IFSI CNR	**Herschel DPU-ICU Thermal Vacuum Test Procedure**	**Ref.:** CNR.IFSI.2002TR02 **Issue:** Issue 1 **Date:** 30/10/02

Herschel

DPU-ICU Thermal Vacuum

Test Procedure

Document Ref: CNR.IFSI.2002TR02

Issue 1

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Acronyms

ASI	Agenzia Spaziale Italiana (Italian Space Agency)
AVM	AVionic Model
CDMS	Central Data Management System
CDMU	Central Data Management Unit
CE	Conducted Emission
CEDM	Conducted Emission Differential Mode
CECM	Conducted Emission Common Mode
CGS	Carlo Gavazzi Space
CM	Common Mode
COG	Centre Of Gravity
DM	Differential Mode
EEPROM	Electrically Erasable Programmable Read Only Memory
EGSE	Electrical Ground Support Equipment
EIDP	End Item Data Package
EMC	ElectroMagnetic Compatibility
ESD	Electro Static Discharge
EQM	Electrical Qualification Model
DPU	Digital Processing Unit
FIRST	Far Infra-Red and Sub-millimetre Telescope
FCU	Focal plane Control Unit
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
HRS	High Resolution Spectrometer
HRSU	High Resolution Spectrometer Unit
HW	HardWare
IC	Instrument Control
ICD	Interface Control Document
ICE	In Circuit Emulator
ICU	Instrument Control Unit
I/F	Interface

ILT	Instrument Level Test
LCU	Local oscillator Control Unit
LISN	Line Impedance Stabilization Network
LOA	Local Oscillator Assembly
LO S/S	Local Oscillator sub-system
LOU	Local Oscillator Unit
MOI	Moment Of Inertia
NA	Not Applicable
NB	Narrow Band
NCR	Non Conformance Report
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
RE	Radiated Emission
S/C	Spacecraft
S/S	Subsystem
SLE	Standard Laboratory Equipment
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 S/S	Wide Band Spectrometer sub-system
WBSU	Wide Band Spectrometer Unit

1 INTRODUCTION

1.1 General

The content of this procedure is based on the DPU-ICU (from now on "the unit") model philosophy and the unit subsystem specification (AD05-AD07), the unit product tree; it is consistent with the interface documents AD01 and AD02-AD04. This document specifies how the thermal vacuum test will be carried-out on the unit, to be sure that the unit fulfils its thermal performances.

The subsystem that has to undergo the test at unit level consists of an electronic box called DPU (for the PACS and SPIRE instruments) and ICU (for HIFI instrument) (dimensions: 274x258x194 mm^3) and of the On Board Software both appropriate for each of the delivered models.

1.2 Scope

This document describes the detailed procedure for the thermal vacuum test. This procedure applies to the following deliverable models of the unit subsystem:

EQM subsystem
FM subsystem

The letters EQM and FM identify these models respectively.

1.3 Objectives

Verification by means of testing of the unit subsystem with respect to the subsystem specification, especially with reference to AD01, AD02-AD08.

2 DOCUMENTS

2.1 Applicable Documents

AD	Name
01	Herschel/Planck Instrument Interface Document, part A
02	Herschel/Planck Instrument Interface Document, part B-Instrument PACS
03	Herschel/Planck Instrument Interface Document, part B-Instrument HIFI
04	Herschel/Planck Instrument Interface Document, part B-Instrument SPIRE
05	Herschel PACS DPU Subsystem Specification Document
06	Herschel HIFI ICU Subsystem Specification Document
07	Herschel SPIRE DPU Subsystem Specification Document
08	DPU/ICU P.A. Plan

2.2 Reference Documents

RD	Title
01	PACS DPU HW User Manual
02	HIFI ICU HW User manual
03	SPIRE DPU HW User Manual

3 General Test Condition and Instrumentation (AD01)

The following minimum test requirements shall be satisfied:

- equipment shall be tested in a thermal vacuum environment having a pressure of 0.0013 Pa (10^{-5} Torr) or less. The test may begin when the pressure falls below 0.013 Pa (10^{-4} Torr), and a pressure of 0.0013 Pa or less shall be achieved prior to startup of the units not operating during first ascent,
- stabilization is achieved when the equipment temperatures have been maintained within tolerance and have not changed by more than 1 °C during the previous one hour period.

IFSI shall be responsible to define the adequate test instrumentation in order to demonstrate that temperature levels are achieved and to validate the instrument unit thermal mathematical model.

This test instrumentation shall include as a minimum:

- for the shroud temperature, the instrumentation necessary to allow accurate temperature control by using fluid loop or/and electrical resistance heaters,
- for the instrument unit at least one temperature sensor on each unit casing wall, and one temperature sensor on each unit foot,
- for the mounting plate, at least one temperature sensor close to each unit mounting foot, and four temperature sensors to derive the lateral gradients inside the mounting panel.

The general requirements for the design verification, qualification and proto-qualification tests are the following:

- During testing, the same item shall be tested in the normal post-lift-off sequence, to the thermal environments appropriate to non-operating, switch-on (start-up) and operating qualification temperature limits.
- If preferred the temperature cycle profile can be changed to give a hot phase first. The temperature gradient dT/dt must be < 2 °C/min for electronics boxes inside the SVM. For instrument units mounted externally of PLM and SVM, higher gradients can be defined in the equipment specification (TBC).
- Heat dissipations: IFSI shall demonstrate the units dissipate not more than the maximum values defined in IID-B.

The general requirements for the acceptance tests are the following:

- In order to ensure the application of the maximum stress condition, the unit shall be operated continuously throughout the test which shall comprise TBD cycles, with full functional testing at the last 2 extremes, and adequate monitoring during the remainder of the test.

4 Thermal Vacuum and Balance Test (AD01)

4.1 Thermal Vacuum Test

The thermal vacuum test is required to evaluate and demonstrate the functional performance under vacuum of the instrument units. This is performed under the extreme and nominal modes of operation, with temperature conditions for the instrument more severe than the maximum and minimum temperatures predicted for the mission, namely within the acceptance or qualification temperature range.

4.2 Thermal Balance Test (NA)

A thermal balance test at instrument level shall be conducted on instrument units whose thermal control is under PI responsibility: **this test is Not Applicable for the DPU-ICU whose temperature is strictly connected to the temperature of the S/C panel where the DPU-ICU are bolted.**

4.3 Thermal Cycling Tests

Thermal cycling tests will be performed in order to demonstrate that the instruments and its units are able to withstand without degradation and under vacuum a number of thermal cycles representative of the lifetime of the instruments with margins starting from the minimal temperatures to the maximal temperatures defined in the IID-B (AD02 - AD04). Each thermal cycle shall include a soak time long enough to achieve thermal equilibrium of the instrument or the unit (T change 1°C/hour).

The cold start-up capability at – 30 °C shall also be tested.

In the following figure 4-1 a typical temperature cycling diagram is shown (TBC).

By considering the maximum operating temperature of 45 °C and the minimum operating temperature of – 15 °C, the maximum and minimum temperatures of the temperature cycling will be as follows:

For qualification the maximum will be 55 °C (i.e.10 °C above the maximum) and the minimum will be – 25 °C (i.e. 10 °C below the minimum);

For acceptance the maximum will be 50 °C (i.e.5 °C above the maximum) and the minimum will be – 20 °C (i.e. 5 °C below the minimum).

4.4 Thermal Shock Test

A thermal shock test will be conducted to verify that the instruments or the units can withstand a rapid cool-down under vacuum from room temperature to the minimal temperature defined in the IID-B. The PI shall establish what is the minimal duration of the cool-down still compatible with the unit/instrument. However, this duration shall be no greater than 5 hours for Herschel.

With the proposed temperature cycling diagram there will be 3 of such thermal shocks (TBC).

4.5 Thermal Bake-out Test (NA)

A thermal bake-out will be conducted (at least) for the Herschel focal plane units inside the cryostat (about 80°C for 3 days): **the DPU-ICU are not Focal Plane Units, but Warm Electronic Units, so the bake-out is not requested (TBC).**

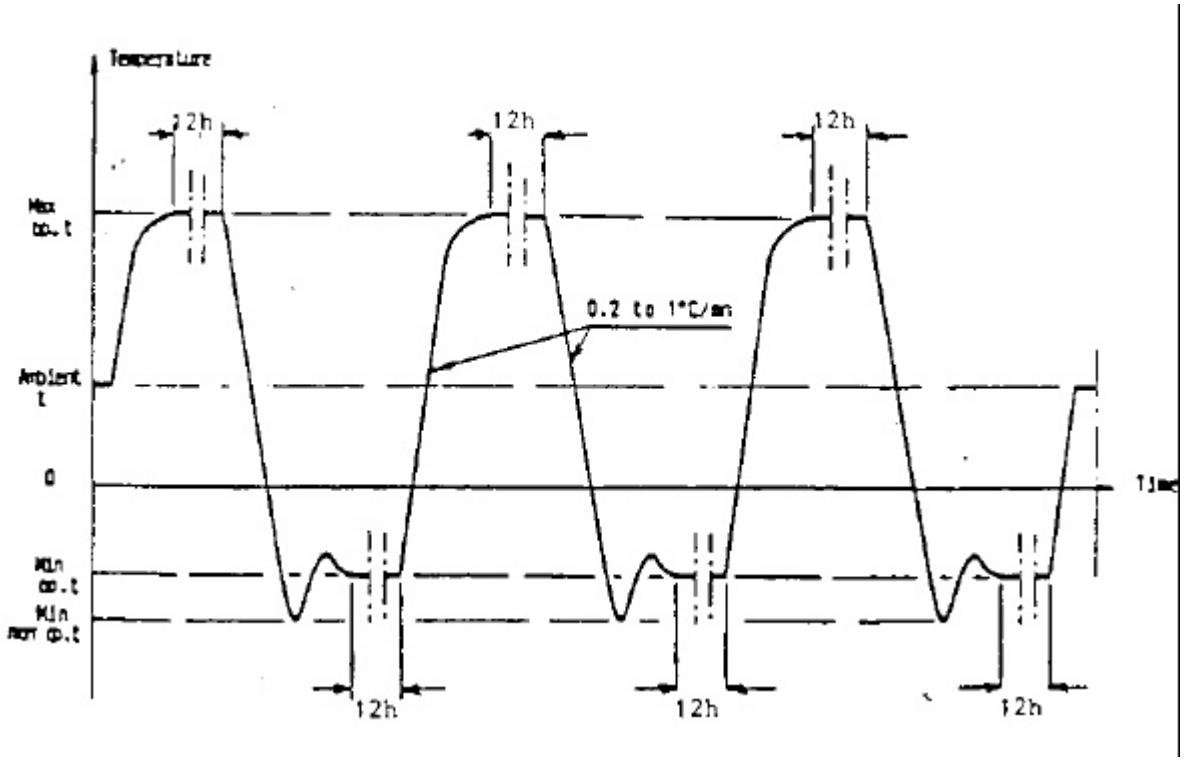

Figure 4-1 Temperature Cycling During Thermal Vacuum