed by the present specification (requirements of section 3.5.7) shall be presented on the same plots.
All such auxiliary data as sensitivity, bandwidth, antenna factor, aso., shall be provided along with the data and photos.

6.1.8.6.4.2 Test report

PL - 6.1.8 -25

The unit EMC test report shall be submitted to the Satellite Contractor by the Payload Supplier within thirty (30) days from official completion of the EMC tests, complete with the relevant test procedures.

PL - 6.1.8 -26

For uniformity, and to ease out analysis, such test report shall contain at least the following:

a) Contents
b) Purpose of test
c) Changes to nominal procedure
d) Summarized results
e) Conclusions
f) Working copy of the procedures, containing:

- description of test set-up, with photos of test configuration,
- detailed description of grounding network,
- problems encountered and corrective actions,
- type and serial number of the measuring instrumentation, date of last calibration,
- measures of ambient noise including EGSE,
- raw measurement sheets, recordings,
- transfer function of actually used probes or antennas,
- interpretation of measurements against specified noise,
- complementary measurements performed, as applicable.

PL - 6.1.8 -27

In addition, the test report shall spell out and justify all deviations from, or changes to the test procedure, which procedure shall have been approved by the Satellite Contractor prior to official inception of the EMC tests.

6.1.8.7 Unit Test set-ups

6.1.8.7.1 Conducted emissions; Power supply lines, steady perturbations

Methods: CE01 - CE04 of MIL-STD-462

Test set-up:

1. 5 cm Stand-off
2. Low-impedance bond to ground plane
3. Current probe
4. Test sample chassis ground
5. High side
6. Return (neutral line)
7. DC bond impedance between the ground plane and enclosure wall
8. Line impedance stabilization network shall be terminated in 50 Ohm resistive.

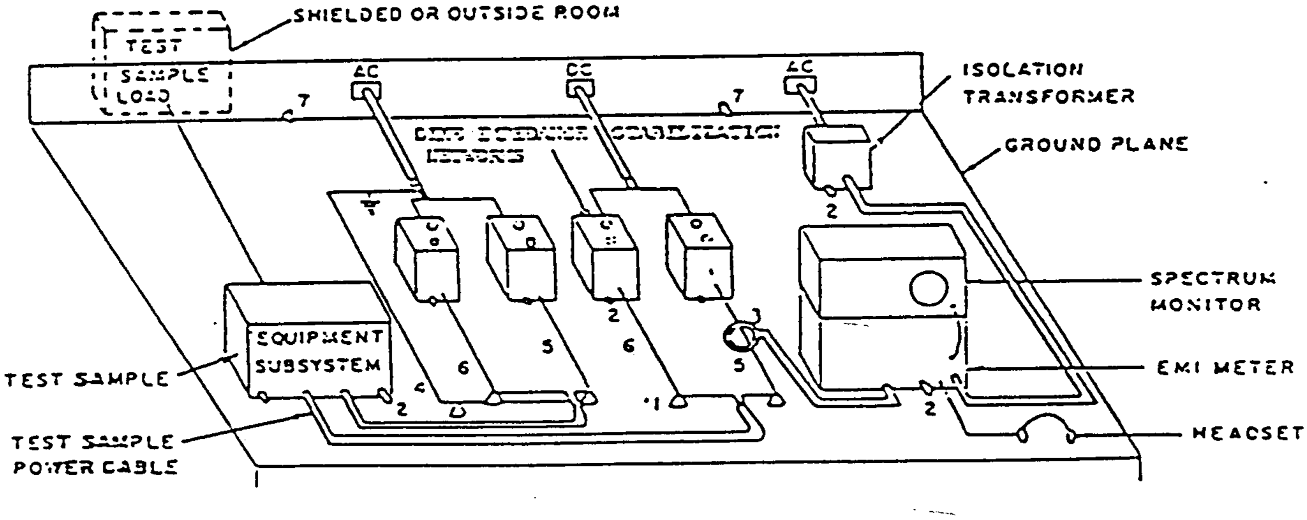


Figure 6.1-3 : Power lines, steady perturbations test set up

6.1.8.7.2 Conducted emissions; Power supply lines, transient perturbations

Method: out of standards
Test set-up:
Test set-up is identical to that one used in steady perturbation measurements, except that an oscilloscope is substituted for the spectrum analyser, and that the current probe bandwidth has to be adapted to the measurement signal.

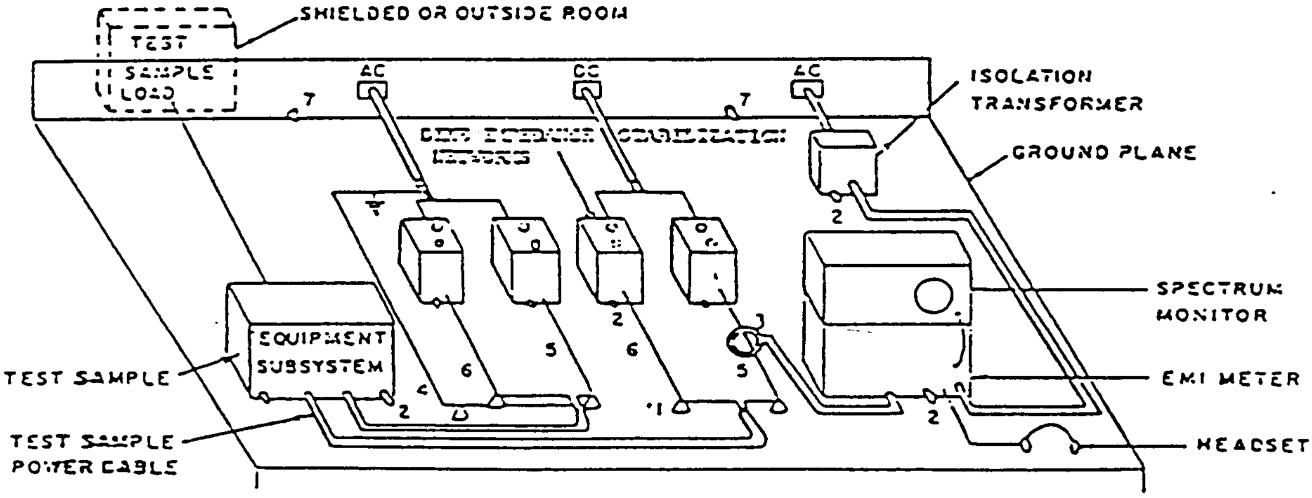


Figure 6.1-4 : Power supply line, transient perturbations test set-up

Observations : Whatever measurements are needed over the command lines at the switching unit, outputs are made with representative harness/wiring and charges, without any LISN or 10 μF capacities.

6.1.8.7.3 Conducted susceptibility ; power supply lines, sine wave and square wave

Methods: CS01 and CS02 of MIL-STD-462
Test set-up:

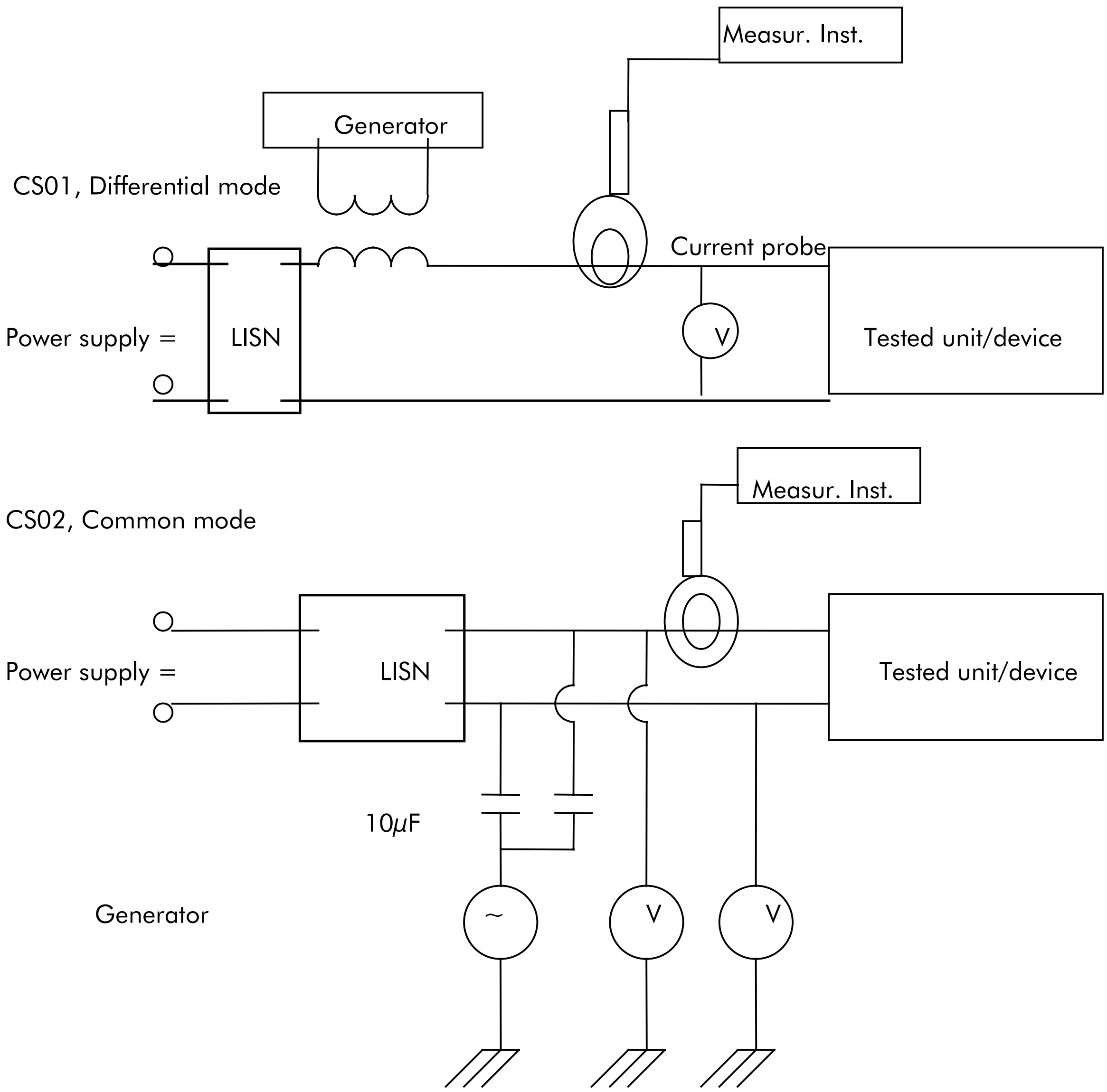
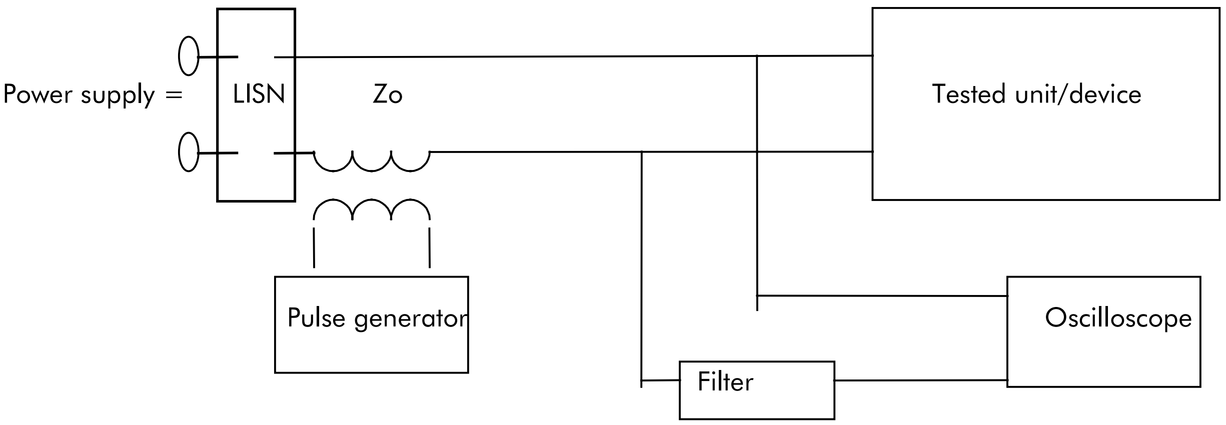


Figure 6.1-5 : Conducted susceptibility test set-up (sine wave and square wave)

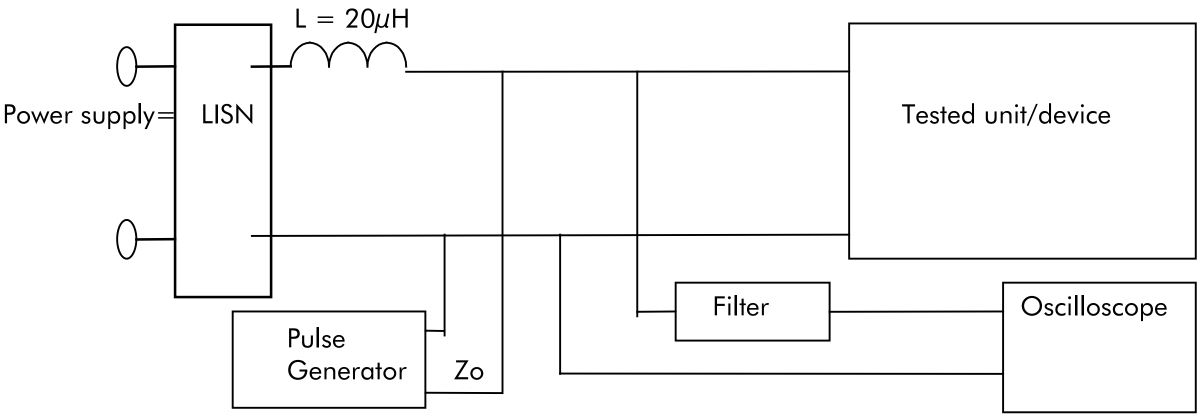
6.1.8.7.4 Conducted Susceptibility; power supply lines, transient signal

Method: CS06 of MIL-STD-462

Test set-up:



CS, spike, power leads, injection in series



CS, spike, power leads, injection in parallel

Figure 6.1-6 : Conducted susceptibility test set-up (transient signal)

6.1.8.7.5 Susceptibility to common mode transients; interface signals

Method: out of standards

Test set-up:

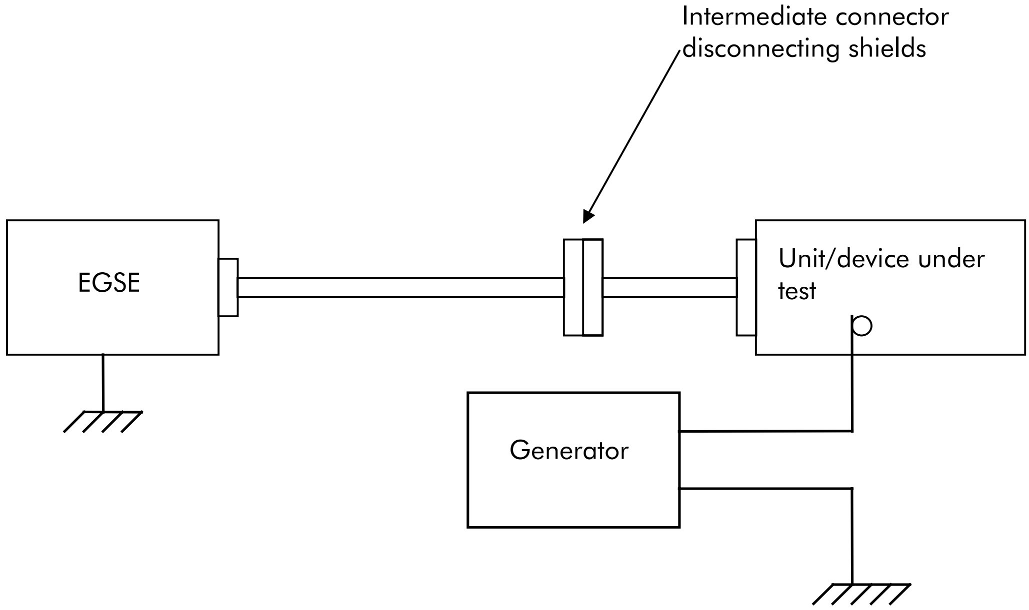


Figure 6.1-7 : Interface signals test set-up

6.1.8.7.6 Radiated emissions E-fields

Test method: RE02 of MIL-STD-462
Test set-up :

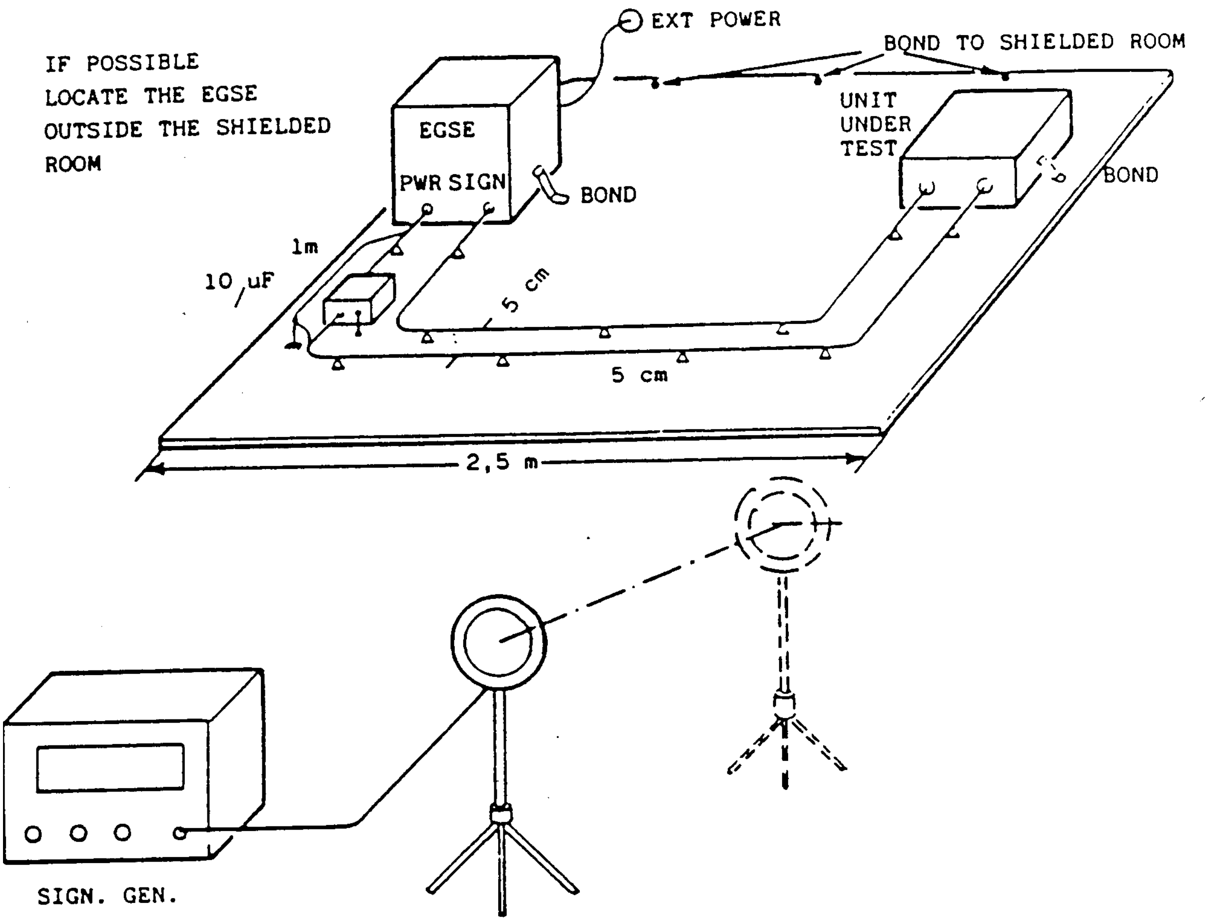


Figure 6.1-8 : Radiated emissions E-fields test set-up

The unit/device to be tested is installed and connected to the ground plane.
Harness/wiring of the tested equipment shall be flight representative: same type, same twisting, same gauge, same shielding connection mode as on the flight model.
Such harness/wiring shall be kept 2 to 3 cm clear above the ground plane, and shall as far as possible offer a length of 1 meter maximum, 1 meter off the measurement antenna.
Remarks :
Measurements shall be made in two linear cross-polarizations, or in one circular polarization beyond 50 MHz.

6.1.8.7.7 Radiated susceptibilities E-fields

Method :RS03 of MIL-STD-462
Test set-up:

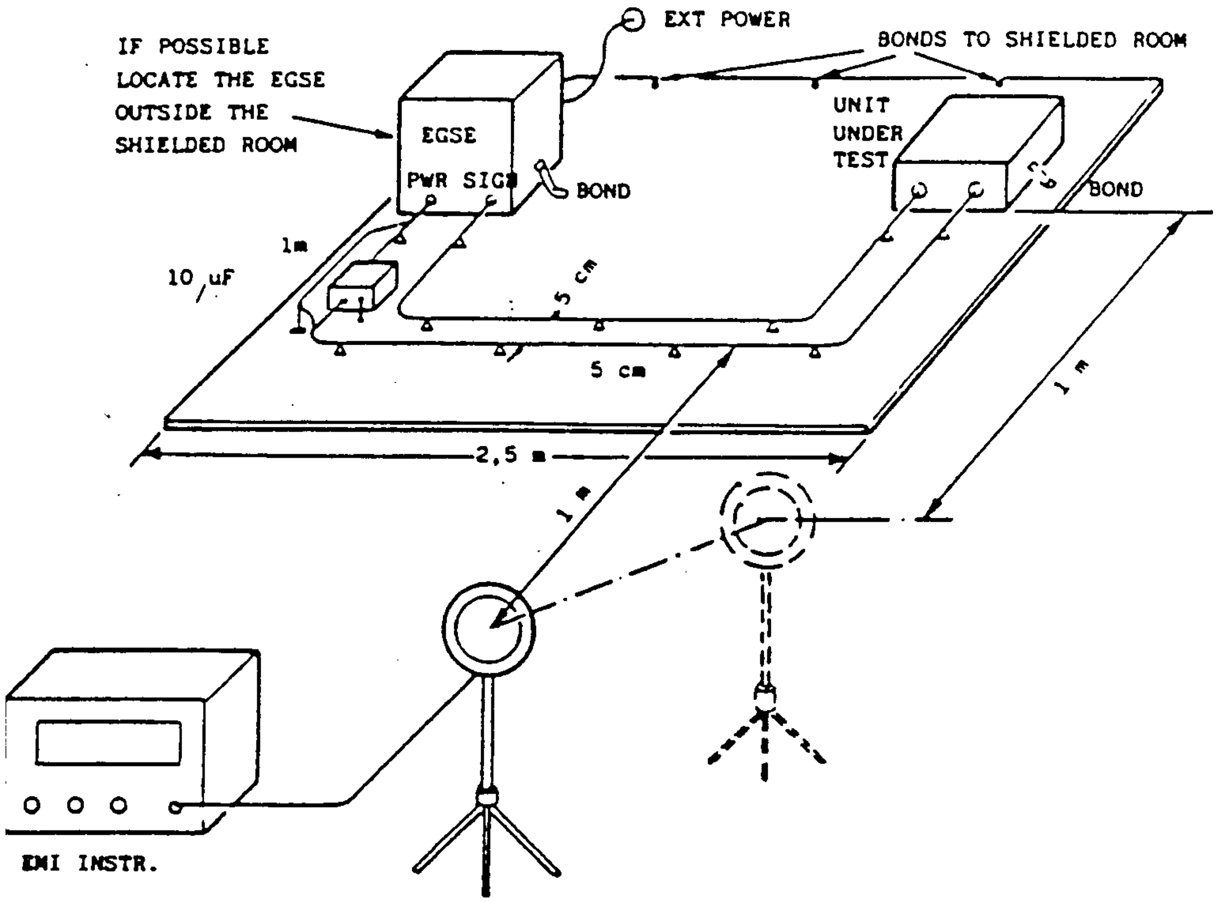


Figure 6.1-9 : Radiated susceptibilities E-fields test set-up

The unit to be tested is installed and attached to the ground plane.

All of the tested equipment harness/wiring (not the power supply strands only) shall be representative in their nature of the real, flight-standard harness/wiring: same type, same twisting, same gauge, same shielding connection mode. Lengths shall be limited to 2 meters for significant lengths.

Such harness/wiring shall be kept 2 to 3 cm clear above the ground plane, and shall as far as possible offer a length of 1 meter, 1 meter off the measurement antenna.

Remarks :

Such test sample orientation shall be sought to maximize emitted perturbations.

Measurements shall be made in two linear cross-polarizations (or in one circular polarization beyond 50 MHz).

6.1.8.7.8 Magnetic moment (DC)

The measuring procedure to be used shall be subject to prior approval by the Satellite Contractor.

6.1.9 ESD Verification

PL - 6.1.9 -1

The payload shall verify its compatibility with the arc discharge described in section 3.5.8.

PL - 6.1.9 -2

The test shall be performed with the discharge electrodes being directly applied on the payload chassis and cables shields for repetitive electrostatic discharges of 10 to 15 kV.

PL - 6.1.9 -3

The repetition rate shall be 1 ESD pulse per second, during at least 3 minutes.

6.1.10 Magnetic field Verification

PL - 6.1.10 -1

If there are magnetic elements, Magnetic Cleanliness control shall be performed at unit level. It shall include the following:

- quality control of parts and material including magnetic characterization,
- magnetic characterization test in a dedicated magnetic facility.

6.1.11 Verifications prior to Payload Delivery

6.1.11.1 Inspections and examinations at unit level

PL - 6.1.11 -1

The Payload shall be examined to verify compliance with the following criteria:

- Configuration,
- Interface Requirements,
- Parts, Materials and Process,
- Identification and Marking,
- Workmanship.

6.1.11.2 Mass properties determination

PL - 6.1.11 -2

The mass shall be determined by weighing before delivery for satellite integration.

PL - 6.1.11 -3

The moments of inertia and the center of gravity shall be determined by test.

6.1.11.3 Unit acceptance and delivery for satellite integration

PL - 6.1.11 -4

After completion of all acceptance tests at Payload level, accepted Payload shall be appropriately sealed by the Payload Supplier QA and released for storage or transportation or integration.
An Acceptance Data Package as defined in Payload Deliverable Items List shall be delivered with the unit.

6.2 TESTS AND VERIFICATIONS AT SATELLITE LEVEL

Figure 6.2-1 shows the main sequence of assembly, integration and test at satellite level.

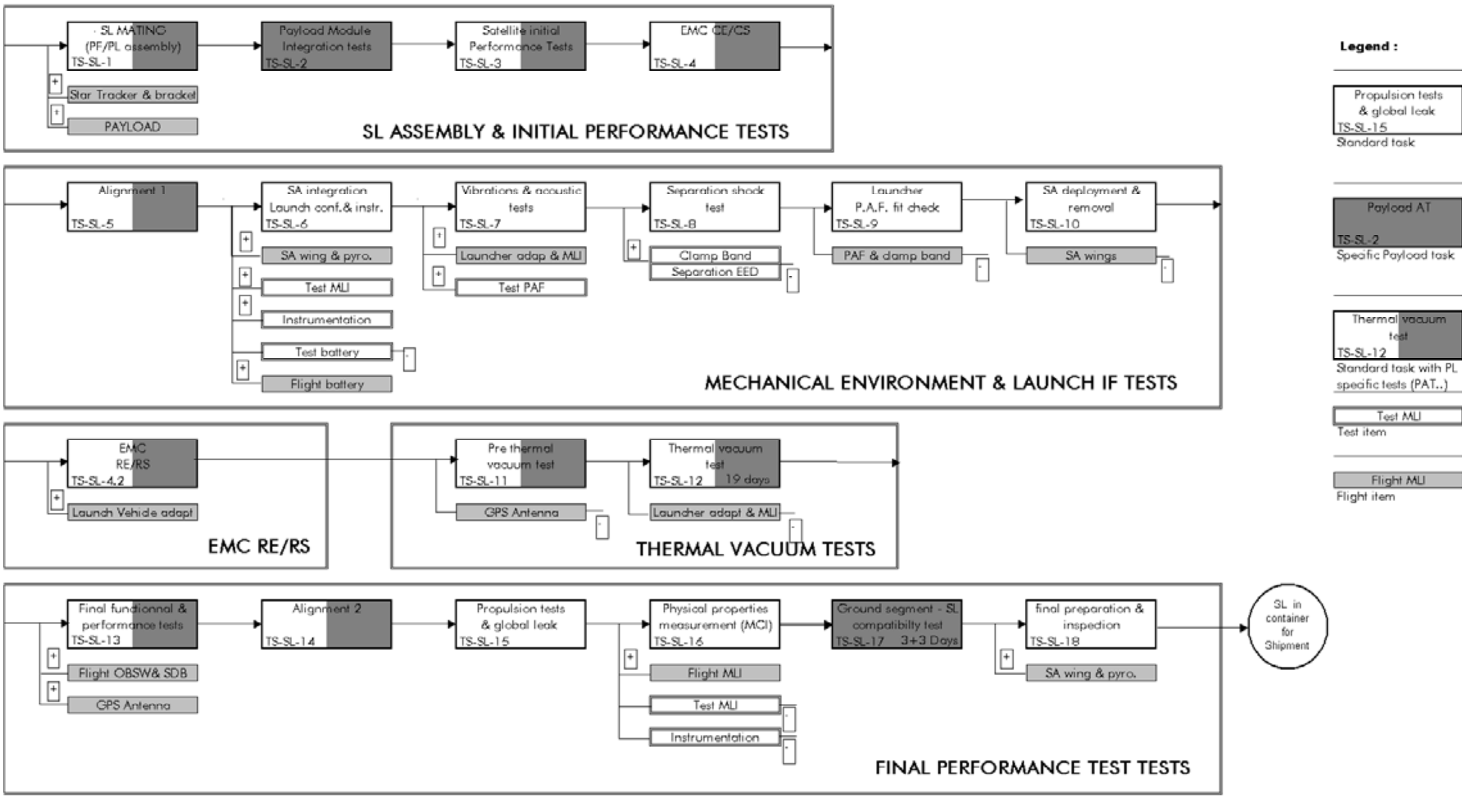


Figure 6.2-1 : Satellite Assembly Integration and Test

6.2.1 Payload Inspection before Integration

PL - 6.2.1 -1

The Payload shall be examined visually to verify that no handling damage has occurred.

6.2.2 Functional tests

The Functional tests will be as follows :

What kind ?	How many ?	When ?
AT	3	Initial, final & post vibration
HCT	2	EMC & thermal vacuum
PVT	2	Initial & final

Table 6.2-1: Functional tests

6.2.3 Thermal Vacuum tests

The satellite will be submitted to a thermal balance test (cold case) to correlate the platform thermal mathematical models and qualify satellite thermal control and to a thermal vacuum test (thermal cycling) to verify the satellite ability to meet the qualification requirements under vacuum conditions and extreme temperatures, which simulate those predicted in flight with qualification margins.
To obtain steady case temperature a vacuum chamber with liquid nitrogen-cooled shroud is used. The pressure will be lower than 10^{-4} torr. The thermal conditions will be established with infrared heat sources or by skin heaters. The choice could be different for the platform and for the payload. Nonetheless, with regard to the payload, this thermal environment shall be simulated thanks to the dedicated electrical facilities specified in PL-6.2.3-4.
Moreover the Payload shall be compatible with the « ESPACE 70 » thermal vacuum facility of Alcatel Space Cannes. Consequently, the payload shall comply with the following requirements.

PL - 6.2.3 -1

The payload and its specific thermal facilities and instrumentation in thermal vacuum test configuration must be enclosed in a volume defined as a cylinder centred on the Satellites Xs axis with a diameter less than 3.60 m and a height less than 2.80 m.

PL - 6.2.3 -2

The mechanical configuration of the payload during thermal vacuum test shall be, indiscriminately, the following :

- even Xs horizontal and Ys vertical (Satellite axis)
- even Xs horizontal and Zs vertical (Satellite axis)

PL - 6.2.3 -3

The Payload shall have its own thermal thermocouple instrumentation. The maximum allocation for Payload thermocouples is :

- 110 thermocouples in the Cu/Cs class
- 25 thermocouples in the Cr/Al class

PL - 6.2.3 -4

If needed, the Payload shall have its own thermal facilities dedicated to external fluxes simulation in orbital environment (solar, albedo and IR earth fluxes). In order to achieve this simulation, the Payload has at its disposal, during test, the following maximum electrical power lines allocation :

- 3 lines in the category : { Pmax=100W under Umax=50V with Imax=2A }
- 2 lines in the category : { Pmax=200W under Umax=35V with Imax=5.5A }
- 6 lines in the category : { Pmax=200W under Umax=60V with Imax=3.5A }
- 3 lines in the category : { Pmax=500W under Umax=60V with Imax=5.5A }

These electrical power lines are driven by a dedicated computer.
Note that the programming of a succession of different required power for each line during the test is possible (by modifying the needed power at each step of update of the command, for instance each 30 or 60 seconds).

PL - 6.2.3 -5

The satellite thermal test campaign is divided in 2 phases :

- first, a thermal balance test in order to declare the final qualification of the satellite
- second, a functional test in simulated spatial thermal conditions in order to qualify and verify performances of the satellite in extreme thermal environment configurations.

These tests are performed in succession, without chamber pressure or shroud temperature modifications.
The maximum duration for satellite thermal test campaign is :

- 3 days for the thermal balance test step
- 10 days for the functional verification in thermal environment condition step.

PL - 6.2.3 -6

During all the tests, thanks to the efficient thermal uncoupling between the payload and platform, no constraint on thermal configuration synchronisation is required between the payload and the rest of the satellite. Nevertheless, the PL thermal environment simulation facilities (in case of use of infrared heat sources) shall not generate fluxes towards the platform.

PL - 6.2.3 -7

During the thermal balance step, the functioning scenario of the payload units (with the exact timing) is defined by the payload and specified to the satellite (if any).
During the functional test in simulated spatial thermal conditions step, the functioning scenario of the payload units is determined in accordance with the satellite.
This information shall be supplied at the latest 4 months before the beginning of the satellite thermal test campaign.

PL - 6.2.3 -8

The Payload shall supply ALCATEL SPACE with the detailed mechanical, thermal and electrical ICD (Interface Control Documents) and IDS (Interface Data Sheets) of the payload in its thermal satellite test configuration, including instrumentation and dedicated thermal test facilities, at the latest 6 months before the beginning of the satellite thermal test campaign.

PL - 6.2.3 -9

The Payload shall supply ALCATEL SPACE with all the data allowing the monitoring of the thermal test. More particularly, the Payload must deliver all the parameters of the thermal test facilities dedicated to the payload and monitored by ALCATEL SPACE during all the tests (thermal regulation parameters, test heaters instructions, ...).
This information shall be supplied at the latest 2 months before the beginning of the satellite thermal test campaign.

The vacuum before first turn on shall be 10^{-5} hPa. During cycling, temperature and current will be continuously monitored. During these tests, provisions will be made to prevent the Payload from exceeding the specified operating temperature limits.

6.2.4 Vibration tests

PL - 6.2.4 -1

The Payload shall have its own mechanical instrumentation. The maximum allocation for Payload instrumentation is: • 50 sensors for sine, acoustic (or random) vibrations and shock tests (no specific instrumentation is foreseen for shock tests).

6.2.4.1 Sinusoidal Vibrations

The satellite will be qualified for each of the three axes with the following sequence:

Low level sine scan for resonance search (verification of the primary notching if any).

Intermediate level run, with notching (notching defined divided by 2), performed with qualification levels divided by 2.

Qualification level, with notching defined, at acceptance sweep rate.

Control low level (to verify that vibration did not modify the behaviour of the satellite).

To avoid unrealistic overtesting, the sine spectrum may be adjusted by notching the input on the basis of the load limit levels derived from mathematical analysis.

House keeping telemetry monitoring is performed to know the satellite status.

6.2.4.2 Random Vibrations

Random vibrations test at satellite level is not foreseen.

6.2.4.3 Acoustic Noise

Acoustic noise qualification test will be performed on the integrated satellite.

The expected levels seen by the payload will be covered by random qualification level specification of section 5.1.3. and acoustic qualification level specification of section 5.1.4.

The test sequence will be as described hereafter:

Low level, performed with 8 dB less than the qualification level, during 1 minute.

Intermediate level, performed with 4 dB less than the qualification level, during 1 minute.

Qualification level during 1 minute.

Control low level, performed with 8 dB less than the qualification level during 1 minute to verify that vibration did not modified the behaviour of the Payload.

House keeping telemetry monitoring is performed to know the satellite status.

6.2.4.4 Pyrotechnic shocks

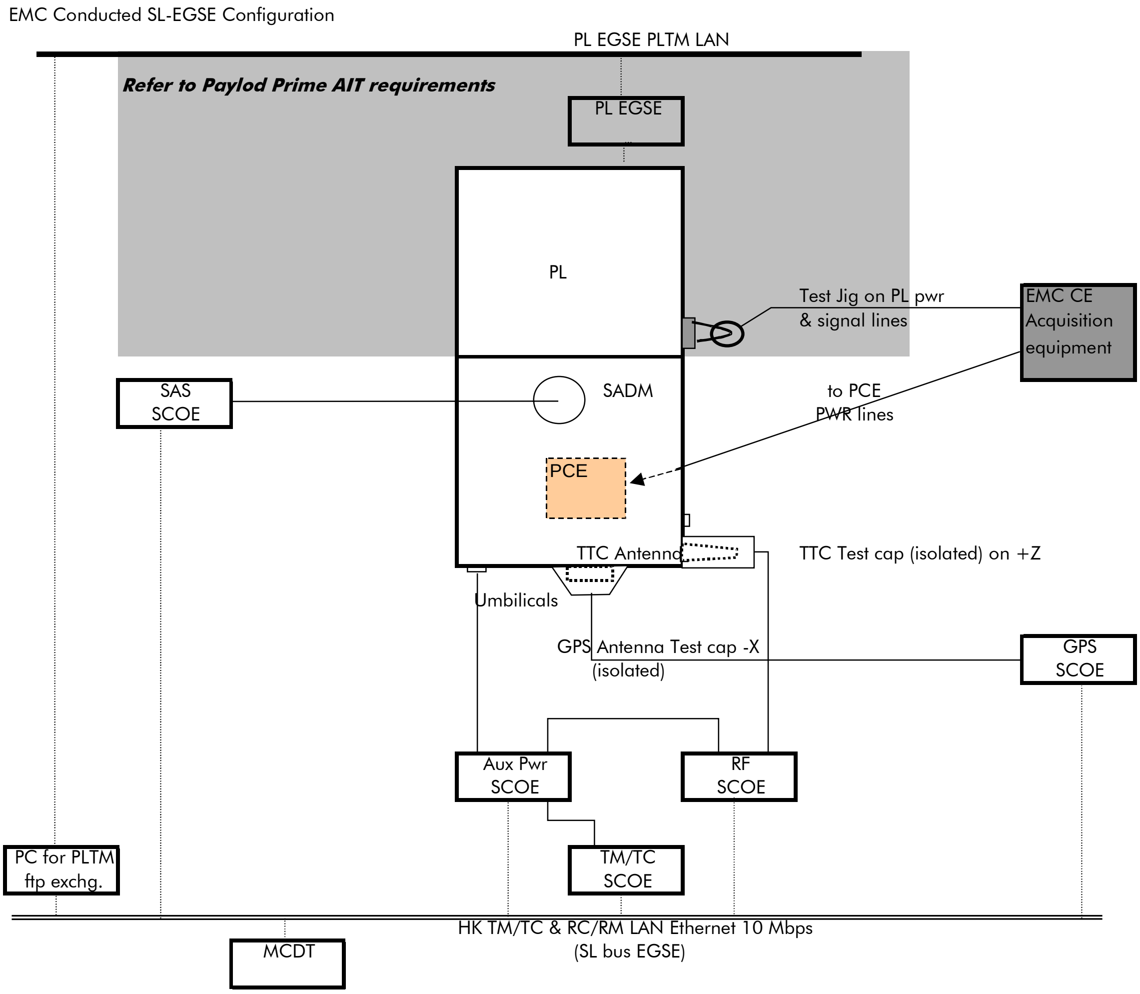
Pyrotechnic tests will be performed on the integrated satellite simulating launch vehicle separation and satellite EEDs activation.

The expected levels seen by the units will be covered by pyrotechnic shock qualification level specification of section 5.1.5.

6.2.5 EMC-Test

6.2.5.1 Conducted emission

- **Electrical configuration** is defined as below :



N.B.: Battery integration is required for this qualification as battery simulator EGSE is not reprentative of conducted EMC characteristics.

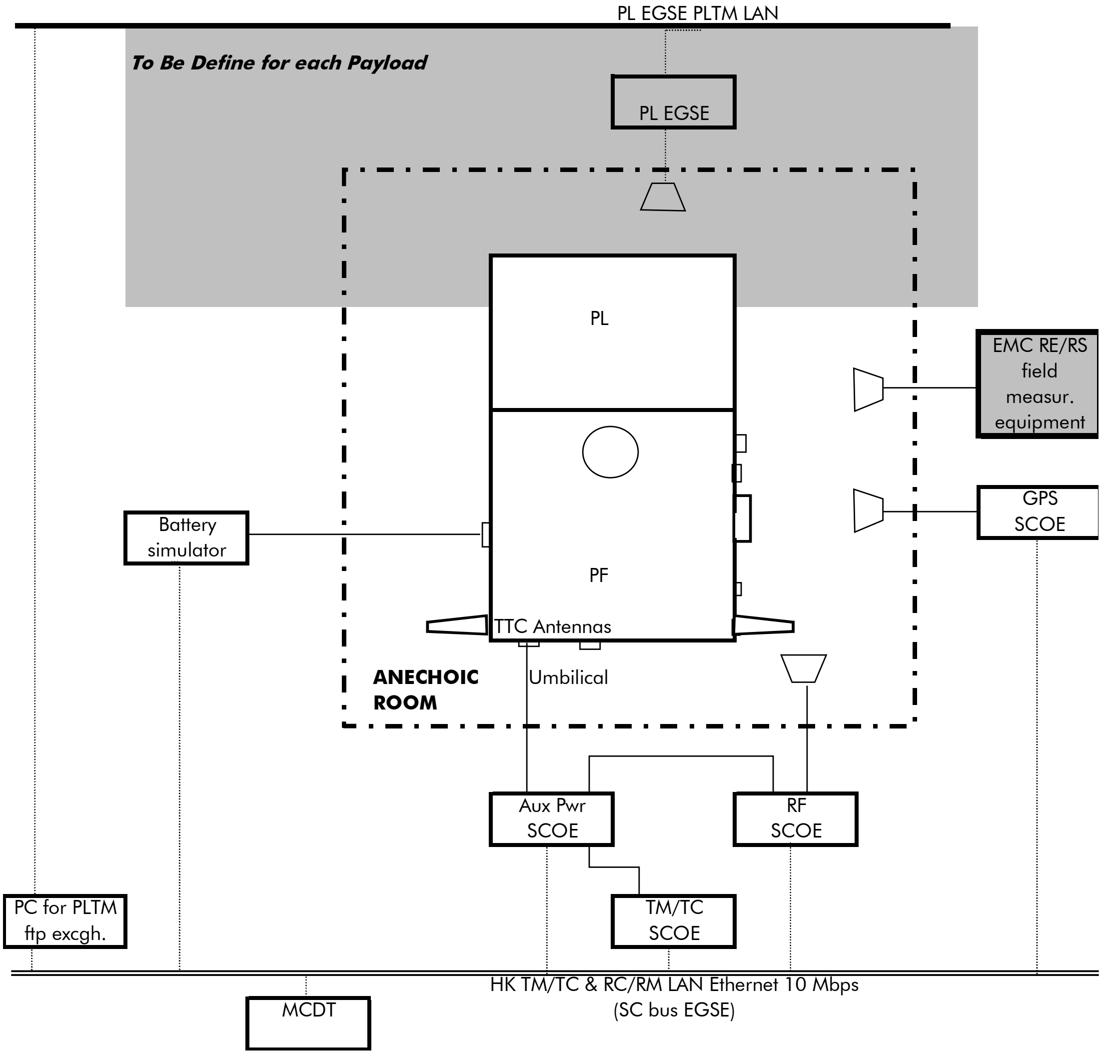
- Conducted emission verification:
  A blank scan is performed to calibrate the background noise (test set up operating with satellite power switch off).
  Satellite is powered on to noisy mode : equipment in the CE worst cases
  Conducted emission is measured on BNR primary bus at PCE connection (ripple detection..) and at PF/PL I/F connector bracket

6.2.5.2 Radiated emission and susceptibility

These tests will be performed with the satellite in a shielded anechoic chamber on a tilting dolly MGSE, with a minimum hard-line connection to EGSEs.
This test will be performed with the satellite in a shielded anechoic chamber on integration dolly MGS, with a minimum hard-line connection to EGSEs.

- **Electrical configuration** is defined as below :

EMC Radiated Configuration : Autocompatibility



- SC Radiated EMC self-Compatibility:
  A blank scan is performed to calibrate the background noise (test set up operating with satellite power switched off).
  Platform reference measurement by field measurement and reference equipment HCT,
  Instrument characterisation alone and with PF equipment,
  Instrument characterisation all together and with PF equipment.
- S/C EMC Radiated Emission and Susceptibility with launcher TBD:
  S/C removal from integration dolly and hanging on Hosting device by the room crane for EMC/RS susceptibility with launcher

R.E. : S/C is switched on in launch mode and radiated emission is performed within RF launcher required bands range (Radiated emission is measured at 1 m of I/F plane in circular polarisation) as specified in section 3.5.7.2.1.

R.S.: an RF field is radiated according to launcher and launch site requirements, at 1 m by a test antenna , with a circular polarisation or two perpendicular axes with a linear antenna, as specified in section 3.5.7.2.2. Susceptibility is checked by switching on the S/C to launch mode with required checks foreseen during combined operations.

Satellite re-installation on Integration Dolly

6.2.5.3 RF compatibility test

Test sequence TBD.

6.2.6 ESD-Test

ESD test at satellite level is not foreseen.

END OF CHAPTER