SPIRE FCU QM2 QUALIFICATION

Thermal Vacuum (VTC) Tests Report

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DOCUMENT STATUS and CHANGE RECORD

Date	Issue	Purpose / Affected pages
		Creation

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1 Abreviations list

AIV	Acceptance, Integration and Validation
CEA	Commissariat à l'Energie Atomique
DCU	Detector Control Unit
DPU	Digital Processing Unit
DRCU	Detector Readout and Control Unit
EM	Engineering Model
FCU	Focal Plane Control Unit
FM	Flight Model
FPU	Focal Plane Unit
FS	Flight Spare model
GSE	Ground Support Equipment
H/K	HouseKeeping
I&T	Integration and Test
I/F	Interface
ICD	Interface Control Document
IID	Instrument Interface Document
IRD	Instrument Requirements Document
LAM	Laboratoire d'Astrophysique de Marseille
LETI	Laboratoire d'Electronique, de Technologie et d'Instrumentation
LTU	Local Test Unit
MCU	Mechanism Control Unit
PB	Power Bench
PFM	Proto Flight Model
PSU	Power Supply Unit
QM	Qualification Model
RAL	Rutherford Appleton Laboratory
SAp	Service d'Astrophysique (CEA/DAPNIA)
S/C	SpaceCraft
SCU	Subsystem Control Unit
SEDI	Service d'Electronique et d'Informatique (CEA/DAPNIA)
STB	Simplified Test Board
SPIRE	Spectral and Photometric Imaging REceiver
STM	Structural and Thermal Model
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	TeleCommand
TM	TeleMetry

2 Applicable documents

[AD1] HERSCHEL/SPIRE DRCU Interface Control Document	SAP-SPIRE-CCa-075-02
[AD2] HERSCHEL/SPIRE DRCU/DPU Interface Control Document	SAP-SPIRE-CCa-076-02
[AD3] Herschel/SPIRE DRCU AIV PLAN	SAp-SPIRE-HT-0082-02
[AD4] HERSCHEL/SPIRE DRCU Subsystem specification	Sap-SPIRE-CCa-0025-00
[AD5] Herschel/Planck Instrument Interface Document IID Part A ”	SCI-PT-IIDA/SPIRE-04624
[AD6] Herschel/Planck Instrument Interface Document Part B Instrument “SPIRE”	SCI-PT-IIDB/SPIRE-02124
[AD7]	
[AD8] SPIRE FCU FM Functional test procedure	SAp-SPIRE-HT-0388-06
[AD9] Herschel /SPIRE Procédure de vide thermique HS_FCU	SAp-SPIRE-HT-0390-06

3 Reference documents

[RD1] HERSCHEL/SPIRE DCU EM/QM1 Test Report	Sap-SPIRE-CCa-0129-03 Issue 1.0
[RD2] DS-SPIRE development tree	Sap-SPIRE-DS - Version 07/03/2002
[RD3] FIRST/SPIRE DRCU and WIH Development Plan	SAP-SPIRE-JLA-0047-01
[RD4] Rapport d’essais	Référence Intespace E5831 HSDQMTHER
[RD5] HS-FCU FM TRR Report	SAp-SPIRE- QA-0419-06

4 Introduction

This technical report applies to the Vibration tests performed on the FCU FM equipment for the HERSCHEL SPIRE Project.

These tests have been performed at Intespace between June 27th 2006 and June 30th 2006.

5 Test Configuration

We use the LTU in its latest software configuration, the fully assembled DCU and FCU, the FPU and the PSU Flight Model (PSU FM).

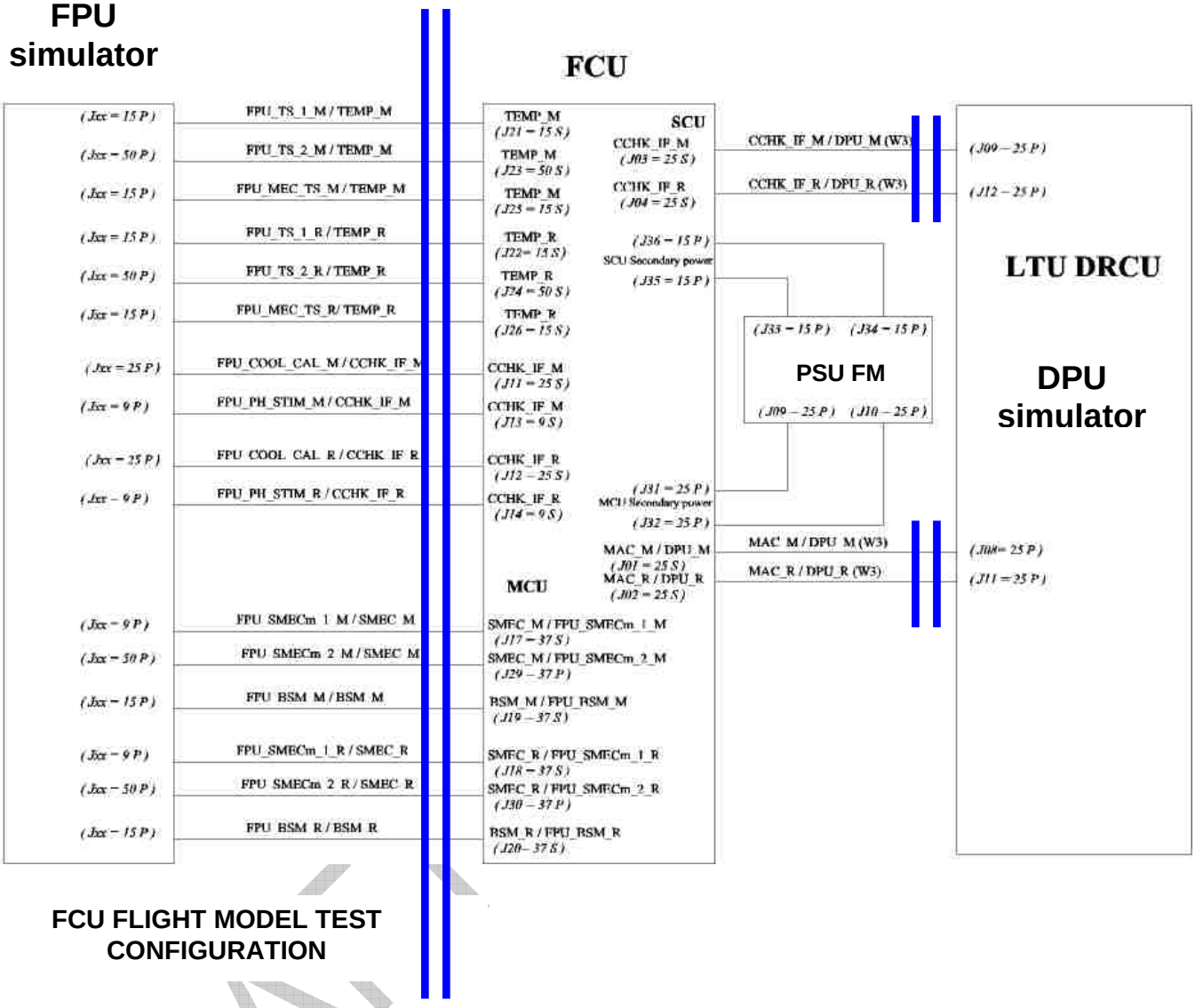
Before to connect any harness, we place savers on all connectors

Connect all harnesses as described below :

- Between SCU and LTU
- Between DCU and PSU FM
- Between SCU and PSU FM

We place savers on all connectors

We connect all harnesses as described below

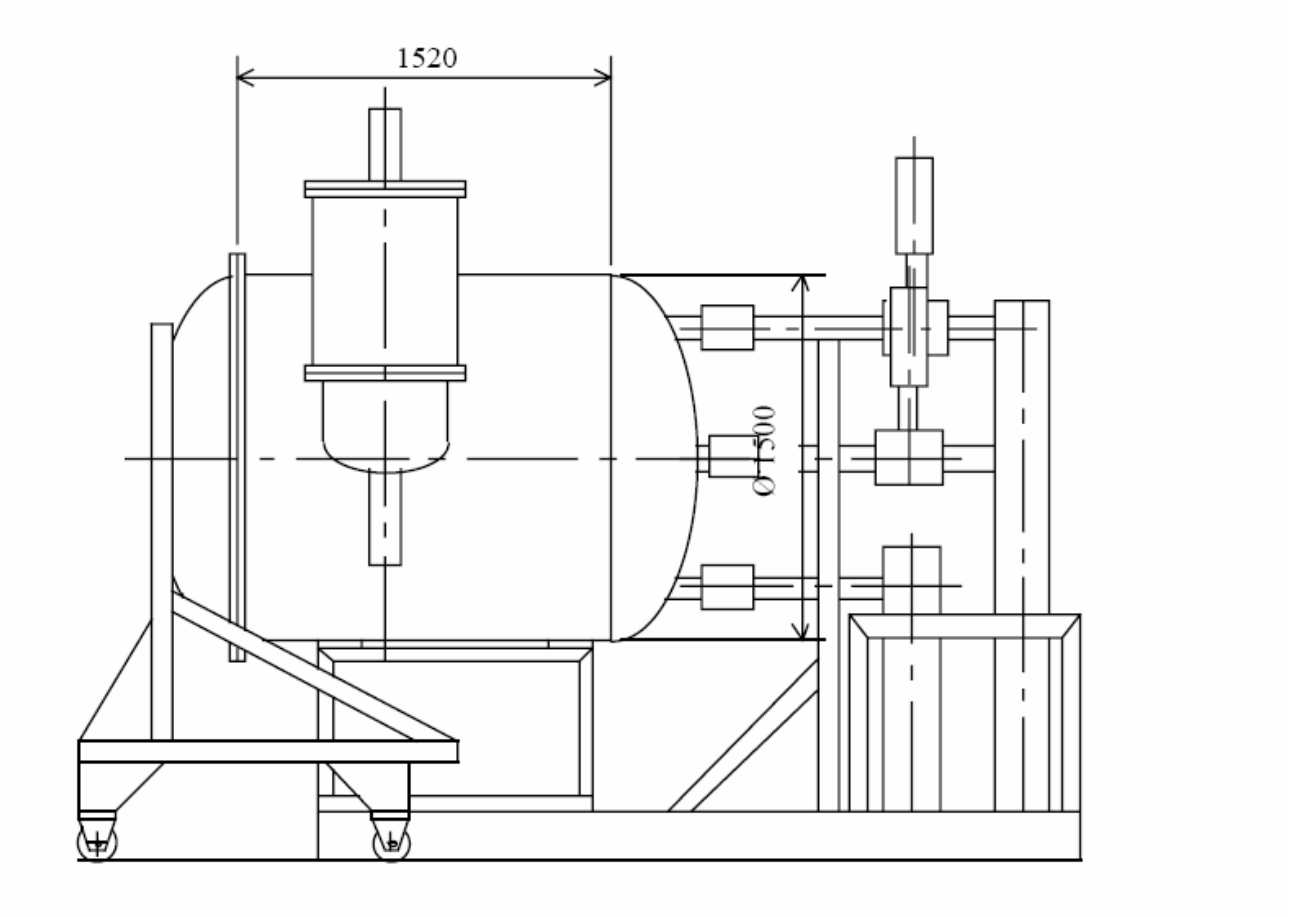


FCU FM acceptance tests configuration

6 Test Program

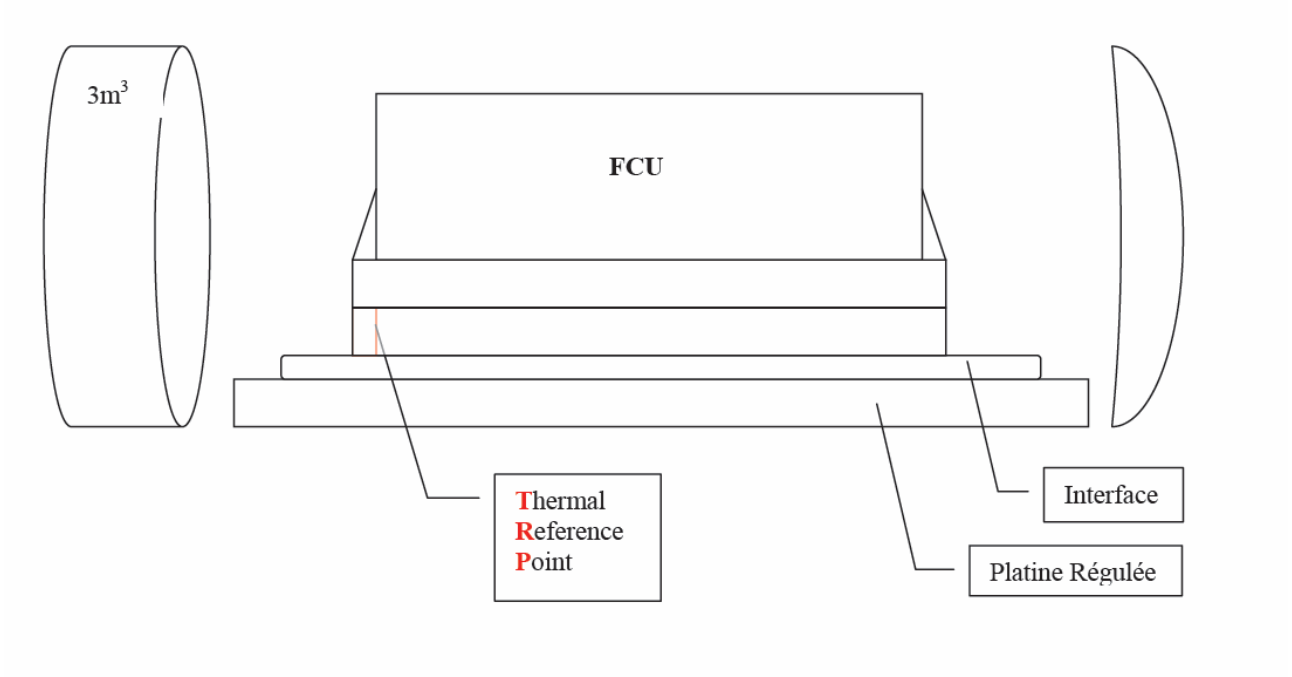
The description of the VTC test is given in the vibration tests procedure [AD9].

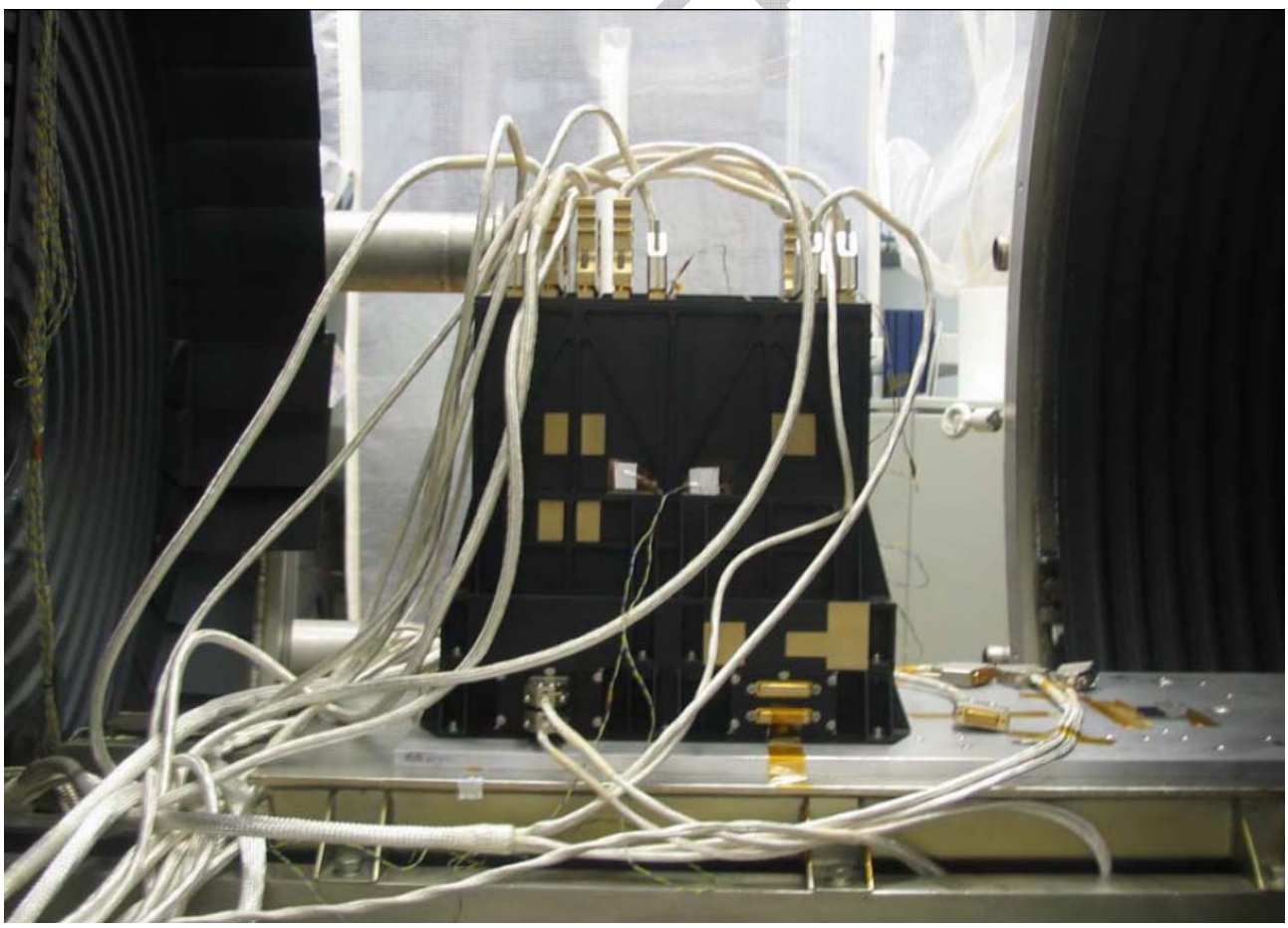
The thermal cycling has been performed in a dedicated thermal vacuum chamber « SEAVOM $3m^3$ » from INTESPACE.



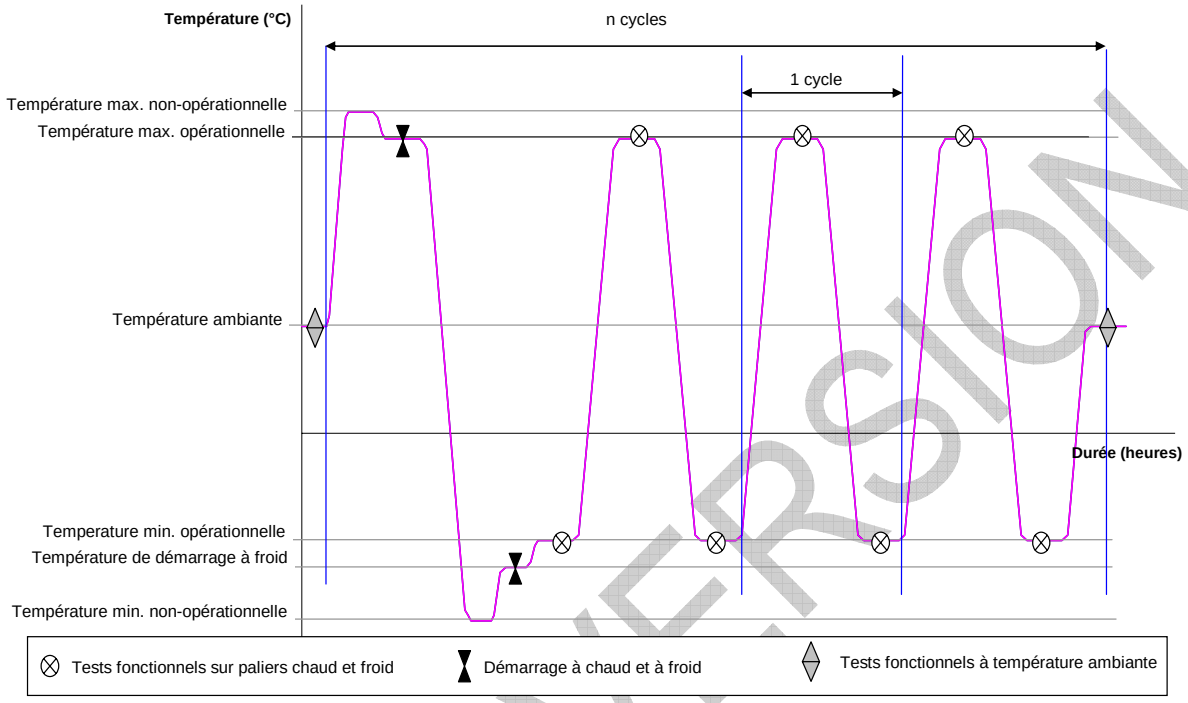
The electronic box DCU is screwed on an interface plate following interface specifications.

The test is monitored with the temperature measured at TRP (Thermal Reference Point) level on the box.


3m3
FCU
Thermal
Reference
Point
Interface
Platine Régulée



The test sequence is represented thereafter :



The test sequence has 4 cycles.

The temperatures applied for qualification are :

Modes de fonctionnement de HS FCU	Température Max (°C)	Température Min
Opérationnel	50	-20
Non opérationnel	60	-35
Démarrage	50	-30

The actual evolution of the temperature is given thereafter. It shows that the specification of the cycling described in [AD9] is fulfilled.

The results of the functional tests are given in the next chapter.

During the first cycle, when the temperature was supposed to reach 60°C, there has been an incident from the thermal vacuum chamber « SEAVOM 3m^3 » from INTESPACE. The temperature exceeded the maximum allowzd during about 1 hour. This is reported in NCR 455. This Excessive temperature was reached during a stabilized temperature level at a time when the FCU was OFF. (the temperature was about 80°C instead of 60°C)

Functional tests have been performed on plateau levels. The detailed description of the cycle is given thereafter.

7 Report of the functional tests

The list of the performed test, with reference to and [AD8] is :

FCU QM2 tests	Test -1 : Before VTC	Test 0 : After installation in VTC cmaber	Test 1 : Warm start (cycle 1)	Test 2 : Cold start (cycle 1)	Test 3 : Cold plateau (cycle 1)	Test 4 : Warm plateau (cycle 2)	Test 5 : Cold plateau (cycle 2)	Test 6 : Warm start (cycle 3)	Test 7 : Cold start (cycle 3)	Test 8 : Warm plateau (cycle 4)	Test 9 : Cold plateau (cycle 4)	Test 10 : Ambient final
Consumption SCU main	x	x	x	x	x	x	x	x	x	x	x	x
Consumption SCU redundant	x	x	x	x	x	x	x	x	x	x	x	x
SCU HouseKeepings	x	x	x	x	x	x	x	x	x	x	x	x
SCU Frames	x											
SCU Temp/SubK channels	x	x	x	x	x	x	x	x	x	x	x	x
SCU Temp/SubK ON/OFF	x											
SCU Heater/Calibrators channels	x	x	x	x	x	x	x	x	x	x	x	x
Heater/Calibrators ON/OFF	x											
SCU currents measured by FPU simulator	x	x	x	x	x	x	x	x	x	x	x	x
SCU Currents in Stand alone	x	x	x	x	x	x	x	x	x	x	x	x
Consumption MCU redundant	x	x	x	x	x	x	x	x	x	x	x	x
Consumption MCU main	x	x	x	x	x	x	x	x	x	x	x	x
HouseKeepings	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 1 Main	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 2 Main	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 3 Main	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 4 Main	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 5 Main	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 1 Redundant	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 2 Redundant	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 3 Redundant	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 4 Redundant	x	x	x	x	x	x	x	x	x	x	x	x
Configuration 5 Redundant	x	x	x	x	x	x	x	x	x	x	x	x

In this document, only the main tests results are given.

7.1 Visual inspection

A visual inspection was performed before and after the VTC tests. It revealed no specific problem.

7.2 Consumption tests

We tested the FCU consumption on each stabilized temperature level with the MCU in the following configurations :

- Configuration 1 : MCU ON, all currents applied to the mechanisms set at 0 level
- Configuration 2 : MCU ON, all currents applied to the mechanisms set at 0 level; latch engaged
- Configuration 3 :MCU ON, all currents applied to the mechanisms set at 10% level;
- Configuration 4 :MCU ON, all currents applied to the mechanisms set at 50% level;
- Configuration 3 :MCU ON, all currents applied to the mechanisms set at 100% level;

The consumption measured at PSU FM level on FCU are :

Before VTC

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	400	400
SCU ON, MCU OFF	410	400
MCU after boot	810	810
Configuration 1	880	870
Configuration 2	880	870
Configuration 3	940	930
Configuration 4	1060	1060
Configuration 5	1220	1210

First warm plateau at 50°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
SCU ON, MCU OFF	400	400
MCU ON	810	**from 820 up to 930**
MCU after boot	870	

An instability of the current drained when powering ON the MCU redundant was observed. The current increased from 820 mA to 930 mA and , as it kept increasing, we stopped the MCU. This is reported in NCR 459.

Cold start at -30°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
SCU ON, MCU OFF	410	400
MCU ON	800	800
MCU after boot	860	860

First cold plateau at -20°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
SCU ON, MCU OFF	400	410
MCU ON	800	800
MCU after boot	860	860
Configuration 1	880	870
Configuration 2	880	870
Configuration 3	940	930
Configuration 4	1060	1060
Configuration 5	1220	1210

Second warm plateau at 50°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	400	400
MCU ON	820	820
MCU after boot	880	880
Configuration 1	880	880
Configuration 2	880	880
Configuration 3	950	940
Configuration 4	1070	1070
Configuration 5	1220	1220

Second cold plateau at -20°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	410	410
MCU ON	810	810
MCU after boot	870	870
Configuration 1	870	870
Configuration 2	870	870
Configuration 3	930	930
Configuration 4	1050	1050
Configuration 5	1210	1210

Third warm plateau at 50°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	400	400
MCU ON	820	820
MCU after boot	880	880
Configuration 1	890	880
Configuration 2	890	880
Configuration 3	940	940
Configuration 4	1070	1070
Configuration 5	1220	1220

Third cold plateau at -20°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	410	410
MCU ON	820	810
MCU after boot	880	870
Configuration 1	880	870

Configuration 2	880	870
Configuration 3	930	930
Configuration 4	1050	1050
Configuration 5	1210	1210

Fourth warm plateau at 50°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	400	400
MCU ON	820	810
MCU after boot	880	880
Configuration 1	890	880
Configuration 2	890	880
Configuration 3	940	940
Configuration 4	1070	1070
Configuration 5	1220	1220

Fourth cold plateau at -20°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	410	410
MCU ON	810	810
MCU after boot	870	870
Configuration 1	870	870
Configuration 2	870	870
Configuration 3	930	930
Configuration 4	1050	1050
Configuration 5	1210	1210

Ambient final 20°C

Report of the primary current consumption (mA) at PSU FM level (28V)

MCU Status	Main	Redundant
OFF	410	400
MCU ON	820	810

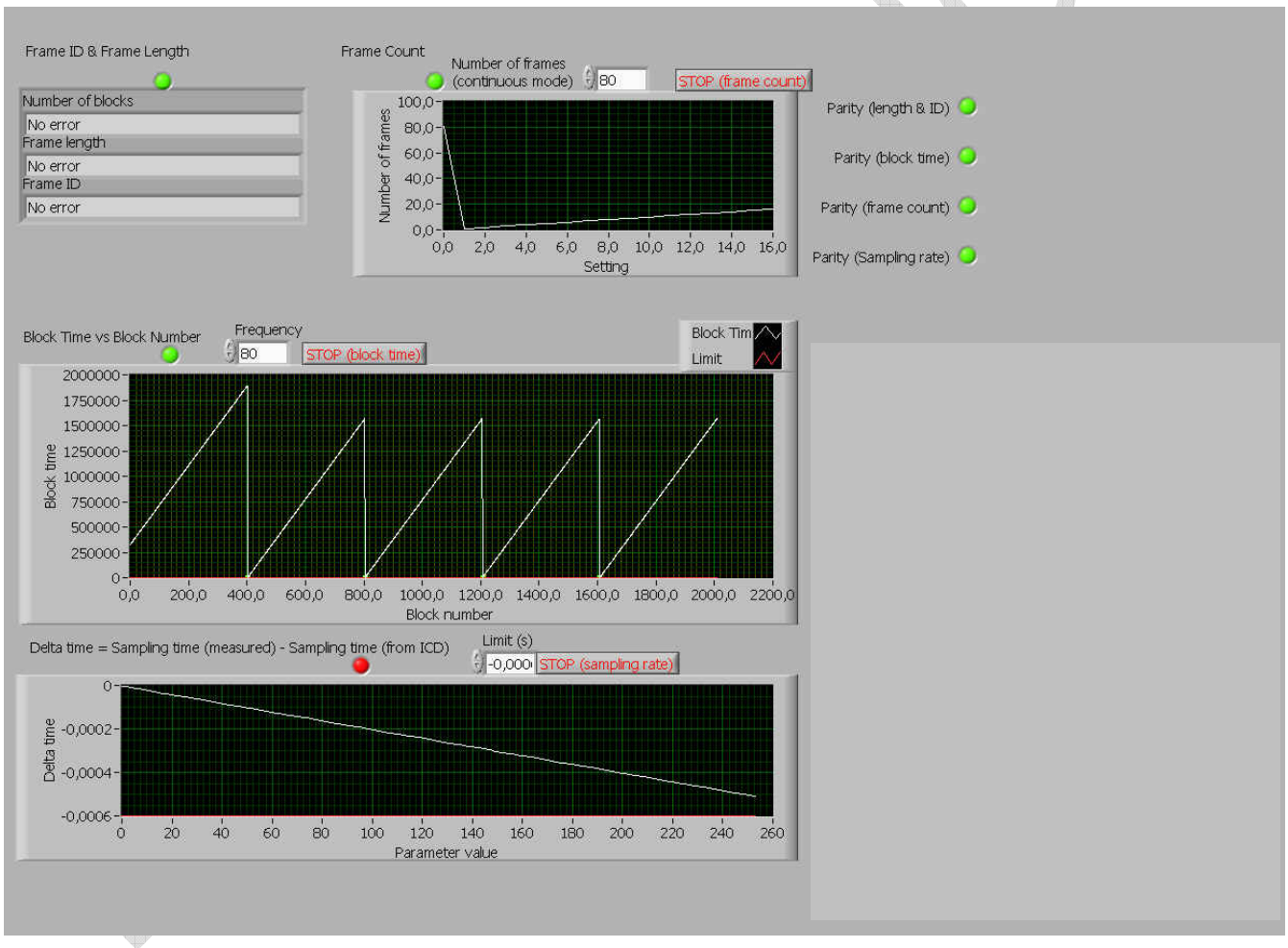
MCU after boot	870	870
Configuration 1	880	870
Configuration 2	880	870
Configuration 3	940	930
Configuration 4	1060	1050
Configuration 5	1220	1210

The consumptions did not move during the VTC cycling.

7.3 Frame generation Tests

The test consist in testing the frame generation (frame length, frame modes, frames content and ID), It also tests the reset of the time stamp within the frames, the frame generation frequency as well as the number of frames commanded during telemetry acquisitions.

The results obtained are the same on each plateau level. These are summarized in the following screenshot relative to the tests performed after the VTC at 25°C.



7.4 FCU HouseKeepings

We have started the FCU Monitoring Mode from LTU (1 Hz frequency) during the whole VTC test and the results were consistent with the expected values.

Note that we observe the results over a sufficient time (1 minute).

We thereafter show the results relative the H/K acquisitions performed after the VTC tests at 25°C :

SCU Main side

SCU

Status

Nom Parametre	Description	Valeur Lue H...	Valeur Nomin...
ScuStatus	SCU Status	0000	

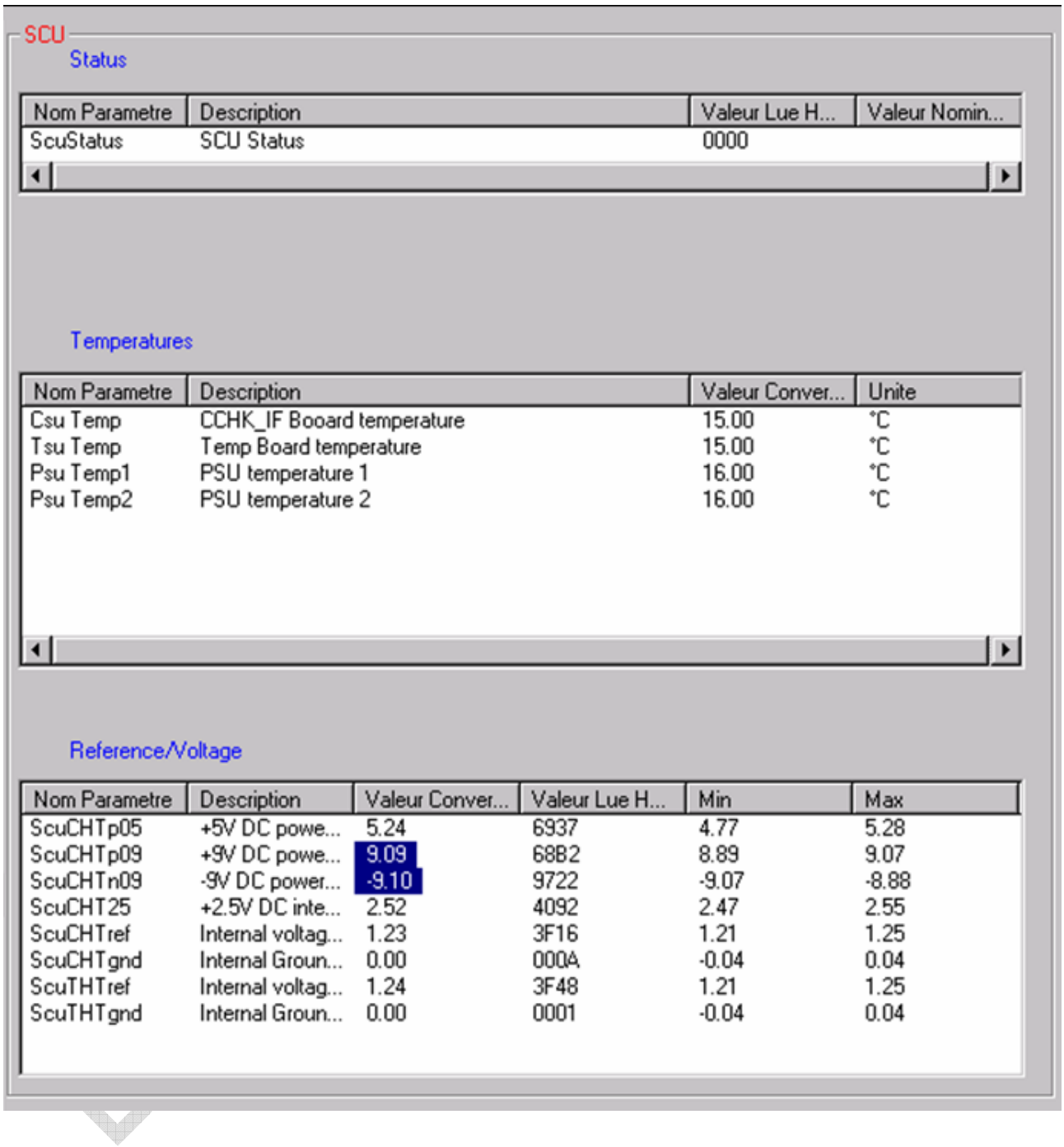
Temperatures

Nom Parametre	Description	Valeur Conver...	Unite
Csu Temp	CCHK_IF Booard temperature	14.00	°C
Tsu Temp	Temp Board temperature	14.00	°C
Psu Temp1	PSU temperature 1	16.00	°C
Psu Temp2	PSU temperature 2	16.00	°C

Reference/Voltage

Nom Parametre	Description	Valeur Conver...	Valeur Lue H...	Min	Max
ScuCHTp05	+5V DC powe...	5.25	696E	4.77	5.28
ScuCHTp09	+9V DC powe...	9.09	68AA	8.89	9.07
ScuCHTn09	-9V DC power...	-9.08	9760	-9.07	-8.88
ScuCHT25	+2.5V DC inte...	2.52	4095	2.47	2.55
ScuCHTref	Internal voltag...	1.23	3F0F	1.21	1.25
ScuCHTgnd	Internal Groun...	0.00	0006	-0.04	0.04
ScuTHTref	Internal voltag...	1.23	3F32	1.21	1.25
ScuTHTgnd	Internal Groun...	-0.00	FFFB	-0.04	0.04

SCU Redundant side



MCU Main side

MCU

Nom Par...	Description	Valeur Decimale	Valeur Convertie	Min	Max	Unite
5V	+5V power supply volt...	39678	5.06	4.85	5.25	V
P14V	+14V power supply vo...	38922	14.02	14.20	14.60	V
M14V	-14V power supply vol...	26474	-14.33	-14.60	-14.20	V
P15V	+15V power supply vo...	39520	15.38	15.20	15.60	V
M15V	-15V power supply vol...	25973	-15.48	-15.60	-15.20	V
MACTemp	MAC temperature probe	38413	6.16	-5.75	30.00	°C
SMECTemp	SMEC temperature pr...	38501	10.52	-5.75	30.00	°C
BSMTemp	BSM temperature probe	38497	10.32	-5.75	30.00	°C
ErrorCode	errors, warnings occur...	0	0.00	0.00	0.00	

MCU Redundant side

MCU

Nom Par...	Description	Valeur Decimale	Valeur Convertie	Min	Max	Unite
5V	+5V power supply volt...	39659	5.04	4.85	5.25	V
P14V	+14V power supply vo...	38908	13.98	14.20	14.60	V
M14V	-14V power supply vol...	26467	-14.35	-14.60	-14.20	V
P15V	+15V power supply vo...	39506	15.35	15.20	15.60	V
M15V	-15V power supply vol...	25984	-15.45	-15.60	-15.20	V
MACTemp	MAC temperature probe	38420	6.51	-5.75	30.00	°C
SMECTemp	SMEC temperature pr...	38492	10.07	-5.75	30.00	°C
BSMTemp	BSM temperature probe	38504	10.66	-5.75	30.00	°C
ErrorCode	errors, warnings occur...	0	0.00	0.00	0.00	

All the H/K reporting the SCU and MCU boards temperatures as well as the MCU and SCU reference voltages voltages have been saved in dedicated files during the whole HS FCU VTC cycling. These files are available upon request.

It appears that the voltages remained within the specified margins during all the FCU VTC cycling :

```
SCU prime +5V = 5,25 V        +/- 0,1 V
SCU prime +9V = 9,1 V         +/- 0,1 V
SCU prime -9V = -9,1 V        +/- 0,1 V

SCU redundant +5V = 5,25 V    +/- 0,1 V
SCU redundant +9V = 9,1 V     +/- 0,1 V
SCU redundant -9V = -9,1 V    +/- 0,1 V

MCU prime +5V = 5,05 V        +/- 0,1 V
MCU prime +15V = 15,35 V      +/- 0,1 V
MCU prime -15V = -15,45 V     +/- 0,1 V
MCU prime +14V = 14,0 V       +/- 0,1 V
MCU prime -14V = -14,35 V     +/- 0,1 V

MCU redundant +5V = 5,05 V    +/- 0,1 V
MCU redundant +15V = 15,35 V  +/- 0,1 V
MCU redundant -15V = -15,45 V +/- 0,1 V
MCU redundant +14V = 14,0 V   +/- 0,1 V
MCU redundant -14V = -14,35 V +/- 0,1 V
```

The boards temperature, as recorded during stabilized temperature levels follow the temperature profile of the thermal vacuum chamber « SEAVOM 3m^3 » from INTESPACE with some differences due to the power dissipation inside the FCU box.

To give example, the temperatures recorded on FCU main and redundant sides are on the last cycle are given for a TRP temperature of respectively 50°C and -20°C.

FCU is ON in redundant mode before the tests,
TRP temperature = 50°C

	Main side	Redundant side
MCU MAC temperature	= 55,48°C	48,89°C
SMEC temperature	= 49,14°C	53,00°C
BSM temperature	= 51,52°C	49,78°C
CCHK-IF board temperature	= 51°C	53°C
TEMP board temperature	= 51°C	53°C
PSU 1 temperature	= 55°C	58°C
PSU 2 temperature	= 55°C	59°C

FCU is ON in redundant mode before the tests,
TRP temperature = -20°C

	Main side	Redundant side
MCU MAC temperature	= -24,25°C	-17,82°C
SMEC temperature	= -15,15°C	-9,51°C
BSM temperature	= -13,07°C	-16,19°C
CCHK-IF board temperature	= -14°C	-13°C
TEMP board temperature	= -14°C	-12°C
PSU 1 temperature	= -13°C	-11°C
PSU 2 temperature	= -14°C	-11°C

7.5 SCU TEMP, SUBK, Calibrator and Heater Channels

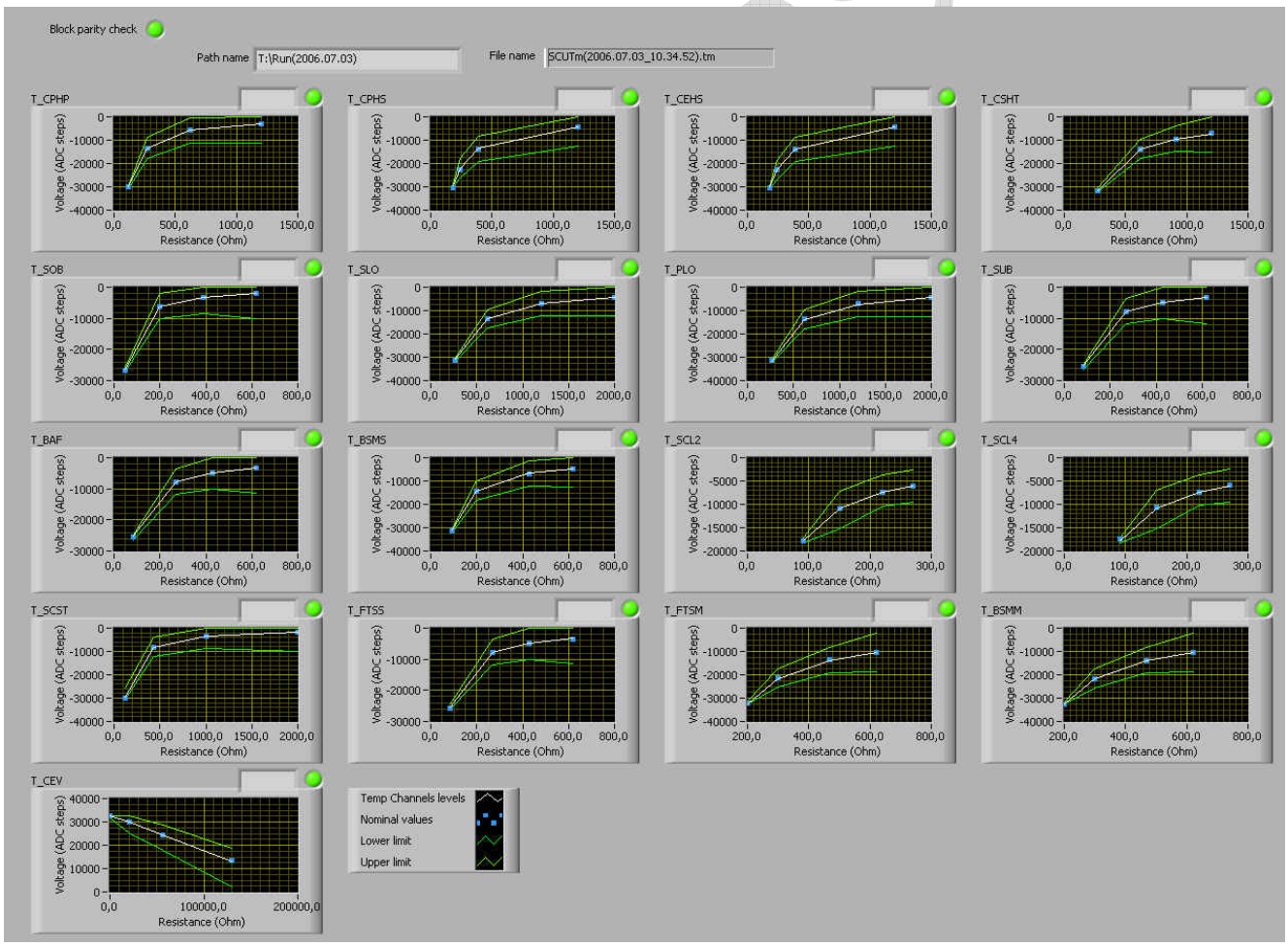
On each stabilized temperature level, the 16 TEMP channels, the SUBK channel, the 3 Calibrators and the 4 heaters channels have been tested.

The responses of these channels always remained within the specified margins and so were always nominal.

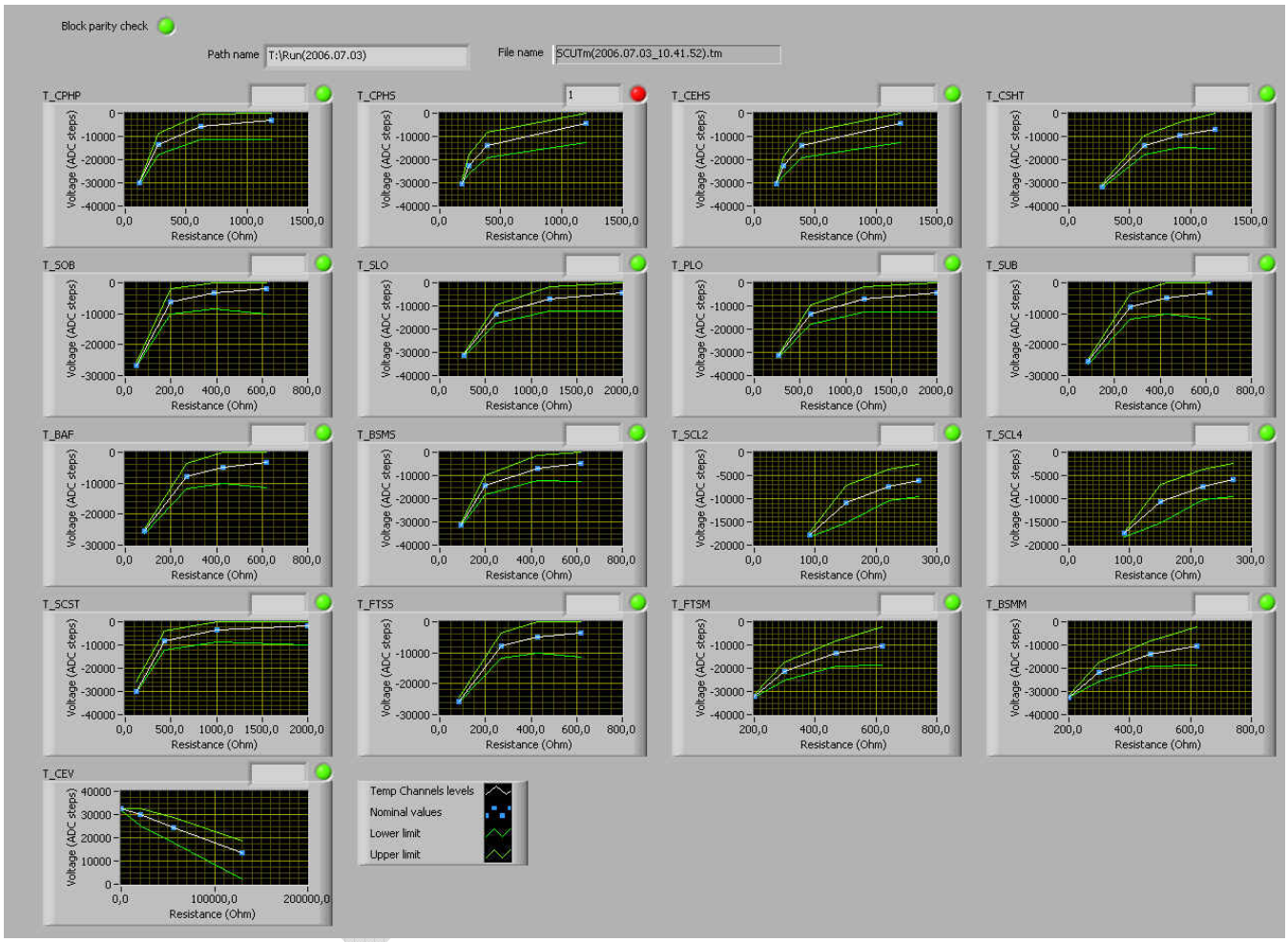
We thereafter represent the results on the last ambient level (after VTC) :

7.5.1 Evolution of the SCU TEMP/SUBK channels responses wrt resistance value

SCU Main side



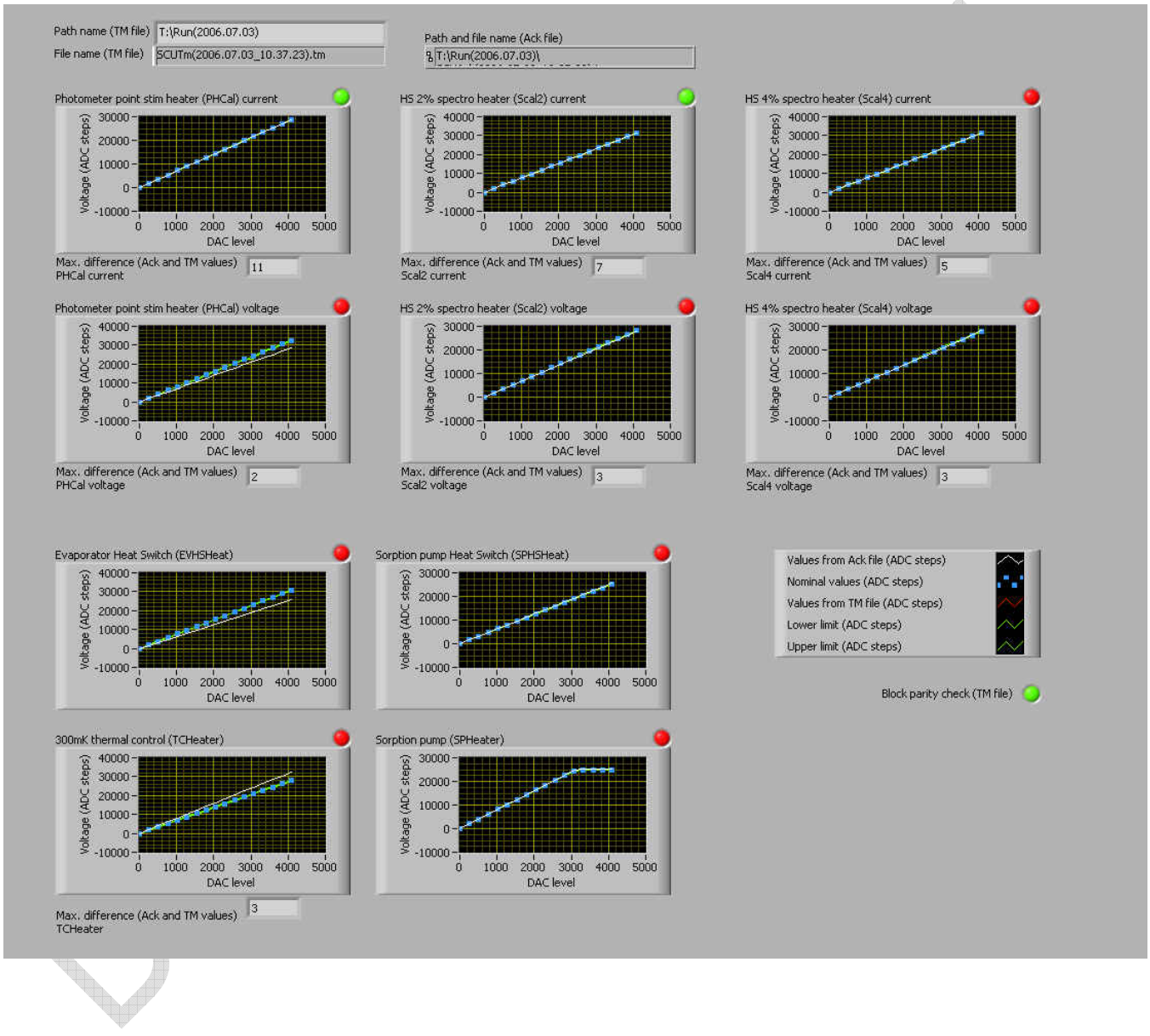
SCU Redundant side



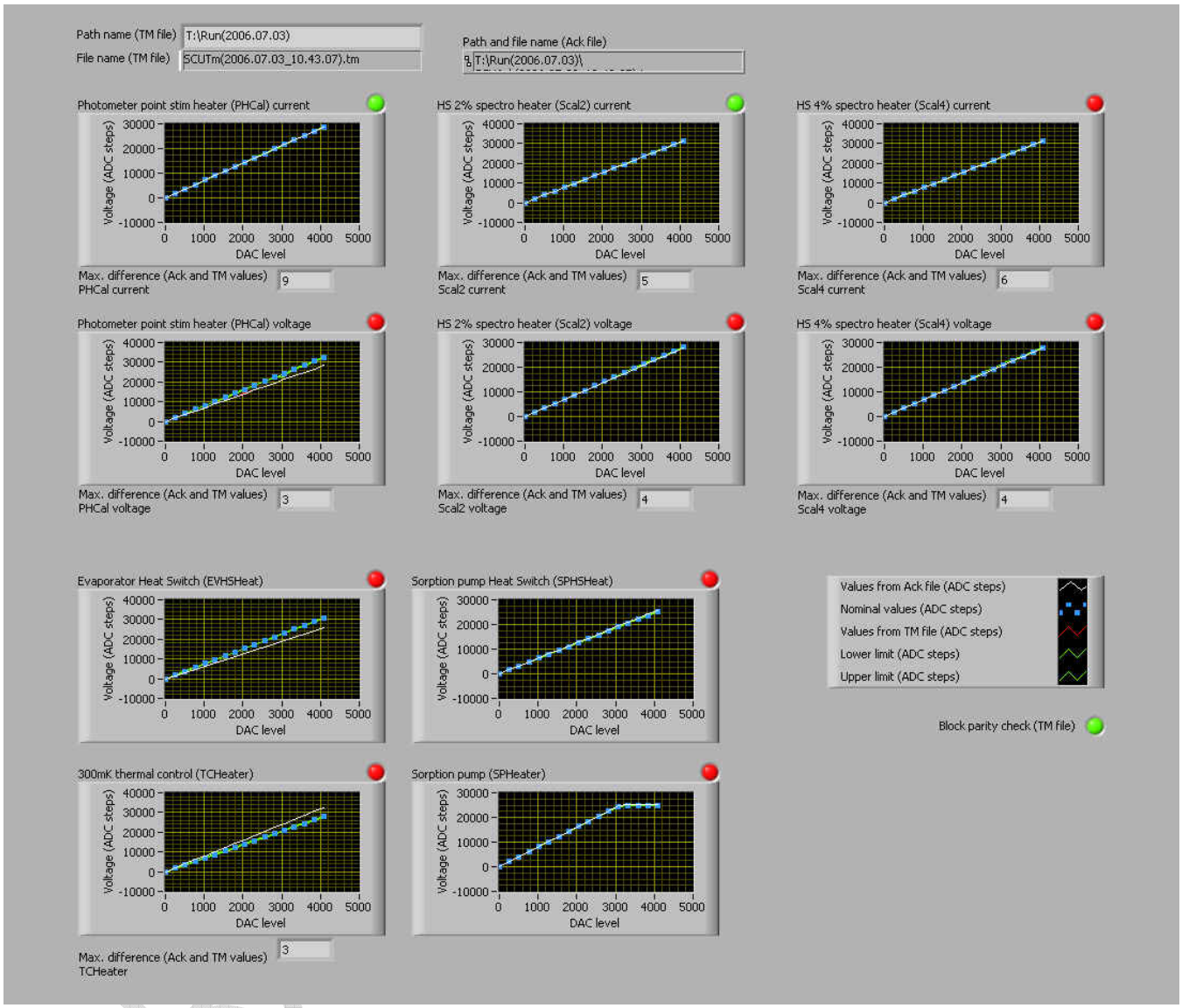
The results, being within the specified margins, are nominal.

7.5.2 Evolution of the SCU Heaters/Calibrators channels responses wrt DAC value :

SCU Main side



SCU Redundant side

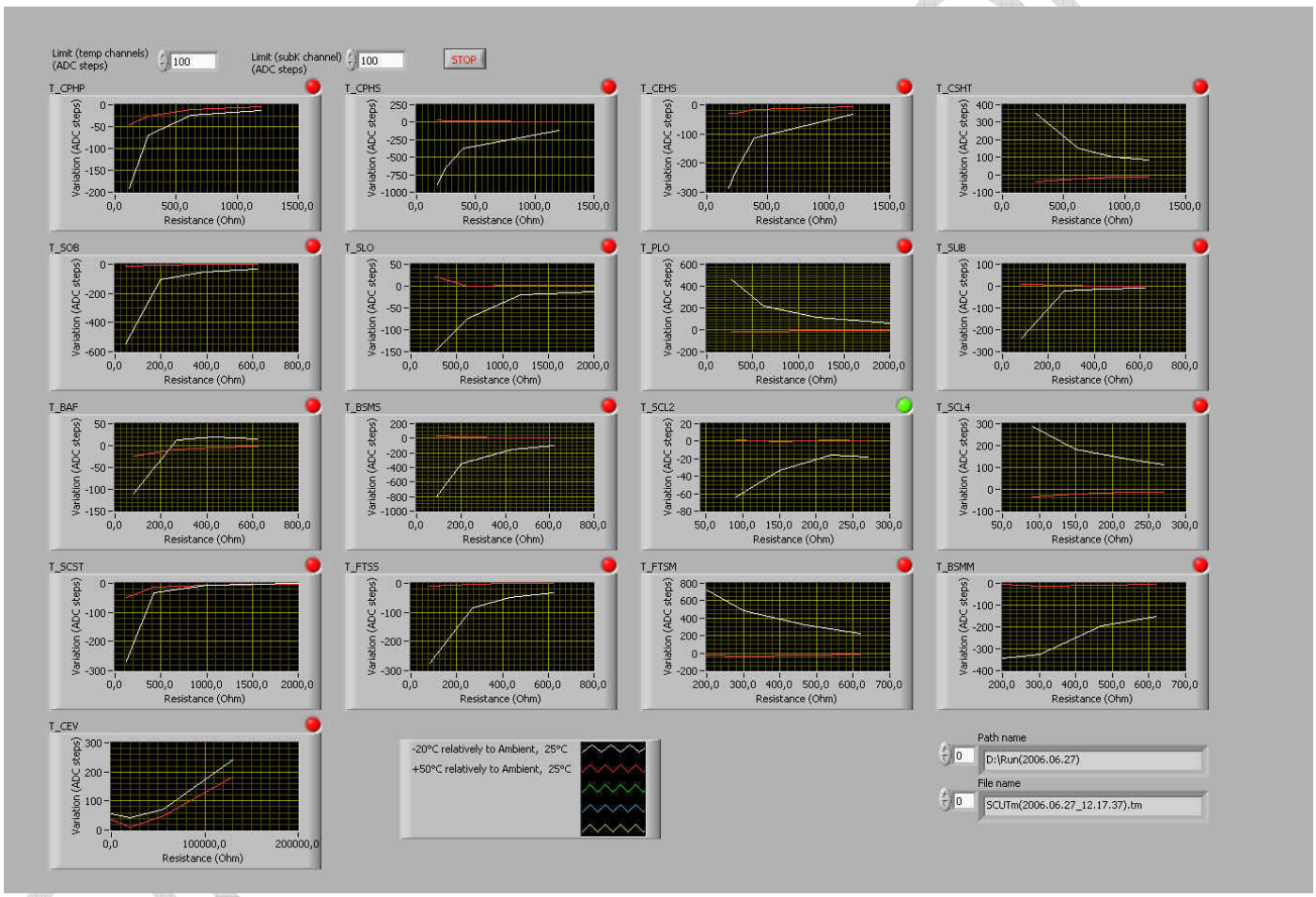


The results, being within the specified margins, are nominal.

7.5.3 SCU channels Thermal analysis

To study the effect of the temperature on the response of the 16 TEMP channels and the SUBK channel, we have plotted the encoder steps responses differences between -20°C and 50°C respectively wrt to ambient level 25°C.

The thereafter graphics represents respectively -20°C wrt 25°C (white) and 550C wrt 25 °C (red).



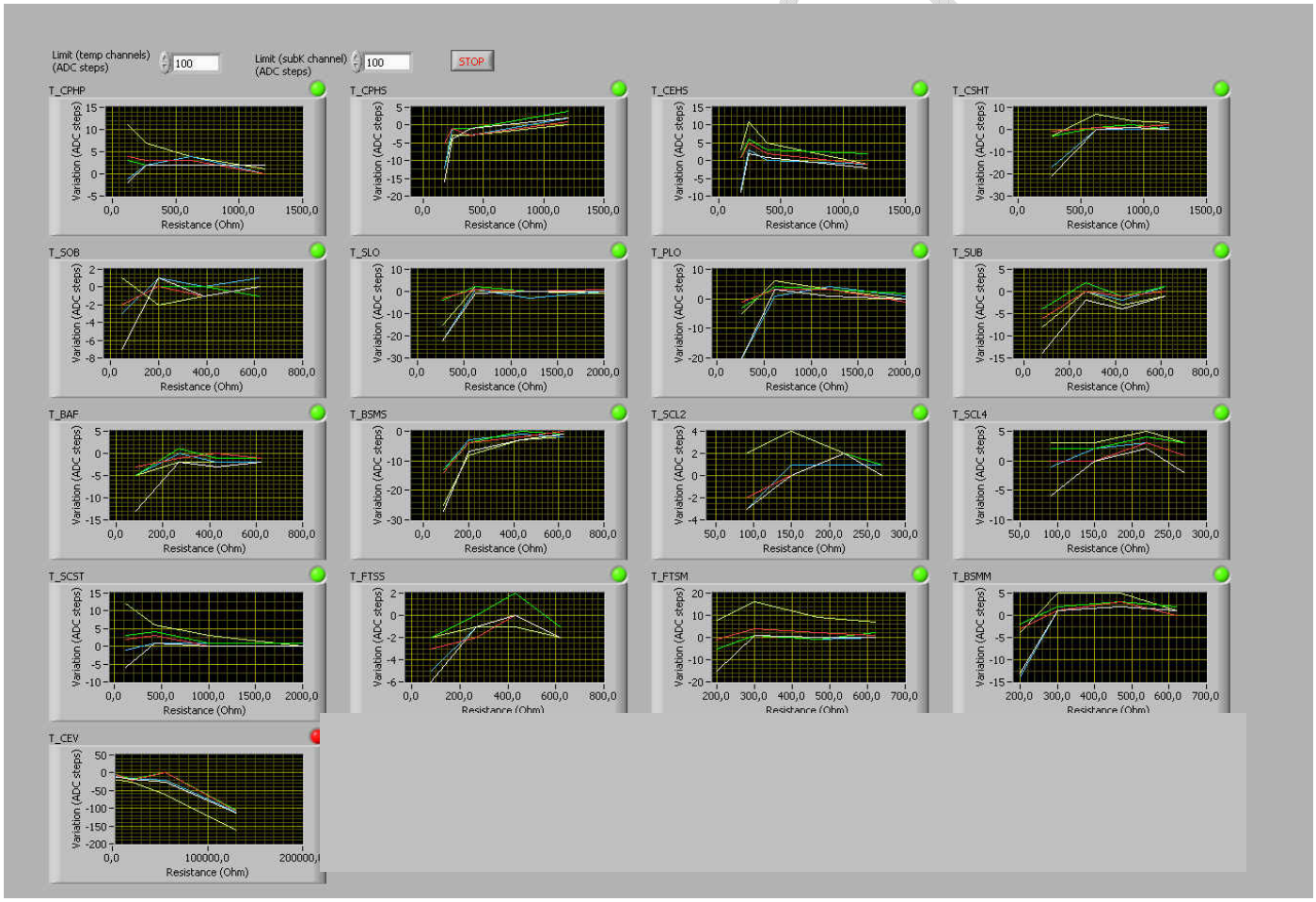
Encoder steps differences wrt Resistance

We see that the effect is more important at low resistances values, which is representative of the increase of sensitivity of the TEMP channels in this range of resistances.

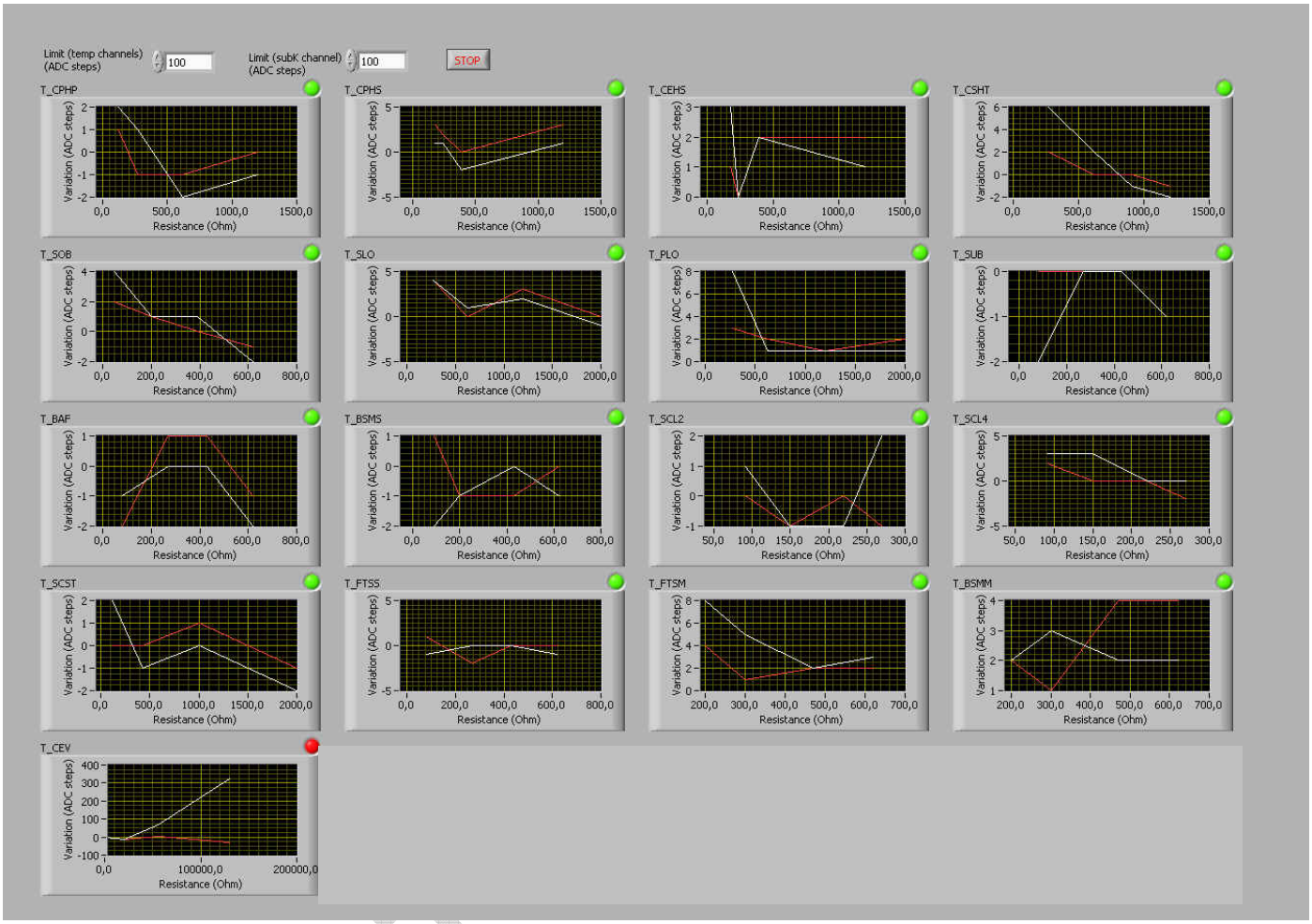
We observe that there is no significant sensitivity at 50°C (order of magnitude of 10 encoder steps) whereas, there lower temperatures (-20°C) have an effect on the TEMP channels responses (order of magnitude of 100 encoder steps), especially at small resistances values.

We also tested that all measurements at a same temperature give the same results, which means, all measurements performed at ambient temperature level give results within a 10 encoder steps margin, all measurements performed at -20°C temperature level give results within a 10 encoder steps margin and all measurements performed at temperature 50°C level give results within a 10 encoder steps margin.

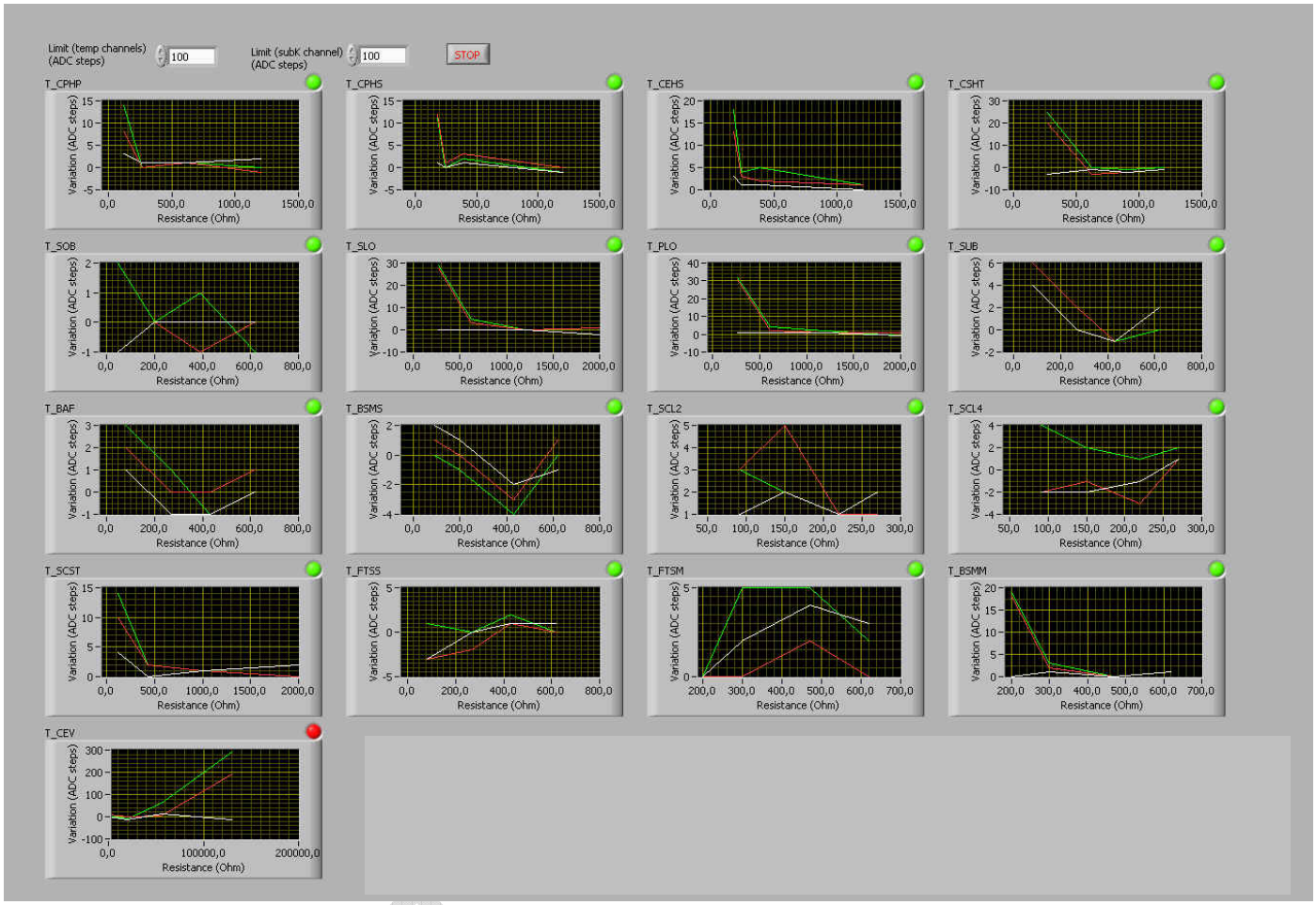
This is shown in the following graphics where we represent the values of the difference of TEMP channels encoder steps responses with respect to reference values.



Measurements performed at ambient temperature level (25°C)
Encoder steps differences wrt Resistance



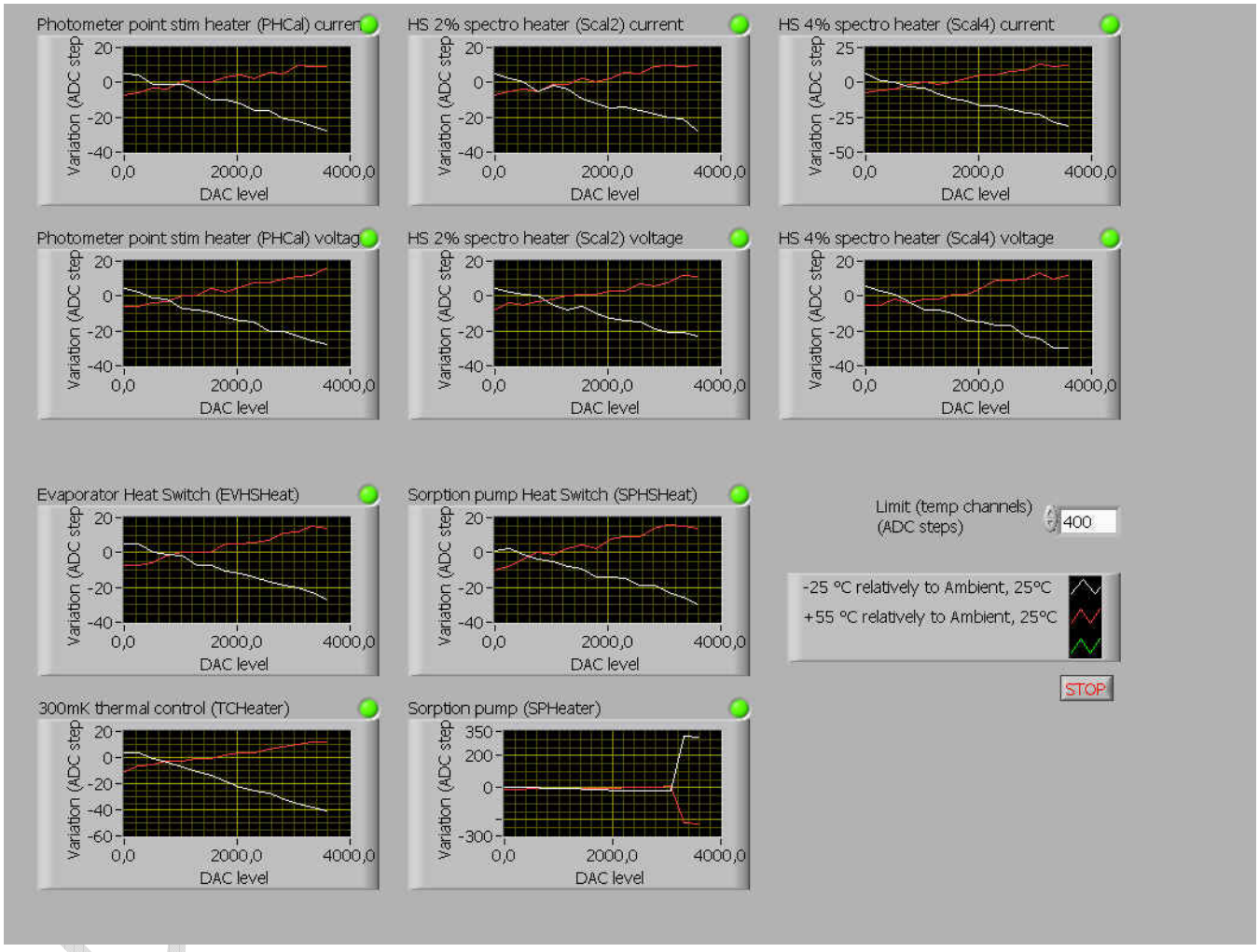
Measurements performed at ambient temperature level (25°C)
Encoder steps differences wrt Resistance



Measurements performed at ambient temperature level (50°C)
Encoder steps differences wrt Resistance

To study the effect of the temperature on the response of the 3 calibrators channels and the 4 heater channel, we have plotted the encoder steps differences wrt ambient level :

The thereafter graphics represents respectively -20°C wrt 25°C (white) and 50°C wrt 25 °C (red).



Encoder steps differences wrt DAC level

The effect of the temperature remains with acceptable values (less than 20 encoder steps).

Note : the increase on the SPHeater channel is due to the fact that this channel saturate at high DAC values.

7.6 Monitoring of currents generated by SCU

In this test, we set the Heater/Calibrators's DAC to their maximum and measure the currents generated on Heaters/Calibrators channels at FPU simulator level.

The results, as obtained after the vibrations, are the following :

Cycle 4, 50°C

	Measured Main side	***Measured Red side***	***Expected*** [(1)]
Sorption pump main :	37,823E-3 A	38.6906E-3 A	38.157E-3 A
Evaporator Switch main :	1.628E-3 A	1.628E-3 A	1.625E-3 A
Sorption pump Switch main :	1.628E-3 A	1.628E-3 A	1.626E-3 A
300mK thermal control main :	4.538E-6 A	4.537E-6 A	4.533E-6 A
HS spect 4% main :	5.611E-3 A	5.611E-3 A	5.597E-3 A
HS spect 2% main :	5.609E-3 A	5.607E-3 A	5.598E-3 A
Photometer point stim main :	7.197E-3 A	7.194E-3 A	7.183E-3 A

Cycle 4, -20°C

	Measured Main side	***Measured Red side***	***Expected*** [(1)]
Sorption pump main :	38,492E-3 A	38.325E-3 A	38.157E-3 A
Evaporator Switch main :	1.627E-3 A	1.628E-3 A	1.625E-3 A
Sorption pump Switch main :	1.628E-3 A	1.628E-3 A	1.626E-3 A
300mK thermal control main :	4.537E-6 A	4.537E-6 A	4.533E-6 A
HS spect 4% main :	5.608E-3 A	5.608E-3 A	5.597E-3 A
HS spect 2% main :	5.606E-3 A	5.605E-3 A	5.598E-3 A
Photometer point stim main :	7.192E-3 A	7.192E-3 A	7.183E-3 A

Ambient final, 20°C

	Measured Main side	***Measured Red side***	***Expected*** [(1)]
Sorption pump main :	38,216E-3 A	38.061E-3 A	38.157E-3 A
Evaporator Switch main :	1.627E-3 A	1.628E-3 A	1.625E-3 A
Sorption pump Switch main :	1.628E-3 A	1.628E-3 A	1.626E-3 A
300mK thermal control main :	4.538E-6 A	4.538E-6 A	4.533E-6 A
HS spect 4% main :	5.610E-3 A	5.610E-3 A	5.597E-3 A
HS spect 2% main :	5.607E-3 A	5.607E-3 A	5.598E-3 A
Photometer point stim main :	7.194E-3 A	7.192E-3 A	7.183E-3 A

[(1)] From tests at saclay

We observe no significant susceptibility of the Heater and calibrators currents generated by SCU with respect to the temperature. This is consistent with the fact that there is no significant variation of the Heaters and calibrators channels responses wrt temperature.

7.7 MCU functional parameters

On each stabilized temperature level, the MCU functional parameters, coming from the telemetry messages, have been tested on main and redundant sides and under the following functional configurations :

- Configuration 1 : MCU ON, all currents applied to the mechanisms set at 0 level
- Configuration 2 : MCU ON, all currents applied to the mechanisms set at 0 level; latch engaged
- Configuration 3 :MCU ON, all currents applied to the mechanisms set at 10% level;
- Configuration 4 :MCU ON, all currents applied to the mechanisms set at 50% level;
- Configuration 3 :MCU ON, all currents applied to the mechanisms set at 100% level;

Under each of these configurations, the values of the following parameters :

- Encoder Sinus 0°,
- Encoder Sinus 120°,
- Encoder sinus 240°,
- LVDT AC
- LVDT DC
- SMEC Motor Current,
- SMEC Motor Voltage
- Chopper Sensor
- Chopper current
- Chopper Voltage
- Jiggle sensor
- Jiggle current
- Jiggle voltage

have been compared to expected values. The values of these parameters remained nominal during the VTC tests.

8 Conclusion

Except the two NCR issued following the incident with the thermal vacuum chamber « SEAVOM $3m^3$ » from INTESPACE (NCR 455 and NCR 459), The VTC tests on the FCU FM showed no functional misfunctionning of the equipment.