HERSCHEL SPACE OBSERVATORY

PACS

DPU AIV PLAN

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Issue 1

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Document Status Sheet

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Acronyms

AVM	AVionic Model
CDMS	Central Data Management System
CDMU	Central Data Management Unit
CGS	Carlo Gavazzi Space
EEPROM	Electrically Erasable Programmable Read Only Memory
EGSE	Electrical Ground Support Equipment
EIDP	End Item Data Package
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EQM	Electrical Qualification Model
DPU	Digital Processing Unit
FIRST	Far Infra-Red and Submillimetre Telescope
FM	Flight Model
FP s/s	Focal Plane sub-system
FPU	Focal Plane Unit
FS	Flight Spare
HIFI	Heterodyne Instrument for First
HK	House-Keeping
HSO	Herschel Space Observatory
HW	HardWare
IC s/s	Instrument Control s/s
ICD	Interface Control Document
ICU	Instrument Control Unit
I/F	Interface
ILT	Instrument Level Test
OBS	On Board Software
PA	Product Assurance
PACS	Photoconductor Array Camera and Spectrometer
PFM	Proto Flight Model
PROM	Programmable Read Only memory
QA	Quality Assurance
QM	Qualification Model

S/C	Spacecraft
S/S	Subsystem
SPIRE	Spectral and Photometric Imaging Receiver
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TLP	Transfer Layer Protocol
TRB	Test Review Board
TRRB	Test Readiness Review Board
UR	User Requirement
URD	UR Document
VCD	Verification Control Document
WBS	Work Breakdown Structure

1 INTRODUCTION

1.1 GENERAL

The content of this plan is based on the DPU model philosophy and the DPU subsystem specification AD-04, the DPU product tree, the pertinent instrument level AIV plan and consistent with the interface documents AD-01, AD-02 and AD-07.

The subsystem that is delivered for integration and tests at instrument level consists of an elctronics box called DPU and of the On Board Software both appropriate for each of the delivered models.

The deliverables are detailed and scheduled in the DPU/ICU Subsystem Development Plan AD-05.

1.2 SCOPE

The document describes the baseline regarding integration, test organisation, test description, test control and a test matrix for the subsystem. It contains references to the procedures used.

There will be the following deliverable models of the DPU subsystem (AD-05):

AVM subsystem

EQM subsystem

FM subsystem

In addition there will be various flight spare boards for the three Herschel Space Observatory (ex FIRST) instruments to cover possible failures as indicated in AD-05.

The letters AVM, EQM and FM identify these models respectively.

This document concentrates on the integration and testing of the various models.

1.3 OBJECTIVES

- Verification by means of testing of the DPU subsystem with respect to the subsystem specification, including operational procedures;
- Establish an integration sequence for the units;
- Identification of test activities on unit level ;
- Show the reviews, (e.g. a TRRB before environmental tests)
- Identify the procedures for the various tests

Test description and control sheets are presented in the different test procedures: (Reference Document RD-01– RD-08).

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD	Name
01	FIRST/Planck Instrument Interface Document, part A
02	FIRST/Planck Instrument Interface Document, part B-Instrument PACS
03	PACS Instrument Specification
04	PACS DPU Subsystem Specification Document
05	DPU/ICU Subsystem Development Plan
06	DPU/ICU P.A.Plan
07	PACS Interface Control Document
08	PACS Instrument Development and Verification Plan
09	Environmental Specification
10	EMC Specification
11	Cleanliness specification

2.2 Reference documents

RD	Title	Reference
01	User manual	
02	Physical properties test procedure	
03	Electrical interface tests procedure	
04	Vibration test procedure	
05	Thermal vacuum test procedure	
06	EMC test procedure	
07	Functional test procedure	
08	PACS Operational modes test procedure	

3 MANAGEMENT AND ORGANISATION

The DPU subsystem shall be verified against the requirements contained in AD-03 and the applicable documents contained therein.

3.1 Description of the test article

The DPU under test is described in document AD-04.

3.2 Responsibilities

The responsibilities of persons during the tests will be defined in the relevant test procedures. QA personnel can witness all tests and especially those on EQM, FM and spare parts.

3.2.1 Test reviews

Each integration test at instrument level will be closed by a test review. Before each environmental test at instrument level a TRRB is held. After environmental testing of the subsystem, there will be a TRB.

3.2.2 Criteria for failure definition

Pass/fail criteria are part of each individual Test Procedure. The proper levels for acceptance are considered at Test Procedure Level.

3.2.3 Non conformance

Non conformances will be issued if test results deviate from criteria identified in AD-04. Major non conformances will be issued against deviations with respect to AD–03 and AD-04.

3.2.4 Reporting

All test results will be documented in a logbook and will be available for review. A summary test report will be issued for each model and will be part of the dedicated End Item Data Package (EIDP).

3.3 Test procedures

Test procedures will be generated for all test steps as identified. They will be applied as a mandatory guidance for performing the test and will be applied as a test log, NCR identification etc.

The test procedures will contain as a minimum:

- a step by step identification of the test
- pass and fail criteria
- test criteria
- environmental conditions
- instrument handling
- responsibilities
- test facility requirements
- data requirements, including data archiving and data analysis as appropriate.

4 TEST ENVIRONMENT

4.1 Facility

For the normal AVM and EQM DPU testing there are no special requirements for pressure, humidity and clean room class. Normal ambient conditions will be sufficient and normal precautions to avoid ESD should be applied. The AVM will be even less stringent with respect to the EQM and obviously FM. The FM will be bolt on an aluminum plate and inside a plexiglass protective box, with

holes to access the connectors savers, and a 100000 class clean room will be required in order for the DPU not to be contaminated and in turn contaminate other subsystems.

The environmental tests like vibrations, thermal vacuum and EMC will be carried out at TBD facilities following the specifications of AD-01.

4.2 TEST SET UP

4.2.1 In house test set up: first step

The general in house first step test set up is shown in the following figure 4.1

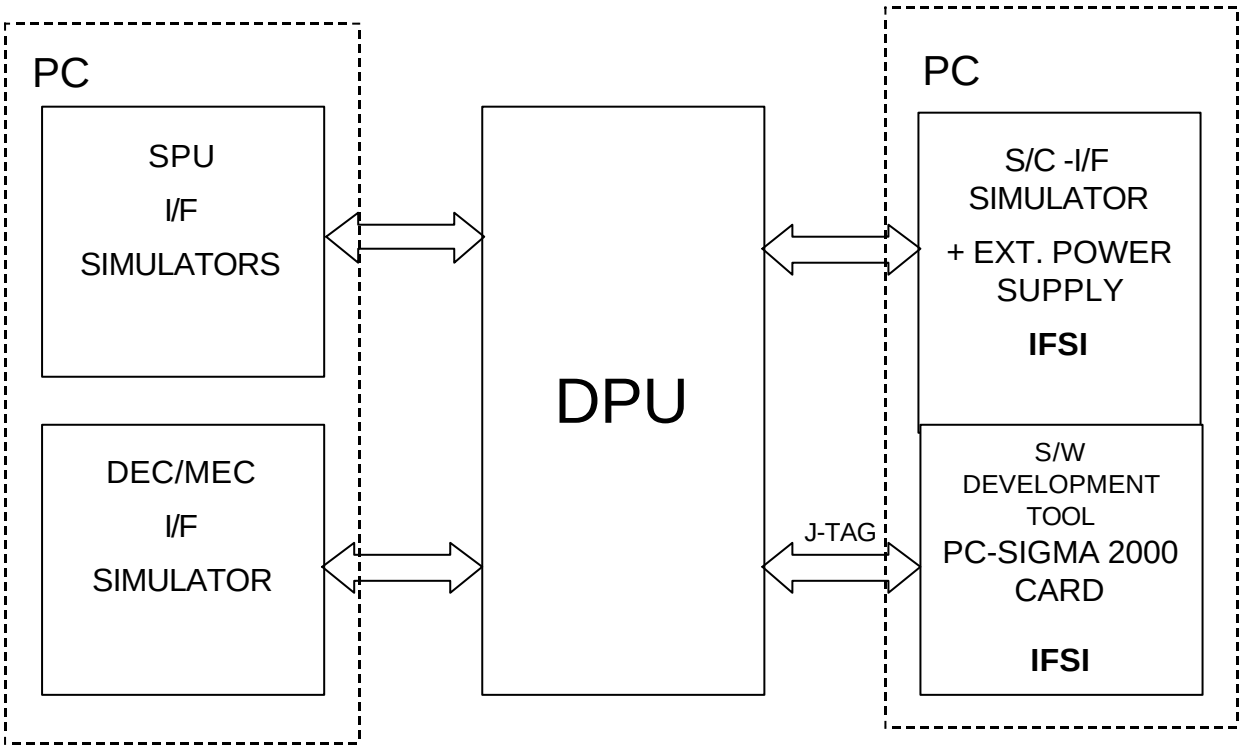

Figure 4-1

This test set up is used during preliminary tests at subsystem level to test:

- hardware interfaces functionalities to/from spacecraft (STD-1553 B HW I/F);
- hardware interface functionalities to/from subsystems (STD-1355 DS-DE serial links);
- low level test software to/from spacecraft (STD-1553 B basic protocol) ;
- low level driving/receiving software to/from subsystems (addressing, data transmission and reception) .
- for all models, after transport from IFSI to the instrument integrating place or test facility to check the subsystem integrity.

The test and debugging software can be loaded into the DPU through the J-TAG connector provided on the CPU board.

The same test set up can be used for all DPU models for debugging purposes.

4.2.2 In house test set up: second step

In the following figure 4.2 the set up is shown of the in house second step, the main difference from step 1 being the PACS provided EGSE, performing **at least** the S/C HW I/F and the SW TLP.

The purpose of this second set up is to test:

- the transfer layer protocol software;
- the on board software as far as possible, taking into account that the IFSI subsystem simulators will be very simple, their design principle being only aiming at testing the hardware interface and the basic command reception and data transmission. As the SPU and DEC/MEC simulators will be through a commercial PC card, the simulation software can be provided by the pertinent subsystems so as to push as far as possible the OBS tests.

The J-TAG link is still foreseen for a cross-check of the EGSE software up-loading facility and for debugging purposes.

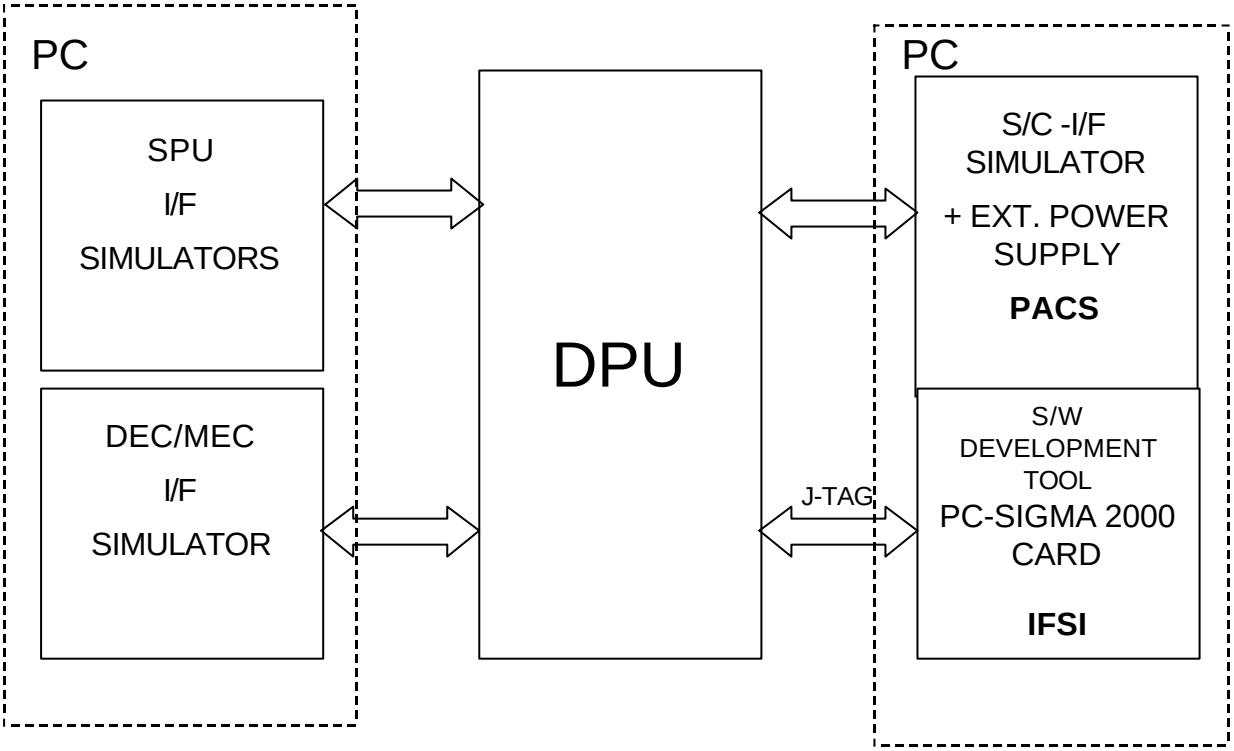

Figure 4-2

4.2.3 Instrument level integration tests

In the following figure 4.3 the DPU integrated together with the PACS EGSE and subsystems, or their simulators, is shown. This is the only configuration in which the full on board software test will be carried out for models EQM and FM and in which the full on board software test could be carried out for the AVM if the subsystems, or the subsystems simulators, can appropriately answer the DPU commands, send back HK and science data. It is also to be noted that the J-TAG connection is not used any longer as the facility to load new software through the telecommand link should be fully operational.

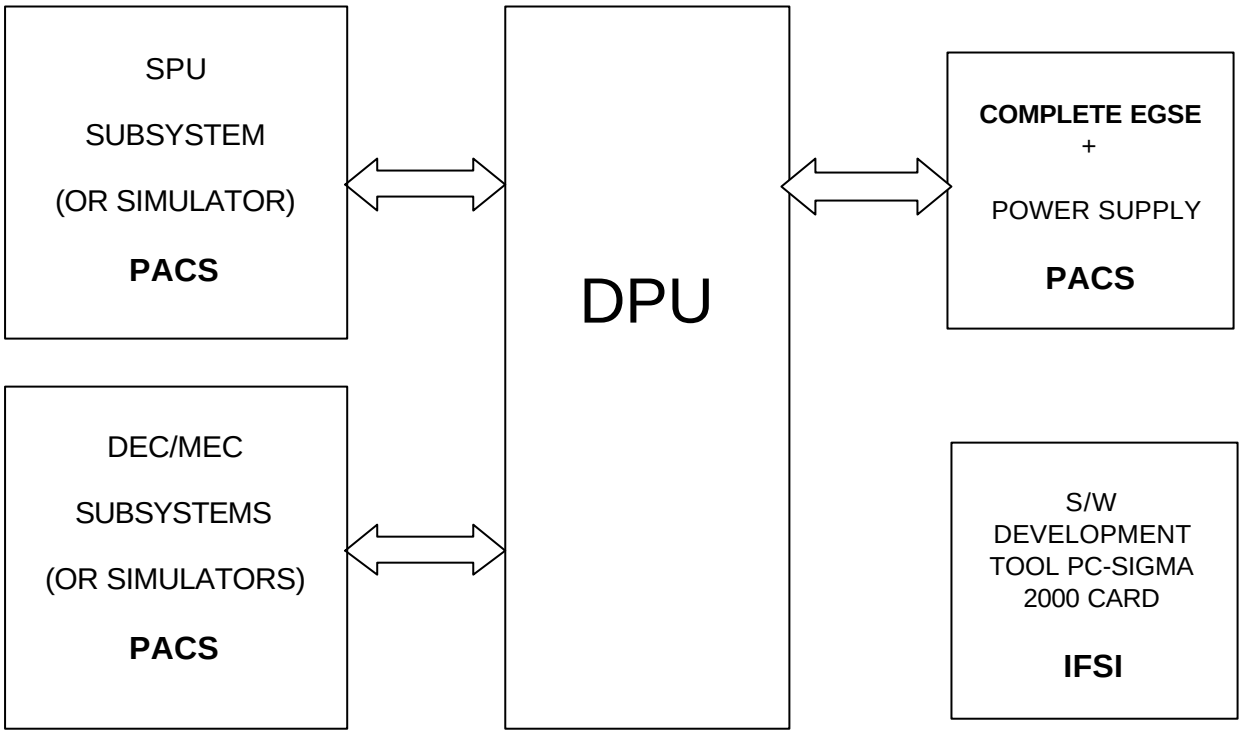
SPU
SUBSYSTEM
(OR SIMULATOR)
PACS
DEC/MEC
SUBSYSTEMS
(OR SIMULATORS)
PACS
DPU
COMPLETE EGSE
+
POWER SUPPLY
PACS
S/W
DEVELOPMENT
TOOL PC-SIGMA
2000 CARD
IFSI

Figure 4-3

4.2.4 Test Parameters Tolerances

The parameters read out from the DPU are analogue and digital. The analogue parameters are:

- DPU temperature
- DPU voltages
- DPU total current drain.

The accuracy of the analogue channels will be within 5% (TBC).

The digital parameters will be shown in a digital word (TBC) showing the DPU status.

No accuracy percentage can be attributed to the digital status word.

4.2.5 Test Apparatus Accuracy

The STD-1355 DS-DE simulators provided by IFSI, will follow, as far as the hardware is concerned, the requirements of the DPU sections in the PACS Interface Control Document (AD-07).

The S/C simulator provided by IFSI, will follow the requirements of the STD 1553B, as far as the Bus Controller is concerned, in the long stub hardware interface configuration.

5 ASSEMBLY, INTEGRATION AND TESTING (AIT)

The following list of tests applies:

- Physical properties (dimensions, mass, mechanical interfaces, alignment, CoG, MoI (computed));
- Electrical tests: electrical interfaces with S/C, subsystems and DPU DC/DC converter tests;

- Functional tests;
- Software tests;
- Vibration Tests;
- Thermal vacuum;
- EMC tests;
- Visual inspection;

Whenever the DPU subsystem is switched on during thermal vacuum test, the OBS will be running and controlling the instrument. If one or more parameters are out of warning limits, the OBS autonomous functions should send a warning in telemetry to be interpreted by the EGSE and made evident to the operator. The EGSE/check-out software should be such that an alarm is given if pre-set emergency limits have been exceeded; the instrument must then be switched off. Monitoring data should automatically be archived so that trends can be identified later.

A full functional test will be performed before and after each environmental test, a subset of the functional test will be performed at certain moments during the testing. This is clearly indicated in the applicable test procedures.

5.1.1 DPU subsystem test matrix

SUBSYSTEM TEST MATRIX	DPU	Instrument Specification
Functional Tests		
1. Electrical I/F	FT-x	AD-01, AD-10
2. Command I/F	FT-x	AD-02
3. Functional reproducebility	NA	
Thermal behaviour	**NA**	
1. Temperature levels (during cooldown)	NA	
2. Thermal response on dissipation	NA	
Operational procedures		
1. Start-up and shutdown procedures	OP-x	RD-01
2. Monitoring procedures	OP-x	RD-01
3. Tuning procedures	NA	
4. Calibration procedures	NA	
5. Instrument modes	OP-x	RD-08
6. Synchronization	OP-x	AD-01
7. Data handling	OP-x	AD-01 AD-04

Performance tests	**NA**	

5.2 AIT flow

A more detailed Assembly, Integration and Test flow is presented in Fig. 5.1

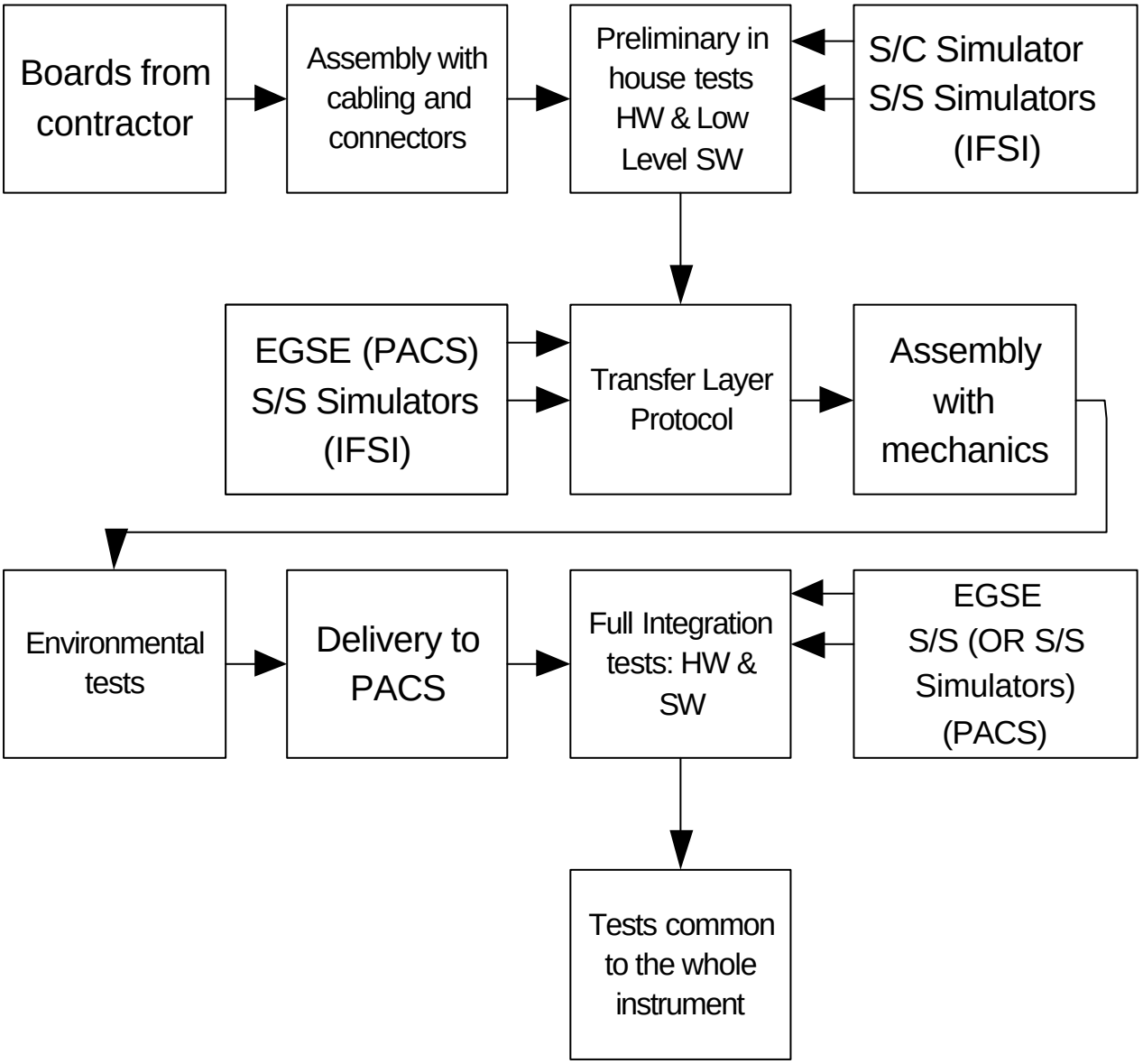

Figure 5-1

A full functional test will at least be performed at the beginning and at the end of each environmental test.

Each test is closed with a Test Review.

6 TESTS DESCRIPTION

6.1 Physical properties

The measurements will be performed on all boxes and for the FM ones in a clean room facility. Dimensions, mass, mechanical interface, CoG, will be measured with respect to the quantities shown in the mechanical configuration control drawing, the Moment of Inertia (MoI) will be computed as well as the thermal capacitance.

6.1.1 Dimensions

Test number: **TPHP-01**

Objectives and description:

To verify the requirements identified in AD-02 section 5.5. The test is described in RD-02.

6.1.2 Mass

Test number: **TPHP-02**

Objectives and description:

To verify the mass requirements identified in AD-02 section 5.5.The test is described in RD-02.

6.1.3 Mechanical Interface

Test number: **TPHP-03**

Objectives and description:

To verify the requirements identified in AD-02 section 5.4.

6.1.4 Center of Gravity

Test number: **TPHP-04**

Objectives and description:

To verify the requirements identified in AD-02 section 5.4.

6.1.5 Moment of Inertia

Test number: **TPHP-05**

Objectives and description:

To verify the requirements identified in AD-02 section 5.4.The test is described in RD-02.

6.1.6 Alignment check

NA

6.2 Electrical Tests

The power consumption of the DPU will be measured and this is anticipated to be very slightly dependent on the instrument mode.

6.2.1 Power consumption Stand-by Mode

Test number: **TELT-01**

Objectives and description:

To verify the power consumption in the Stand-by Mode against the requirements of AD-02, section 5.9.5.

The test is described in RD-03, section TBD.

6.2.2 Power consumption Normal (Primary) Mode

Test number: **TELT-02**

Objectives and description:

To verify the power consumption in the Normal Mode against the requirements of AD-02, section 5.9.5.

The test is described in RD-03, section TBD.

6.2.3 Power consumption Test Mode

To verify the power consumption in the Test-by Mode against the requirements of AD-02, section 5.9.5.

The test is described in RD-03, section TBD.

6.2.4 S/C interface test

To verify that the HW interface to/from the S/C is according to AD-01.

The test is described in RD-03, section TBD.

6.2.5 Subsystems interface test

To verify that the HW interface to/from the various subsystems are according to AD-07.

The test is described in RD-03, section TBD.

6.3 FUNCTIONAL TESTS

6.3.1 Electrical I/F test

Test number: **FT-01**

Objectives and description:

Switch on procedure to command the instrument into the Init Mode.

The test is described in RD-07, section TBD.

6.3.2 Command I/F test

Test number: **FT-02**

Objectives and description:

To verify the CDMS protocol against the requirements identified in AD-02 section 5.13

The test is described in RD-07, section TBD.

6.4 Operational modes

To verify the operational modes against the requirements of RD-08, section TBD.

6.4.1 Start up and shutdown procedures

Test number: **OP-01**

Objectives and description:

to properly switch On and OFF the DPU especially if integrated with the whole instrument. The procedure is described in RD-01 section TBD.

6.4.2 Monitoring procedures

Test number: **OP-02**

Objectives and description:

to assess the normal working of the DPU in the various modes. The procedure is described in RD-01 section TBD.

6.4.3 Tuning procedures

NA

6.4.4 Calibration procedures

NA

6.4.5 Subsystem modes

NA

6.4.6 Synchronisation

Test number: **OP-06**

Objectives and description:

to test that the DPU will normally work also without the external DC/DC converter synchronisation signal according to AD-01 section 5.9.5.7.

6.4.7 Data handling

Test number: **OP-07**

Objectives and description:

to test that the data interface for telecommands according AD-04 section 3.2.5 for the DPU itself and for telecommands and telemetry for the whole instrument is properly working according to AD-01 sections 5.11. and 5.13.

6.5 Performance tests

NA

6.6 VIBRATION TESTS

These tests will take place at TBD vibration facility in a clean environment, according to AD-01 section 9.5.3.

The test is described in RD-04.

6.6.1 Random vibration

Test number: **VIB-01**

Objectives and description:

To verify the requirements identified in AD-01 section 9.5.3.4.

The test is described in RD-04.

6.6.2 Sine vibration

Test number: **VIB-02**

Objectives and description:

To verify the requirements identified in AD-01 section 9.5.3.3.2.

The test is described in RD-04.

6.7 THERMAL VACUUM TEST

This test will be performed in a TBD vacuum test facility. This facility is located in a clean room.

Test number: **TVT-01**

Objectives and description:

To verify the requirements identified in AD-01 section 9.5.4.3.

The test is described in RD-05

6.8 EMC TESTS

To verify the requirements identified in AD-01 section 9.5.6.

The tests are described in RD-06.

6.9 VISUAL INSPECTION

After the test campaign each model shall be carefully inspected visually in order to detect changes that may have occurred during testing. A cleanliness check will be performed; all testing and handling will be performed in sufficiently clean environments.

Test number: **VIS-01**

Objectives and description:

The inspection shall be performed in the subsystem clean room facility. The instrument shall be OFF and disconnected from the test equipment. The instrument shall show no evidence of damage, cracking, bending, etc.

The test is described in RD-01.