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SMART-1
AMIE-FM Thermal Vacuum Test

Test report: TOS-MCV/2001/2677/ln/SR

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AMIE-FM
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Content

Reference documents

1. SMART-1, Test and Calibration Plan
   Doc.: S1-AMI-PL-3004, 15th of June 2001, issue 3.2

1. Introduction

The Asteroid Moon micro-Imager Experiment (AMIE) is an imaging system derived from the development efforts already under way for the Technological Research Program of ESA, the ROSETTA mission and Mars mission. The development of the SMART 1 payload elements has to meet stringent mass constraints, so the AMIE unit is miniaturised as much as possible.

This AMIE FM TV Test was performed at ESTEC in the Mechanical Systems Laboratory in July 2001.

2. Objectives

The purpose of this test is to verify the proper functional behaviour of the camera system during and after thermal cycling.

3. Responsibilities

The test was executed with shared responsibilities. The Mechanical Systems Laboratory (TOS-MCV) is responsible to provide the vacuum conditions / the thermal environment defined in the ref.1 and shall provide the needed electrical feed through, test thermocouples (TC) and data acquisition.

CSEM (Centre Suisse d' Electronique et de Microthechnique) is responsible for the functional/ performance verification tests to be executed during the test.

4. Test sample

The test sample consists of the flight model of the AMIE imaging system which is constituted of a camera (unit 1) and its dedicated electronic box (unit 2).
The two units are linked with a cable supporting a serial digital link at 10Mbit/s and the power supply from unit 2 to unit 1.

5. Test procedure

The AMIE-FM shall undergo thermal cycling testing in non-operational and operational condition.
The test sequence shall consist of 1 cycle within the non-operational (TNO) followed by 5 cycles within operational temperature range (TO).

The units are switched on during the last 5 cycles. A functional tests consisting of an image with simple analyses are performed at each maximum/minimum temperatures and at the end of the test at ambient temperature.

The temperature requirements are showed in table 1.

Temperature definition at TRP (TC01)	Values [°C]	Tolerances[°C]
Maximum Non-Operating: TNO-MAX	+ 60	-0/+3
Maximum Operating: TO-MAX	+ 55	-0/+3
Ambient: $T_{ambient}$	+ 23	+/- 3
Minimum Operating: TO-MIN	- 15	-3/+0
Minimum Non-Operating: TNO-MIN	- 30	-3/+0

Table 1: Temperature requirements

- The pressure level in the vacuum chamber shall be lower 1.0 10^{-5} mbar.

- The temperature change rate shall be not higher than 5°C/min.

6. Test set-up

The facility used for this test was the LIVAF of the Mechanical Systems Laboratory (TOS-MCV). Units 1&2 were mounted on an aluminium interface plate using thermal interfiller between the cold plate and the aluminium interface plate (Sigraflex, based on graphite).

The cold plate was mounted onto an adjustments set-up levelled at 0.1 mm/m.
the camera was pointing threw the quartz window of the facility a collimator adjusted outside the chamber.

The temperature controlled shroud was active during the test.

The test instrumentation consisted of:

- 2 GN2/LN2 heat exchanger with an Eurotherm temperature controller, one for the shroud, one for the cold plate
- a chart recorder Siemens Multireg C1732
- a set of thermocouples (08, type T: i.e. copper/constantan)

Thermocouple listing

MCPS Nº	Location	TC Nº	Type
1	Interface front (TRP)	TC01	T
2	Lents	TC02	T
3	Connector base	TC03	T
4	Top electronic box	TC04	T
5	Connector electronic box	TC05	T
6	Interface electronic box	TC06	T
7	Cold plate	TC07	T
8	Shroud	TC08	T

Table 2: TC identification

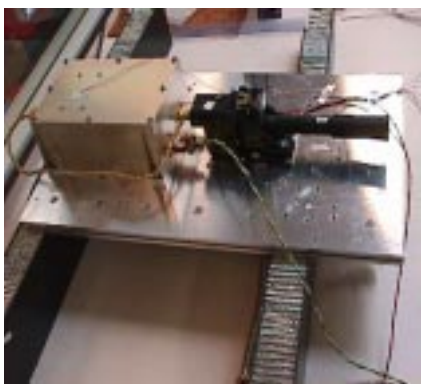


Fig 1: Set up on cold plate

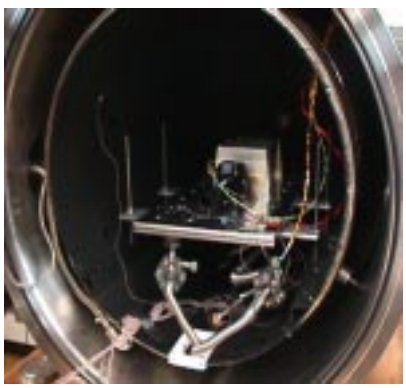


Fig 2: Set up in the LIVAF

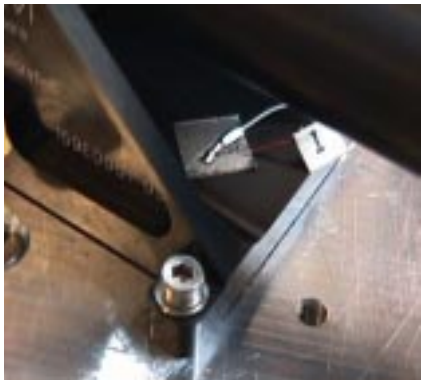


Fig 3: TC01 (TRP)

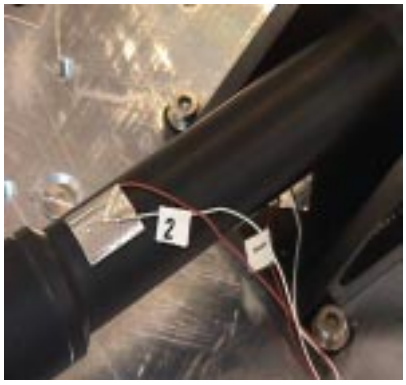


Fig 4: TC02

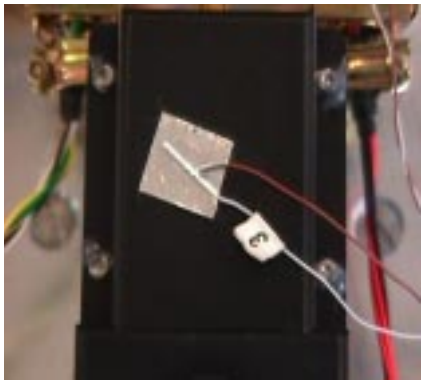


Fig 5: TC03

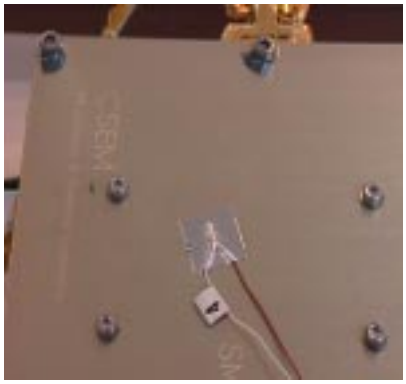


Fig 6: TC04

Fig 7: TC05

Fig 8: TC06

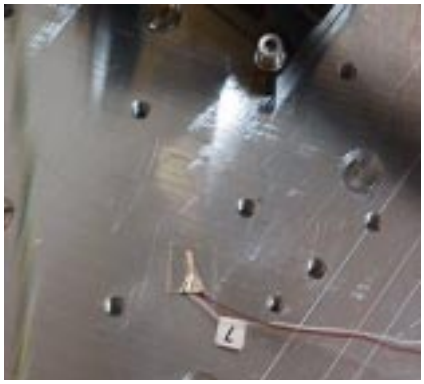


Fig 9: TC07

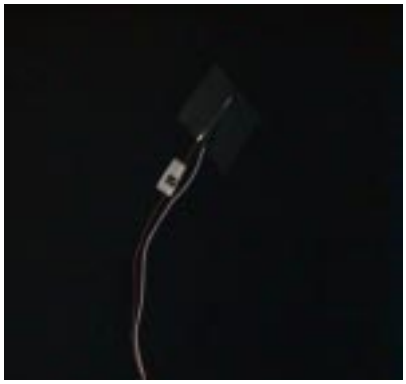


Fig 10: TC08

7. Test execution

7.1. Non operational Cycle 1

The Eurotherm units have been programmed with the following parameters:

Setting	Cold plate [°C]	Shroud [°C]	Dwell time [Hours]
TNO-MAX	+ 63	+ 56	1.3
TNO-MIN	- 33	- 36	1.3
$T_{ambient}$	+ 24	+ 19	Indefinite
T° rate	5 °C/min.	5 °C/min.	

Table 3: Eurotherm program, Cycle 1

7.2. Operational Cycles 2 to 6

The Eurotherm units have been programmed with the following parameters:

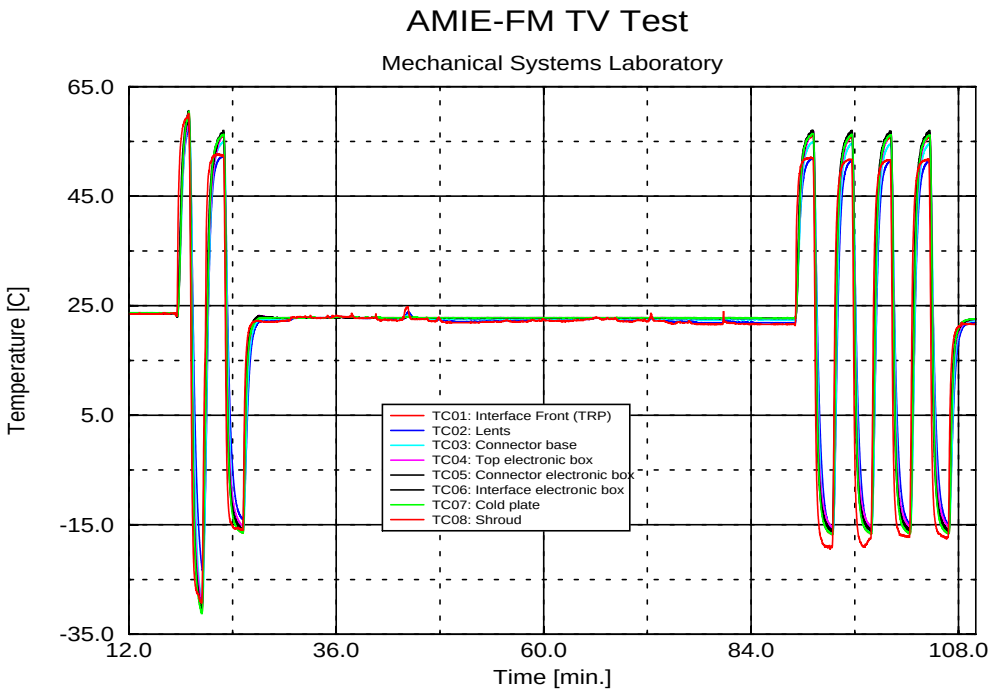
Setting	Cold plate [°C]	Shroud [°C]	Dwell time [Hours]
TO-MAX	+ 57	+ 50	2
TO-MIN	- 17	- 20	2
$T_{ambient}$	+ 23	+ 18	Indefinite
T° rate	5 °C/min.	5 °C/min.	

Table 4: Eurotherm program, Cycles 2 to 6

8. Test results

8.1. Complete test

The following plot show the complete test sequence performed on AMIE FM.



A 60 hours dwell was performed between cycle 2 & 3 to stay at ambient temperature during the week end.

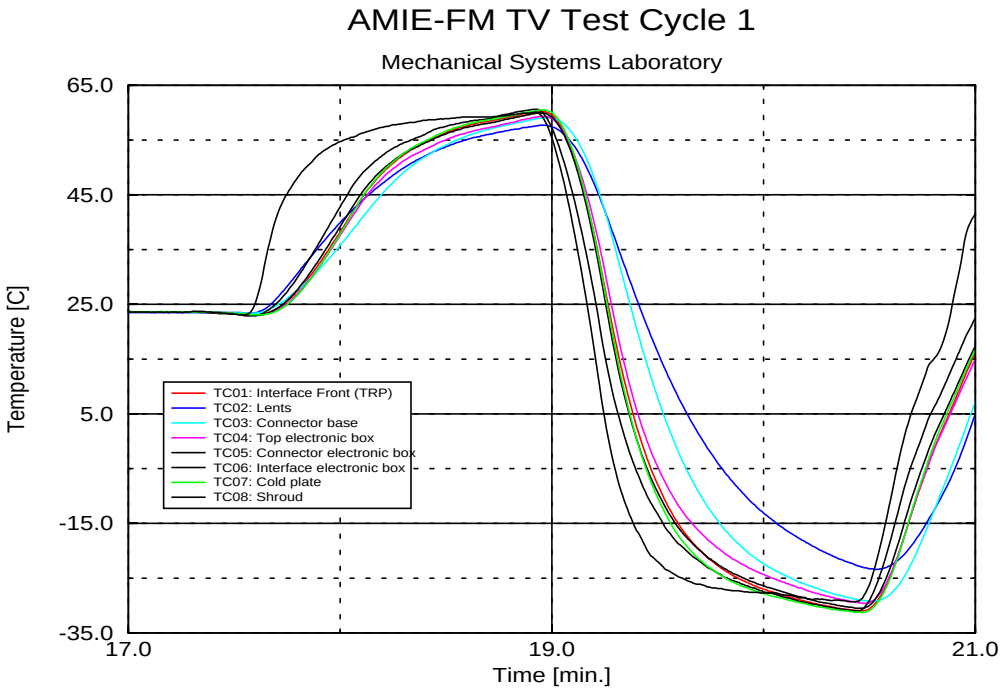
8.2. Non operational cycle 1

The maximum/minimum temperatures are summarised in Table 5.

TC Number	TNO_{max} [°C]	TNO_{min}[°C]
TC01	+ 60.3	- 29.2
TC02	+ 57.7	- 29.1
TC03	+ 58.9	- 23.4
TC04	+ 59.3	- 29.6
TC05	+ 60.0	- 30.5
TC06	+ 60.5	- 31.0
TC07	+ 60.4	- 31.4
TC08	+ 60.1	- 31.0

Table 5:maximum/minimum temperatures of Cycle1

The temperature of TC's are given in the following plot.



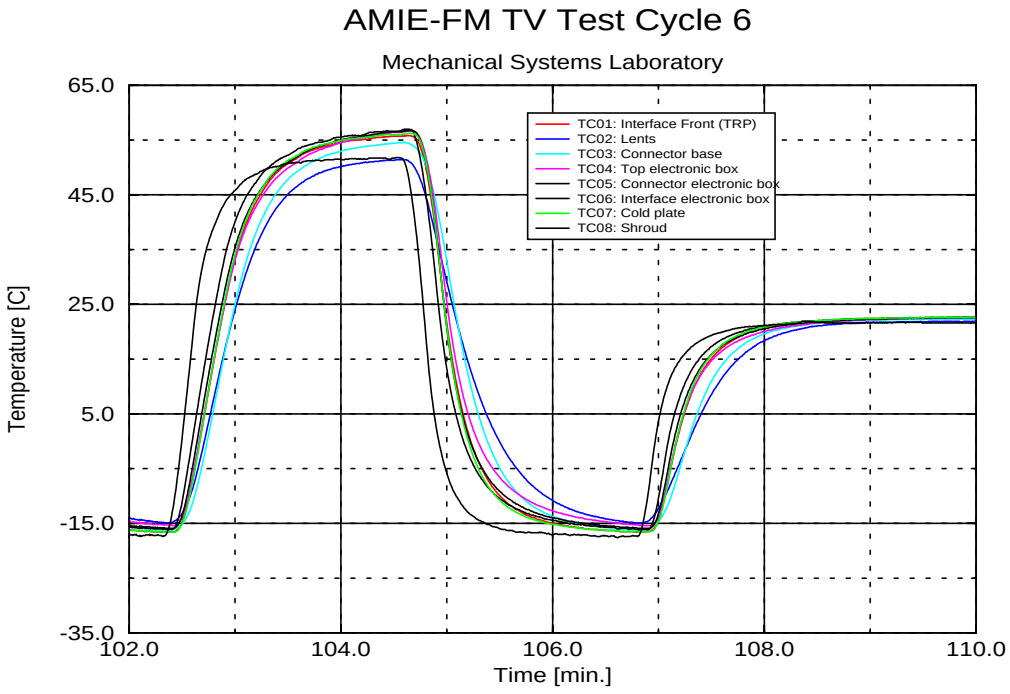
8.3. Operational Cycle 6

The maximum/minimum temperatures are summarised in Table 6.

TC Number	TO_{max} [°C]	TO_{min}[°C]
TC01	+ 55.8	- 31.1
TC02	+ 51.4	- 23.5
TC03	+ 54.5	- 29.3
TC04	+ 56.6	- 29.6
TC05	+ 56.6	- 30.6
TC06	+ 56.9	- 31.0
TC07	+ 56.2	- 31.4
TC08	+ 51.8	- 29.4

Table 6:maximum/minimum temperatures of Cycles 6

The temperature of TC's are given in the following plot



9. Conclusion

The AMIE-FM Thermal Vacuum Test was performed successfully in accordance with the test procedure (Ref. 1).

A dwell of 60 hours at ambient temperature was performed between cycle 2 & 3 during the week end. At each operational minimum/maximum temperatures, the dwell was increased from 1.5 to 2 hours to have a better stabilisation phase for all thermocouples.

A visual inspection performed after re-pressurisation did not showed any sign of degradation.