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Planck Sorption Cooler System TV/TB Test Procedures at CSL

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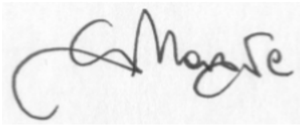
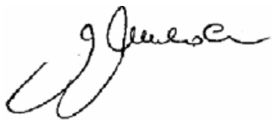
Prepared by	**G. MORGANTE** **SCS AIT and Operations Manager** **LFI System Team**	**Date:** **Signature:**	**May, 16th 2008** 
Agreed by	**C. BUTLER** **LFI** **Program Manager**	**Date:** **Signature:**	**May, 16th 2008** 
Approved by	**N. MANDOLESI** **LFI** **Principal Investigator**	**Date:** **Signature:**	**May, 16th 2008** 

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DISTRIBUTION LIST

Recipient	Company / Institute	E-mail address
B. GUILLAUME	ESA – Noordwijk	Bernard.Guillaume@esa.int
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O. PIERSANTI	ESA – Noordwijk	Osvaldo.Piersanti@esa.int
M. BRAGHIN	ESA – Noordwijk	Massimo.Braghin@esa.int
C. DAMASIO	ESA – Noordwijk	Claudio.Damasio@esa.int
B. COLLAUDIN	TAS-F – Cannes	bernard.collaudin@thalesaleniaspace.com
J.P. CHAMBELLAND	TAS-F – Cannes	jean-philippe.chambelland@thalesaleniaspace.com
D. PEARSON	JPL – Pasadena	David.P.Pearson@jpl.nasa.gov
L. TERENZI	IASF – Bologna	terenzi@iasfbo.inaf.it
D. SANTOS	LPSC - Grenoble	Daniel.Santos@lpsc.in2p3.fr
P. STASSI	LPSC - Grenoble	stassi@lpsc.in2p3.fr
C. VESCOVI	LPSC - Grenoble	vescovi@lpsc.in2p3.fr
F. PANCHER	LPSC - Grenoble	pancher@lpsc.in2p3.fr
O. ZIMMERMAN	LPSC - Grenoble	ozimmer@lpsc.in2p3.fr
F. MELOT	LPSC - Grenoble	frederic.melot@lpsc.in2p3.fr
E. LAGORIO	LPSC - Grenoble	lagorio@ lpsc.in2p3.fr
C. BUTLER	IASF – Bologna	butler@iasfbo.inaf.it
LFI System PCC	IASF – Bologna	lfispcc@iasfo.inaf.it
L. STRINGHETTI	IASF – Bologna	stringhetti@iasfbo.inaf.it
G. GUYOT	IAS - Paris	guy.guyot@ias.u-psud.fr
A. ZACCHEI	OATS –Trieste	zacchei@oats.inaf.it
A. GREGORIO	UniTS – Trieste	anna.gregorio@ts.infn.it

CHANGE RECORD

Issue	Date	Sheet	Description of Change
0.1	Jun 2007	All	First Draft of the Document
1.0	Dec 2007	All	First issue of the document
2.0	Mar 2008	All	General Revision, integration of comments
2.1	Mar 2008	All	General Revision, integration of comments
2.1	Apr 2008	Par. 4.1.1	Revision of PrTV-1-2-d objectives
2.1	Apr 2008	All Test Phases	Included test procedures in test cases paragraphs
2.1	Apr 2008	Par.12.1.1	Reviewed Ph-8-01-a objectives
2.1	Apr 2008	Par. 14.1, 14.2	Par. 14.1 and 14.2 have been unified
2.1	Apr 2008	Par. 16.1	Ph-12-1-a and Ph-12-05 have been split in Par 16.1
2.1	Apr 2008	Appendix 4	Included preliminary LUT
2.2	May 2008	Par. 3.5	Included TM mnemonic in Performance Table
2.2	May 2008	Par. 9.1, 9.2, 10.1, 10.2, 11.1	LUT upload and READY Mode transition swapped
2.2	May 2008	Par. 9.1, 9.2, 10.1, 10.2, 11.1	LUT Dump process (after Upload) included
2.2	May 2008	Par. 9.2.4, 10.3.4	Changed LUT section upload order
2.2	May 2008	Par. 4.2 & 19.2	Removed SCS-R Healthcheck in PreTV and PostTV
2.2	May 2008	Appendix 1.7	Changed SCS Shutdown procedure
2.2	May 2008	Appendix 4.3	Changed LUT Healthcheck and Regeneration
2.3	May 2008	Appendix 4.3	Changed LUT Healthcheck and Regeneration
2.3	May 2008	Appendix 3	Changed Parameters Monitoring Limits in Table

Acronyms

AD	Applicable Document
AIV	Assembly, Integration and Verification
ASW	Application SoftWare
AVM	Avionics Verification Model
BEM	Back End Module (LFI)
BEU	Back End Unit (LFI)
BIN, bin	Binary
BOL	Begin of Life
CCE	Central Check-out Equipment
CCS	Central Check-out System
CDMS	Command and Data Management Subsystem
CDMU	Central Data Management Unit
CQM	Cryogenic Qualification Model
CSL	Centre Spatial de Liege
CTE	Coefficient of thermal expansion
DAE	Data Acquisition Electronics (LFI)
DC	Direct Current
DMS	Documentation Management System
DPC	Data Processing Centre
DPU	(Data (or Digital) processing Unit
DTCP	Daily Telecommunication Period
ECR	Engineering Change Request
EE	End to End test
EGSE	Electrical Ground Support Equipment
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
EOL	End of Life
EPS	Electrical Power Subsystem
ESA	European Space Agency
ESD	Electro Static Discharge
ESOC	European Space Operations Centre
ESTEC	European Space Technology and Research Centre
FDIR	Failure Detection, Isolation and Recovery
FEM	Front End Module (LFI)
FEU	Front End Unit (LFI)
FM	Flight Model
FMECA	Failure-Modes, Effects and Criticality Analysis
FOP	Flight Operations Plan
FPU	Focal Plane Unit
FS	Flight Spare
FTS	File Transfer System
GS	Ground Segment
H/W	Hardware
HC	Healthcheck
HFI	High Frequency Instrument (Planck)
HK	House Keeping (data)
ICD	Interface Control Document
ICWG	Instrument Coordination Working Group
ID	Identifier

IID	Instrument Interface Document
IID-B	Instrument Interface Document - part B
ILT	Instrument Level Test
IOM	Instrument Operations Manager
IOT	Instrument Operations Team
IST	Integrated System Test
JPL	Jet Propulsion Laboratory
JT	Joule Thompson
kbps	kilobits per second
LCL	Latch Current Limiter
LFI	Low Frequency Instrument (Planck)
LGA	Low Gain Antenna
LL	Low Limit
LPSC	Laboratoire Physic Subatomic et Cosmologie
Mbps	Megabits per second
MGSE	Mechanical Ground Support Equipment
MLI	Multilayer Insulation
MOC	Mission Operations Centre
N/A, n.a.	Not Applicable
NaN	Not a Number
NCR	Non Conformance Report
NRT	Near-Real-Time
OBCP	On-Board Control Procedure
OBSM	On-Board Software Maintenance
OD	Operational Day
OIRD	Operations Interface Requirements Document
OM	(DPC software) Operations Model
OOL	Out-of-Limits
PGSSG	Planck Ground Segment System Group
PID	Proportional, Integral, Derivative active control
PLFEU	Planck LFI Front End Unit (FEU)
PLM	Payload Module
PM	Project Manager
PPLM	Planck Payload Module
PSO	Planck Science Office
QA	Quality Assurance
QLA	Quick Look Analysis (software)
RD	Reference Document
RFW	Request for Waiver
RT	Real Time
RTA	Real-Time Analysis
S/C	Spacecraft
S/W	Software
SC	SpaceCraft
SCC	Sorption Cooler Compressor
SCCE	Sorption Cooler Cold End
SCE	Sorption Cooler Electronics
SCOE	Special Check-out Equipment
SCOS	Spacecraft Control and Operations System
SCP	Sorption Cooler Pipes
SCS	Sorption Cooler Subsystem (Planck)
SFT	Short Functional Test

SID	Structure Identifier
SPACON	SPAcecraft CONtroller
SR	Secondary Reflector
SS	Stainless Steel
ST	Science Team
STM	Structural/Thermal Model
SVM	SerVice Module
SVT	System Validation Test
TBC	To Be Confirmed
TBD	To Be Defined
TBS	To Be Specified
TBW	To Be Written
TC	TeleCommand
TCS	Thermal Control System
TID	Task Identifier
TM	Telemetry
TMM	Thermal Mathematical Model
TMU	Thermo Mechanical Unit (Sorption cooler)
TOD	Time-Ordered Data
TOI	Time-Ordered Information
TQL	Telemetry Quick-Look
UM	User's Manual
VG	V-Groove radiator
WU	Warm Units

TABLE OF CONTENTS

1. APPLICABLE AND REFERENCE DOCUMENTS

1.1. APPLICABLE DOCUMENTS

[AD1] Herschel/Planck Instrument Interface document Part A
SCI-PT-IIDA-04624 Issue 3.3

[AD2] Herschel/Planck Instrument Interface document Part B
SCI-PT-IIDB-04142 Issue 3.1

[AD3] Herschel/Planck Instrument Interface document Part B
SCI-PT-IIDB-04142 Issue 3.1, Annex 3, ICD 750800115

[AD4] Herschel/Planck Instrument Interface document Part A
SCI-PT-IIDA-04624 Issue 3.3 Annex 10

1.2. REFERENCE DOCUMENTS

[RD1] Planck SCS User Manual
PL-LFI-PST-MA-002, Issue 1.0

[RD2] Planck FM TV Test Sequence 8.02

[RD3] Planck TV/TB Test Specification
H-P-3-ASP-TS-0893, Issue 3.0

[RD4] Planck Sorption Cooler Electronics MIB USER GUIDE
UM-PSCZ-600092-LPSC, Issue 1.0 Rev. 4.0

2. INTRODUCTION

This document describes the test sequence and procedures of the Planck Sorption Cooler System planned for the thermal vacuum cryogenic test campaign at CSL. Each Chapter is dedicated to a specific Phase of the Test Campaign. For each Phase in which the SCS is operated is shown a summary of:

- Rationale
- Objective
- Configuration of SVM and PLM needed
- Thermal boundaries
- Pass/fail criteria
- Duration

3. GENERAL REQUIREMENTS

3.1. Responsibilities

TAS-F is the test conductor and responsible for the test steps performed with the SCS.
The SCS Operation Team (SCS OT) will witness and support TAS-F during tests execution in order to evaluate test results, assess pass/fail criteria and respond to any contingency that could arise. SCS Operation team will analyse offline the data for each test and produce report that will be integrated in a SCS Performance Verification test report. Each test will be reported by one TQL session file.

3.2. Environmental Conditions

All operations shall be conducted at ambient temperature, humidity, and pressure conditions in a class 100.000 environment or better in accordance with [AD2].
CLS Facility cryo-chamber shall be compliant to specification.

3.3. Operational Constraints for PFM2 Test

Main operational constraints for SCS testing are:

- SCS database loaded in CCS
- I-EGSE Connected to CCS and fully tested.
- TQL machine is connected to I-EGSE and fully tested.
- IOT on site

3.4. TV/TB SCS Test sequence

The TV/TB Test Campaign will be performed in the CSL cryo-facility in thermal and general conditions that, for each test case, will be representative of flight. The main objective of the TV/TB tests is to verify the functionality and performances of SCS comparing results to previous ground test campaigns and acquiring data for System in-flight performance predictions.

Up to date reference for SCS during the PFM2 test is summarized in the following table

3.5. SCS Performance Requirements

TMU Spec	Requirement Value	TM Mnemonic
Cold End T	**17.5 K < LVHX1 < 19.02 K** **17.5 K < LVHX2 < 22.50 K**	**SD028540 (LVHX1)** **SD029540 (LVHX2)**
Cold End T Fluctuations	**ΔT @ LVHX1 < 450 mK** **ΔT @ TSA < 100 mK**	**SD028540 (LVHX1)** **SD030540 (TSA)**
Cooling Power	**Cooling power @ LVHX1 > 190 mW** **Cooling power @ LVHX2 > 646 mW** **TSA dissipation = 150 mW** **Total Cooling Power > 986 mW**	**N/A**
Input Power	**TMU Input power < 426 W @ BOL**	**N/A**

3.6. Data analysis

SCS telemetry will be checked by SCS OT on-line. Full data processing will be performed off-line and reported in the test Final Report.

4. Phase PrTV-1 - Functional Tests pre-TV Activities

4.1. PrTV-1-2-d SCS Warm Healthcheck N

4.1.1. Objective

To ensure that no damage occurred at the SCS during all activities (and in particular transportation to testing site) performed after last HealthCheck (HC). “Warm HC” is a reduced procedure with respect to the “full HC”, due to the fact that cold sensors and heaters cannot be checked in warm conditions for hardware safety reasons. This HC will provide a reference baseline for the functional verifications to be performed at the end of test campaign.

4.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber but the door of the chamber will be left open to avoid heating problems.

LFI	HFI	SCS	SVM
OFF	OFF	OFF	ON

4.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Ambient T	Ambient T	Ambient T	Ambient T

4.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Activate SCS	SCS BOOT	Switch On SCE	0:10
Enter INIT Mode	SCS INIT		0:05
Enter READY Mode	SCS READY	SCS in Health Monitoring	0:05
Load LUT (if needed)	LUT UPLOAD	LUT for N Warm HC	0:10
Dump LUT	LUT READ BACK	Check loaded LUT	0:20
Enter Healthcheck	SCS HEALTHCHECK	Start Automatic procedure	2:00

Note: Procedures description and details are reported in Appendix 1

4.1.5. Constraints and others instrument configuration

No mechanical or electrical integration activity should be performed during the test.

4.1.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- Sensors response as expected
- Power consumption as expected [RD1]

5. Phase 1 – Final Check before Chamber Closure

During Phase 1 the SCS is OFF

6. Phase 2 – Pump Down

During Phase 2 the SCS is OFF

7. Phase 3 – Launch Simulation, Leak Checks, 4K Clr cleaning

During Phase 3 the SCS is OFF

8. Phase 4 – Shrouds & PPLM Passive Cooling

From Ph-4-01 to Ph-4-04 the SCS must be OFF for SVM thermal balance reasons. It may be possible to activate it part time at beginning of each sub-Phase.

At the end of Phase 4-05 (Ph-4-05-e), the SCE shall be switched On in READY Health Monitoring, in order to monitor the remaining part of PLM cooldown.

8.1.1. Objective

Objective of this test is to start the SCE-N in READY Mode (Health Monitoring) to monitor SCS status during passive cooldown.

8.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
OFF	OFF	OFF	ON

8.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold Case (TBC)	Cold Case (TBC)	TBC (Cooling down)	TBC (Cooling down)

8.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Activate SCE (BOOT Mode)	SCS BOOT	Switch On SCE	0:10
Enter INIT	SCS INIT		0:05
Enter READY	SCS READY		0:5
Upload full LUT for Cold TB Case	LUT UPLOAD	If not already done in previous phase	0:10
Dump LUT	LUT READ BACK	Check loaded LUT	0:20
SCS Monitoring	N/A	SCS is in Health Monitoring part time	TBD (part time)

Note: Procedures description and details are reported in Appendix 1

8.1.5. Constraints and others instrument configuration

No mechanical or electrical integration activity should be performed during the test

8.1.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- No unexpected sensor readings

9. Phase 5 – Cryo Chain Active Cooling

9.1. Phase 5-01 SCS Start-up

9.1.1. Objective

Objective of this test is to start the SCS-N and take it into Run Mode and Nominal Operations.

9.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
OFF	OFF	ON	ON

9.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold TB Case T	Cold TB Case T	<100K	<100K

9.1.4. Test sequence

SCS Cold Case LUT parameters will be set on the basis of actual thermal boundary conditions (see LUT Appendix).

If SCE-N is already ON after Switch-On in Ph-4-05-e then the below reported sequence shall start from the "Enter to RUN" step. If, at the beginning of Ph5-01, the SCE-N is OFF then the whole sequence below shall be executed.

Sequence Step	Procedure	Comments	Time Duration
Activate SCE (BOOT Mode)	SCS BOOT	Switch ON SCE if not already ON from previous phase	0:10
Enter INIT	SCS INIT	"	0:05
Enter READY	SCS READY	"	0:05
Upload full LUT for Cold TB Case	LUT UPLOAD	If not already done in previous phase	0:10
Dump LUT	LUT READ BACK	Check loaded LUT	0:20
Enter RUN	SCS RUN	Start Cooldown	0:05
SCS enters Nominal	NA	Autonomous transition	About 100:00

Note: Procedures description and details are reported in Appendix 1

9.1.5. Constraints and others instrument configuration

No mechanical or electrical integration activity should be performed during the test

9.1.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- SCS shall enter RUN Mode
- SCS shall enter Nominal Operations
- SCS shall meet performance requirements

9.2. Phase 5-02-e SCS parameters and TSA tuning

9.2.1. Objective

Objective of this test is to adjust the SCS operational parameters for nominal cooler performance in order to ensure optimal conditions for instruments test. In such a way, the cooler will perform in nominal conditions, meeting all requirements. This is a fundamental step for the whole cryo test, an out of balance SCS has a strong impact on the thermal status of other sub-systems and of the whole cryo test.

It is important to note here that any activity during the test campaign that can thermally unbalance the SVM, PLM or SCS itself might require new or frequent SCS adjustment (tuning) iterations.

This test is performed by optimizing cooler operational parameters in terms of input power and cycle time in order to produce required heat lift and cold end conditions as close as possible to balance. At the same time, TSA active control parameters will be adjusted relatively to all other parameters for optimized cold end absolute temperature and fluctuations. In such a way temperature oscillations at the LFI and HFI interfaces will be maintained below the required limits, reaching expected operational stable conditions for both instruments.
In particular, the TSA has been tested during JPL ground test campaigns in a thermal environment not fully representative of the flight conditions. This will be the first time for a verification of the TSA

behaviour on the S/C, with the real instruments (and their dissipation) connected and with the satellite (and the relevant I/F's) in TV conditions representative of flight.
During TSA tuning, once stabilization has been reached with PID, the OpenLoop algorithm will be activated to verify its functionality and to check if its capability in achieving better stabilization. On the basis of test results, it will be decided whether both control systems (PID and OpenLoop) will be used together for the test campaign or not.

9.2.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON (full load)	ON	ON (Nominal Ops)	ON

9.2.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold TB Case T	Cold TB Case T	20K	Nom. Stroke

9.2.4. Test sequence

The final stabilization has to be reached before starting Instruments testing. It should be performed with both instruments in nominal operating conditions and after 4K cooler switch ON.

Sequence Step	Procedure	Comments	Time Duration
Upload "tuned" LUT	LUT UPLOAD		0:10
Enable TSA	SC501530	Enable PID in LUT SW Section	-
Powers and times section	SC502559	Cycle and Power are updated	
PID/OL section	SC506559	PID/OL parameters are updated	-
Dump LUT Sections	SC601530	Check LUT sections	0:20
"	SC602559	"	
"	SC606559	"	
Wait for stability	NA	LFI MF thermal balancing	6:00

Note: Procedures description and details are reported in Appendix 1

From present test schedule, it results that the tuning process will be performed before 4K cooler transition to Nominal stroke. If this transition will induce a variation of the load dissipated on the SCS cold end by 50 mW or more, then it might be needed to perform an adjustment to SCS parameters in order to cope with this unbalance. This adjustment will be done at the end of LFI test, in order not to impact test data quality.

9.2.5. Constraints and others instrument configuration

The expected full load form LFI and HFI should be applied.

9.2.6. Pass/Fail criteria

There are the following criteria for the success of the test:

- No unexpected event Packets
- SCS shall remain in Nominal Operations
- SCS shall meet performance requirements
- Peak-to-peak T fluctuations at the TSA stage shall be below 100 mK, while LVHX1 ΔT shall remain below 450 mK
- TSA PID control power below 150 mW

9.3. Phase 5-03 to Phase 5-99

For the rest of Phase 5 SCS is run unperturbed into Nominal conditions.

10. Phase 6 – HFI Functional Testing

10.1. Phase 6-01 to Phase 6-07

During first part of Phase 6 SCS is run unperturbed into Nominal conditions.

10.2. Phase 6-08 TSA failure test

10.2.1. Objective

This test shall verify the Instruments performance/behaviour in case of TSA failure, i.e. the impact on instruments performance of the raw unfiltered T fluctuations directly transmitted to the HFI (cryo-chain and 4K load) and LFI (FPU). The TSA is a critical stage for the SCS performance. For this reason there is 100% redundancy in both SCS FM units. Nevertheless there might be contingency situations requiring cooler operations (for either a limited or extended period of time) without Cold End stabilization as in the case, for example, of a hardware failure. It is crucial to test the impact of a disabled TSA on both instruments and cryo-chain functionality: higher raw, uncontrolled T oscillations will be entirely transmitted trough the instruments interfaces.

This test should be performed before SCS Heat Lift Measurement.

10.2.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON	ON	ON (Nominal Ops)	ON

10.2.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold TB Case T	Cold TB Case T	20K	20K

10.2.4. Test sequence

The TSA control algorithm is disabled in the LUT to simulate a failure. The immediate impact is a drop in the Cold End absolute T with an increase of the peak-to-peak fluctuations (and a resulting change in the spectral behaviour). As a slower effect, the TSA dissipated load is added to the extra cooling power produced by the SCS: this will cause an increase of the liquid produced and accumulated in the cold end that, with time, going back up the return line can cause an appreciable extra increase in the peak-to-peak oscillations.

Sequence Step	Procedure	Comments	Time Duration
Upload LUT	LUT UPLOAD		0:10
Disable TSA	SC501530	Disable PID in LUT SW Section	-
Dump LUT	SC601530	Check LUT change	0:05
Wait for instability	NA	Monitor Instrumental response	4:00

Note: Procedures description and details are reported in Appendix 1

10.2.5. Constraints and others instrument configuration

The expected full load from LFI and HFI shall be applied. Both instruments shall be in their nominal science acquisition state.

10.2.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- SCS shall meet all performance requirements except cold end temperature fluctuations

10.3. Phase 6-09 SCS Heat lift Measurement

10.3.1. Objective

The objective of this test is to measure the cooling power produced by the SCS in the Cold TB Case. This is a fundamental verification of cooler functional performance and LFI thermal behaviour: it will allow not only to measure SCS performance in terms of heat lift but also to provide an indirect estimation of the LFI passive dissipation (parasitics).

This test should be performed after the TSA failure test.

10.3.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON	ON	ON (Run Mode)	ON

10.3.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold TB Case T	Cold TB Case T	20K	20K

10.3.4. Test sequence

Test procedure:

1. TSA stays OFF (from previous test) to measure LFI load on LVHX2
2. Switch TSA on again and change TSA set-point, T_{TSA}, to increase the heat load to the sorption cooler. Approximately 200 mK is 100 mW.
3. Use the measurement of the TSA heater circuit current, I_{TSA}, and the TSA heater resistance, ~480 ohm, to check the transfer function between T_{TSA} and the heat load applied to the sorption cooler.
4. If dry-out of LVHX2 is observed before LVHX2 T stabilizes (usually takes about 30 min), then cooling power produced is confirmed. End of test.
5. If no dry-out is noticed then increase TSA set-point by 100mK (that is about 50mW) and wait for the liquid to evaporate.
6. Follow this procedure until LVHX2 dry-out is observed (usually from 3 to 4 steps are required). End of test.

Sequence Step	Procedure	Comments	Time Duration
Upload new LUT	LUT UPLOAD	TSA PID set-point changes are used to perform such measurement	0:10
Enable TSA	SC501530	Enable TSA in LUT SW Section	-
PID section	SC506559	Set PID set-point	-
Dump LUT sections	SC601530	Check LUT	0:10
"	SC606559	"	-
Wait for stabilization	NA	Cold End and Instrument IFs	-
Check Cold End T	NA	Check stability/dry-out	-
If needed repeat step 1	-	Several steps might be required	Up to 6:00
TSA tuning LUT upload	LUT UPLOAD	Go back to stable operations	0:10
PID section	SC506559	Set PID parameters for TSA stability	
Dump LUT section	SC606559	Check LUT	0:05

Note: Procedures description and details are reported in Appendix 1

At the end of the heat lift measurement, nominal stable conditions should be achieved back before starting instruments Autocompatibility Test. This might take up to 6.00 extra hours.

10.3.5. Constraints and others instrument configuration

The expected full load form LFI and HFI must be applied. Both instruments shall be in their nominal science acquisition state. Thermal conditions of instruments and pre-cooling stages will be perturbed for the whole duration of this measurement.

10.3.6. Pass/Fail criteria

There are the following criteria for the success of the test:

- No unexpected event Packets
- SCS cooling power shall be compliant to requirement with a max error of 100mW

11. Phase 7 – EMC & Autocompatibility

11.1. Phase 7-01 SCS Cycle time and Power small adjustment

11.1.1. Objective

SCS operations will be optimized to maximize cooler lifetime. The baseline operational scenario is requiring frequent (monthly or weekly) small adjustment steps of the cooler parameters. This test is intended to check possible effects on cooler balance and instruments performance of such small tuning iterations.
Objective of this test is to change SCS tuning parameters (usually cycle time and input power) by the typical amount of a weekly tuning step (i.e. by about 10-20 s and few watts) to check cooler response and performance to this variation together with instrumental effects on scientific data. This test will allow to check and, possibly, quantify the effect of small cooler performance variations on instruments scientific output.

Before starting this test SCS should be in stable Nominal operations, meeting all performance requirements.

11.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON (Nominal)	ON (Nominal)	ON (Nominal Ops)	ON

11.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Cold TB Case T	Cold TB Case T	20K	20K

11.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Upload “tuned” LUT	LUT UPLOAD		0:10
Powers and times section	SC502559	Cycle time and Power are updated	
Dump LUT Section	SC602559	Check LUT	0:20

Note: Procedures description and details are reported in Appendix 1

11.1.5. Constraints and others instrument configuration

The expected full load form LFI and HFI must be applied. Both instruments shall be in their nominal science acquisition state. Cooler parameters tuning will be performed just before the beginning of the 24 hours HFI/LFI compatibility test (Phase 7-02) since instrumental effects should be monitored for at least a typical OD period.

11.1.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- SCS shall remain in Nominal Operations
- SCS shall meet performance requirements

Off-line scientific analysis of instrument data shall verify possible perturbations introduced by SCS adjustments and quantify their impact on data quality.

12. Phase 8 – SVM and S/C Warm Thermal Balance

12.1. *Phase 8-01-a SCS Warm LUT upload*

12.1.1. Objective

Objective of this test is to verify SCS performance in Warm TB and TV conditions and its impact on SVM thermal balance. Major thermal interfaces will be taken up to worst case temperatures in order to check PPLM functionality in these conditions. SCS shall be verified in worst case, end of life, max dissipation case as it has been done in PFM1 Thermal Hot Case Test. LUT values for the Hot Case will be approximately the same (480s, 466W) as previous test.

In such SCS worst and EOL operations case nominal required performance cannot be ensured.

12.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON	ON	ON (Nominal Ops)	ON

12.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Warm TB Case T	Warm TB Case T	20K	20K

12.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Upload Warm LUT	LUT UPLOAD		0:10
Dump Warm LUT	LUT DUMP	Check loaded LUT by operators	0:20
Wait for system stability	NA	Thermal equilibrium	6:00

Note: Procedures description and details are reported in Appendix 1

12.1.5. Constraints and others instrument configuration

The expected full load form LFI and HFI should be applied. SVM shall be in stable Warm TB/TV test conditions.

12.1.6. Pass/Fail criteria

There are the following criteria for the success of the test:

- No unexpected event Packets
- SCS shall be in Nominal Operations
- SCS shall meet performance requirements

12.2. Phase 8-02 to Phase 8-99

For the rest of Phase 8 SCS is run into Nominal conditions

13. Phase 9 – HFI Dilution Cooler Testing

In Phase 9 SCS is run unperturbed into Nominal Operations

14. Phase 10 – 4K Cooler Heat lift and Coolers Failure Tests

14.1. Phase 10-05 SCS failure test and Switchover to SCS-R unit

14.1.1. Objective

14.1.1.1. Ph-10-5-a

This phase shall verify the Instruments response and behaviour in case of SCS failure, i.e. the impact on instruments and cryo-chain FDIR of an unexpected SCS stop.
A sudden SCS failure has an impact on the whole Planck cryo-chain and on mission timeline. If problem is not critical, the cooler might be restarted in the following (TBC) DTCP but the effects on the PPLM need to be evaluated, mainly in terms of:

- SCCE T holding/relaxation time
- Impact on 4K cooler
- Impact on dilution cooler
- LFI T transient
- HFI T transient

To perform this test the SCS shall be taken by TC to READY Mode (Health Monitoring) and its cycle shall be stopped.

This test will provide fundamental info for correlation of transient PPLM TMM.

14.1.1.2. Ph-10-5-b

In order to complete SCE FM Redundant qualification on board the Planck S/C, a switchover from the Nominal Unit to the Redundant is planned ***during*** the execution of SCS N Failure Test.

This SCE FM-R qualification is based on a simple switchover procedure down to the activation of SCE R and a short Healthcheck:

- Shutdown SCS Nominal
- Initialise SCS Redundant
- GOTO READY MODE, enter Health Monitoring
- SCS R Healthcheck (TBC)
- Shutdown SCS Redundant
- Initialise SCS Nominal
- GOTO READY MODE
- GOTO RUN Mode SCS N

On ground, the orientation of the second (redundant) cooler fixed by the test setup prevents the redundant cooler compressor elements (CE) from being activated. For this reason only a short Healthcheck procedure (no actual gas desorption) will be executed, including the check of cold end sensors and heaters (TBC).

At the end of Phase 10-5, SCS N shall be restarted and taken to RUN Mode (Conditioning). Reaching Nominal stable conditions shall not be required to proceed with next Phase 11 (Transition to Safe Mode). Nominal cooler operations in RUN (Conditioning) at Restart should be limited to the shortest possible time before Phase 11 execution in order to minimize impact on system warm up. For this reason, Phase 11 should start as soon as coolers and instruments are taken back to their normal operational Mode.

14.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
ON	ON	ON (Nominal Ops)	ON

14.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Warm TB Case T	Warm TB Case T	20K	20K

14.1.4. Test sequence

The sequence of the two combined tests (Ph-10-05-a and b) can be described as follows.

Sequence Step	Procedure	Comments	Time Duration
Stop SCS N cycle	SCS READY	SCS N is taken to READY Mode	0:00
GOTO READY Mode		Enters Health Monitoring	
Monitor SCS N in READY	N/A	Monitor SCS N warm-up	3.30
SCS N Switch OFF	SCS SHUTDOWN	SCS-N Switch OFF process (A1.7)	0:05
CDMS request for SCE-N LCL OFF			
Wait for Event Report from S/C		See Appendix for TM	
SCS R Activation			
SCS R into BOOT	SCS BOOT		0:15
Transfer ASW (if not automatic)			
Wait for Event Report from S/C		See Appendix for TM	
SCS R into INIT	SCS INIT		0:05
SCS R into READY	SCS READY		0:05

SCS R HealthCheck	SCS HEALTHCHECK	Short HC with dedicated LUT (see A4.3)	0:45
SCS R Switch OFF	SCS SHUTDOWN	SCS-R Switch OFF process (A1.7)	0:05
CDMS request for SCE-R LCL OFF			
Wait for Event Report from S/C		See Appendix for TM	
SCS N RESTART			
SCS N into BOOT	SCS BOOT		0:15
Transfer ASW (if not automatic)			
Wait for Event Report from S/C		See Appendix for TM	
SCS N into INIT	SCS INIT		0:05
SCS N into READY	SCS READY		0:05
Monitor SCS N in READY		Monitor SCS N warm-up (Part2)	0:40
SCS N in Start-up again	SCS RUN	SCS N in RUN conditioning	0:05

Note:

- ***Procedures description and details are reported in Appendix 1***
- ***SCS-Redundant packets APID for Boot and Essential HK is 1665, for non-Essential and Diagnostic is 1667***

Total duration of combined Ph-10-05-a and b is **6:00** hours

14.1.5. Constraints and others instrument configuration

The expected full load form LFI and HFI shall be applied. Both instruments shall be in their nominal science acquisition state.

14.1.6. Pass/Fail criteria

There are the following criteria for the success of the test:

- No unexpected event Packets in both SCS FM units
- Switchover procedure correctly executed
- No errors/failure detected in SCS R

15. Phase 11 – SVM Transition to Safe Mode

In Phase 11, before transition to Safe Mode, SCS should be operated in RUN (Conditioning) for the shortest possible time in order to minimize impact on system warm. Nominal stable conditions shall not be required to proceed with this Phase.

Power lines to SCS shall be switched off.

SCS shall be restarted in RUN Mode at the end of test using the same Start-up procedure described in Chapter 9.1. No need of recovering nominal stable conditions before proceeding with next Test Phase.

16. Phase 12 – FPU & Reflectors Warm-up

16.1. Phase 12-01-a & 12-05 SCS Shutdown (monitor of warm-up)

16.1.1. Objective

In this Phase the SCS will be shut-down to start the PPLM warm-up. This test shall verify the cooler behaviour during warm-up and will provide fundamental data for correlation of transient SCS TMM. For this reason, it is required to keep SCS in READY Mode (Health Monitoring) in Ph-12-01 in order to monitor SCS and PLM warm up until completion of Ph-12-04.

At beginning of Ph-12-05 the SCE-N shall be deactivated and the SCS-N shall be finally OFF.

16.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber in vacuum and in the expected steady state cryo environment.

LFI	HFI	SCS	SVM
OFF	OFF	ON (RUN Conditioning)	ON

16.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Warm TB Case T	Warm TB Case T	20K	20K

16.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Stop SCS N cycle	SCS READY	SCS N is taken to READY Mode	0:00
GOTO READY Mode		SCS N Enters Health Monitoring	
Monitor SCS N in READY	N/A	Monitor SCS N warm-up	Until Ph-12-05
SCS N into INIT	SCS INIT	At beginning of Ph-12-05	0:05
CDMS request for SCE LCL54 OFF		SCS-N Shutdown	
Wait for Event Report from S/C		See Appendix for TM	

Note: Procedures description and details are reported in Appendix 1

16.1.5. Constraints and others instrument configuration

The instruments shall be both OFF.

16.1.6. Pass/Fail criteria

The following criteria define the success of the test:

- No unexpected event Packets
- SCS stable (No Errors) in Health Monitoring operations

17. Phase 13 – PPLM, Facility and SVM Warm-up

During Phase 13 the SCS is OFF

18. Phase 14 – Pressure Recovery and Chamber Opening

During Phase 14 the SCS is OFF

19. Phase PsTV – Functional Checks after Tests

19.1. PsTV-1-3 SCS Warm Healthcheck N

19.1.1. Objective

Objective of this phase is to verify that no damage occurred at the SCS during TV/TB test. Warm HC is a reduced procedure with respect to the full HC due to the fact that cold sensors and heaters cannot be checked in warm conditions.
This HC will provide a reference baseline for future functional verifications.

19.1.2. Initial configuration set-up

The S/C shall be mounted inside the chamber but the door of the chamber will be left open to avoid heating problems.

LFI	HFI	SCS	SVM
OFF	OFF	OFF	ON

19.1.3. Thermal environment

Warm Radiator	VGroove3	FPU	4K Cooler IF
Ambient T	Ambient T	Ambient T	Ambient T

19.1.4. Test sequence

Sequence Step	Procedure	Comments	Time Duration
Activate SCS	SCS BOOT	Switch On SCE	0:10
Enter INIT Mode	SCS INIT		0:05
Enter READY Mode	SCS READY		0:05
Load LUT (if needed)	LUT UPLOAD	No LUT change is expected	0:10
Dump LUT	LUT DUMP	Check Loaded LUT	0:20
Enter Healthcheck	SCS HEALTHCHECK	Start Automatic procedure	2:00

Note: Procedures description and details are reported in Appendix 1

19.1.5. Constraints and others instrument configuration

No mechanical or electrical integration activity should be performed during the test.

19.1.6. Pass/Fail criteria

There are the following criteria for the success of the test:

- No unexpected event Packets
- Sensors response as expected
- Power consumption as expected [RD1]

A. Appendix. SCS Operational Procedures

A.1 Procedures Blocks (Level 2)

These procedures are the building blocks for the Level 1 procedures that can be performed during CSL test campaign. Each one can be considered as a stand-alone micro-procedure but they are usually executed only as steps of transitions to Op Modes. They can be considered completed when the TM(5.1) event report for that Mode is received.

A1.1 SCS BOOT

Applicative Software (ASW) transfer can be performed automatically or by “manual” CMD (it depends on the lookup table settings). No TM(5.1) ID = 1 packet is generated by BOOT SW, so BOOT (and INIT) Mode entry can be verified by the operator in TM(3,25) and TM(3,26) sent by BSW.

SCS BOOT

Step #	Description	Type	Action	Result	Delay
1	CDMS Action: Turn ON Powerline 1	CDMS Action			
2	SCE auto entrance in BOOT MODE				
2.1	Event Report Reception: BOOT Mode entered	TM(5.1) Event Report	SA0605630 ID = 1, PI1 = 1 Boot Mode entered	Receive Packet 190501530 APID=1664, PI1 = 1	
2.2	Boot SW HK	TM(3.25)	SA010530, SM700530 and SM701530	Receive Packet 190301530 APID=1664, PI1=1, HSK1 Boot SW	
2.3	Boot SW diagnostic	TM(3.26)	SA021530	Receive Packet 190311530 APID=1666, PI1=1, Diag1 Boot	
3	Transfer ASW (can be automatic or by cmd, depending on LUT settings)	TC(8.4)	SC000530, Transfer ASW (SM505530=1) - CVS_ID=4	Transfer ASW = transferred (SM291530=0) - CVS_ID=5	
3.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	

A1.2 SCS INIT

Transition into INIT Mode can happen only after:

- 'GOTO INIT' TC from BOOT (or INIT or READY) Mode
- ASW transfer (automatically or by command) in BOOT Mode has been completed

It follows that the only way to enter INIT Mode is by sending the 'GOTO INIT' TC. This telecommand is not accepted if ASW has not been previously transferred.
No TM(5.1) ID = 2 packet is generated by BOOT SW, so INIT Mode entry can be verified by the operator in TM(3,25) and TM(3,26) sent by BSW. Generation of TM(5.1) ID = 2 is performed by ASW, so transitions to INIT in ASW are correctly reported.

SCS INITIALISATION

Step #	Description	Type	Action	Result	Delay
1	GOTO INIT	TC(8.4)	SC006530, GoTo Init, SID=210,	Current State=Init (SM502530=2) - CVS_ID=8	
1.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
1.2	Event Report Reception: INIT Mode entered	TM(5.1) Event Report	SA060530 ID = 2, PI1 = 2 Init Mode entered	Receive Packet 190501530 APID=1664, PI1 = 2	
	ASW Initialisation starts				
1.3	ASW HK non-essential/essential	TM(3.25)		Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
1.4	ASW diagnostic	TM(3.26)	SA022530, DIAG2 ASW	Receive Packet 190312530 APID=1666, PI1=2, Diag2 ASW	

A1.3 SCS LUT Upload

LUT upload is not mandatory. A LUT upload should be executed only if parameters need to be changed; if not the software uses the parameters stored in EEPROM.

LUT UPLOAD

Step #	Description	Type	Action	Result	Delay
1	Memory Load	TC(6.2)	See LUT Upload TC Table		
1.1	Wait for TC acknowledgment TM(1.3)	TM(1.3)	10 - TM(1.3), TC started	TM(1.3) - CVS_ID=2	
1.2	Wait for TC acknowledgment TM(1.7)	TM(1.7)	10 - TM(1.7), TC completed	TM(1.7) - CVS_ID=3	
2	Memory Dump	TC(6.5)	See LUT Read Back TC Table		
2.1	LUT Read Back TM		See LUT Read Back TM Table		

LUT Summary Tables

LUT Sections

Name	Description
SOFTWARE	Parameter for averaging sensors and enabling/disabling of some function
POWERS TIMES	Heater & desorb power and cycle duration
HC REGEN	Health check and regeneration parameters
RUN MODE	Adjustment during run modes (startup, defrost and normal modes)
FAULTS	Fault Conditions and Bad Bed Detection: Automatic diagnostic and FDIR (temperature threshold, pressure, voltage and current)
PID	PID (Proportional Integral Derivative) and Open Loop Algorithms
HEATERS	Parameter for beds resistance value (depend on the SCE model)
CALIBRATIONS 1	Cernox transfer function (depends on the cooler) – first part
CALIBRATIONS 2	Cernox transfer function (depends on the cooler) – second part

TC depends on the model of SCE used.

LUT Upload TC

CCF Name	Description	# of Param	Memory ID	Start Address	Length
SC501530	TC 6_2 Load LUT Software – FM1, FM2, PFM1 and PFM2	66	DM EEPROM 5 (0x8004)	100	48
SC502559	TC 6_2 Load LUT Powers and Times – FM1, FM2, PFM1 and PFM2	43		130	38
SC503559	TC 6_2 Load LUT Health Check and Regeneration – FM2	21		156	16
SC504559	TC 6_2 Load LUT Run Mode transitions – FM2	30		166	25
SC505559	TC 6_2 Load LUT Fault Conditions and Bad Bed Detection – FM2	34		17F	29
SC506559	TC 6_2 Load LUT PID and Open Loop Algorithms – FM2	17		19C	12
SC507559	TC 6_2 Load LUT Heaters Resistances – FM1, FM2, PFM1 and PFM2	32		1A8	27
SC508530	TC 6_2 Load LUT Calibrations 1 – FM1, FM2, PFM1 and PFM2	35		1C3	30
SC509530	TC 6_2 Load LUT Calibrations 2 – FM1, FM2, PFM1 and PFM2	41		1E1	36
SC510559	TC 6_2 Load LUT health Check and Regeneration – FM1	21		156	16
SC511559	TC 6_2 Load LUT Run Mode transitions – FM1	30		166	25
SC512559	TC 6_2 Load LUT Fault Conditions and Bad Bed Detection – FM1	34		17F	29
SC513559	TC 6_2 Load LUT PID and Open Loop Algorithms – FM1	17		19C	12
SC514559	TC 6_2 Load LUT health Check and Regeneration – PFM2	21		156	16
SC515559	TC 6_2 Load LUT Run Mode transitions – PFM2x	30		166	25
SC516559	TC 6_2 Load LUT Fault Conditio ns and Bad Bed Detection – PFM2	34		17F	29
SC517559	TC 6_2 Load LUT PID and Open Loop Algorithms – PFM2	17		19C	12
SC518559	TC 6_2 Load LUT health Check and Regeneration – PFM1	21		156	16
SC519559	TC 6_2 Load LUT Run Mode transitions – PFM1	30		166	25
SC520559	TC 6_2 Load LUT Fault Conditions and Bad Bed Detection – PFM1	34		17F	29
SC521559	TC 6_2 Load LUT PID and Open Loop Algorithms – PFM1	17		19C	12

LUT Dump TC

CCF Name	Description
SC601530	TC 6_5 Dump LUT Software
SC602559	TC 6_5 Dump LUT Powers and Times
SC603559	TC 6_5 Dump LUT health Check and Regeneration
SC604559	TC 6_5 Dump LUT Run Mode transitions
SC605559	TC 6_5 Dump LUT Fault Conditions and
SC606559	TC 6_5 Dump LUT PID and Open Loop
SC607559	TC 6_5 Dump LUT Heaters Resistances
SC608530	TC 6_5 Dump LUT Calibrations 1
SC609530	TC 6_5 Dump LUT Calibrations 1

LUT Dump TM

Name	Description	LUT position	Monitoring Parameter	Command Parameter
SA100530	LUT – SOFTWARE	0x00 to 0x2f	SM325530 to SM384530	SP101530 to SP168530
SA102559	LUT Powers Times	0x30 to 0x55	SM201540 to SM238540	SP001540 to SP038540
SA103559	LUT HC Regen	0x56 to 0x65	SM239540 to SM254540	SP039540 to SP055540
SA104559	LUT Run Mode	0x66 to 0x7e	SM255540 to SM279540	SP056540 to SP080540
SA105559	LUT Faults	0x7f to 0x9b	SM280540 to SM308540	SP081540 to SP109540
SA106559	LUT PID	0x9c to 0xa7	SM309540 to SM320540	SP110540 to SP121540
SA107559	LUT Heaters	0xa8 to 0x2	SM321540 to SM347540	SP121540 to SP148540
SA108530	LUT - CALIBRATIONS	0xc3 to 0xe0	SM385530 to SM414530	SP169530 to SP199530
SA109530	LUT - CALIBRATIONS	0xe1 to 0x104	SM415530 to SM450530	SP200530 to SP235530

A1.4 SCS READY

Reception of TM(5.1) ID = 3 ensures that the transition into READY (Health Monitor) Mode has been completed.

SCS READY

Step #	Description	Type	Action	Result	Delay
1	GOTO READY	TC(8.4)	SC007530, GoTo Ready - Health Monitor, SID=220,	Current State= Health Monitor (SM502530=3) - CVS_ID=9	
1.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
1.2	Event Report Reception: READY Mode entered	TM(5.1) Event Report	SA060530 ID = 3, PI1 = 3 Ready Mode (Health Monitor) entered	Receive Packet 190501530 APID=1664, PI1 = 3	
1.3	ASW HK non-essential/essential	TM(3.25)	Read: SA011559, SA012540, SA013540, SA014540, SA005540, SA090559, SA091540. Check Parameter list for details	Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
1.4	ASW Diagnostic	TM(3.26)	SA022530, DIAG2 ASW	Receive Packet 190312530 APID=1666, PI1 = 2	

Check TM Parameters & Limits in Appendix Table to see TMU and SCE parameters SMxxxxxx identification.

A1.5 SCS RUN

Reception of TM(5.1) ID = 6 ensures that the transition into RUN (Startup) Mode has been completed.

SCS RUN

Step #	Description	Type	Action	Result	Delay
1	GOTO RUN	TC(8.4)	SC010530, GoTo Run - Startup, SID=250	Current State =startup (SM502530 = 6) – CVS_ID = 12	
1.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
1.2	Event Report Reception: READY Mode entered	TM(5.1) Event Report	SA060530 ID = 6, PI1 = 6 Run Mode (Startup) entered	Receive Packet 190501530 APID=1664, PI1 = 6	
1.3	ASW HK non-essential/essential	TM(3.25)	Read: SA011559, SA012540, SA013540, SA014540, SA005540, SA090559, SA091540. Check Parameter list for details	Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
1.4	ASW Diagnostic	TM(3.26)	SA022530, DIAG2 ASW	Receive Packet 190312530 APID=1666, PI1 = 2	

Check TM Parameters & Limits in Appendix Table to see TMU and SCE parameters SMxxxxxx identification.

A1.6 SCS HEALTHCHECK

Health Check (HC) procedure is entered by sending the “GOTO Health Check” tele-command from the Health Monitor state of READY Mode. During the HC process, a periodic diagnostic TM(3.26) “Health Check Diagnostic” is sent once a second reporting the test being performed and the previous tests status (since the start of the HC procedure). The result of the overall HC procedure is given on the last TM(3, 26) diagnostic sent following the automatic transition from HC back to READY Health Monitor.

The Health Check procedure is fully automatic and at the end of the process the software autonomously returns into Health Monitor state. It is anyway possible to stop the HC procedure manually and return to Health Monitor state with the “GOTO READY Health Monitor” tele-command.

The HC procedure parameters used for the system test are defined in the Lookup Table (Health Check procedure Section).

SCS HEALTHCHECK

Step #	Description	Type	Action	Result	Delay
1	GOTO HEALTHCHECK	TC(8.4)	SC008530, GoTo Ready - Health Check, SID=230,	Current State= Health Check (SM502530=4) - CVS_ID=10	
1.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
1.2	Event Report Reception: READY Mode (Health Check) entered	TM(5.1) Event Report	SA060530 ID = 4, PI1 = 4 Ready Mode (Health Check) entered	Receive Packet 190501530 APID=1664, PI1 = 4	
1.3	ASW HK non-essential/essential	TM(3.25)	Read: SA011559, SA012540, SA013540, SA014540, SA005540, SA090559, SA091540. Check Parameter list for details	Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
1.4	Health Check Diagnostic	TM(3.26)	SA023530 DIAG3 - HEALTH CHECK	Receive Packet 190313530 APID=1666, PI1 = 3	

A1.7 SCS SHUTDOWN

Even if a specific procedure for Shutdown has been implemented in the OBSW, SCS units for several reasons are usually switched OFF by a sequence of operations that can be summarized as follows:

- going back to INIT Mode (high power 20A line is automatically disconnected)
- perform an EEPROM test (required for CLS PFM2 test by ESA)
- then manually disabling the relative LCL

Detailed procedure is the following:

SCS Switch OFF

Step #	Description	Type	Action	Result	Delay
1	GOTO READY	TC(8.4)	SC007530, GoTo Ready - Health Monitor, SID=220	Current State= Health Monitor (SM502530=3) - CVS_ID=9	
1.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
1.2	Event Report Reception: READY Mode entered	TM(5.1) Event Report	SA060530 ID = 3, PI1 = 3 Ready Mode (Health Monitor) entered	Receive Packet 190501530 APID=1664, PI1 = 3	
1.3	ASW HK non-essential/essential	TM(3.25)	Read: SA011559, SA012540, SA013540, SA014540, SA005540, SA090559, SA091540. Check Parameter list for details	Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
2	GOTO INIT	TC(8.4)	SC006530, GoTo Init, SID=210	Current State=Init (SM502530=2) - CVS_ID=8	
2.1	Wait for TC acknowledgment TM(1.1)	TM(1.1)	1 - TM(1.1)	TM(1.1) - CV_ID=1	
2.2	Event Report Reception: INIT Mode entered	TM(5.1) Event Report	SA060530 ID = 2, PI1 = 2 Init Mode entered	Receive Packet 190501530 APID=1664, PI1 = 2	
2.3	ASW HK non-essential/essential	TM(3.25)		Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
3	Test EEPROM (required in CSL PFM2 test)	TC(8.4)	SC004530, Test DM EEPROM, SID=130	Current process = test hardware (SM505530 = 2) - CVS_ID = 6 TM(3,26) received test on Diag	
3.1	ASW HK non-essential/essential	TM(3.25)	Read: SA011559, SA012540, SA013540, SA014540, SA005540, SA090559, SA091540. Check Parameter list for details	Receive Packet 190302559 APID=1666, PI1=2, HSK2 non-essential ASW Receive Packet 190302559 APID=1664, PI1=3, HSK3 essential ASW	
3.2	ASW Diagnostic	TM(3.26)	SA022530, DIAG2 ASW	Receive Packet 190312530 APID=1666, PI1 = 2	
4	*Request to CDMS: 1st Power line (5A), (LCL#54) OFF*		SCE is switched OFF	SCS is shutdown	

Notes:
- ***SCS-Redundant packets APID for Boot and Essential HK is 1665, for non-Essential and Diagnostic is 1667***
- ***TBC if EEPROM Test (step 3) must be performed at each Shutdown of both units***

Specific Shutdown Mode is anyway automatically reached if one of the following conditions is true:

- both ADC reading chains are bad.
- JT heaters H34 or H35 is always ON (detection in run mode only).
- Electronics temperature reached the second level limit (detection in run mode only).

Note: *in all 3 cases, the "switch off" event is also sent to CDMS*

A.2 Procedures (Level 1)

A2.1 SCS ASW Initialization

This Level 1 procedure can be used only to initialise the SCS, to perform diagnostic checks and/or to upload a new LUT.

SC System Initialisation

Step #	Description	Comments
1	Execute SCS BOOT procedure	
	Transfer ASW if not automatically executed	
2	Execute SCS INIT Procedure	
	At this point the LUT can uploaded, if needed	

A2.2 SCS Health Monitoring

This Level 1 Procedure can be used to enter the SCS Monitoring state: the sorption cooler cannot be run but all its sensor lines can be monitored.

SC System HealthMonitoring in READY Mode

Step #	Description	Comments
1	Execute SCS BOOT Procedure	
	Transfer ASW if not automatically executed	
2	Execute SCS INIT Procedure	
3	*Execute LUT upload, if needed*	
4	Execute SCS READY Procedure	
5	Execute SCS Shutdown Procedure	

A2.3 SCS Healthcheck

This Level 1 Procedure can be used to perform SCS Health Check: the completion of the process without errors ensures that all SCS subsystems are nominally functioning.

SC System HealthCheck

Step #	Description	Comments
1	Execute SCS BOOT Procedure	
	Transfer ASW if not automatically executed	
2	Execute SCS INIT Procedure	
3	*Execute LUT upload, if needed*	
4	Execute SCS READY Procedure	
5	Execute SCS HealthCheck Procedure	
6	Execute SCS Shutdown Procedure	

A2.4 SCS Shutdown

Execute SCS Switch OFF procedure (see A1.7 SCS SHUTDOWN)

A.3 ASW TM Parameters and Limits

Parameter	Short description	Long description	Unit	H/S	Minimum			Maximum		
					Regen	Ambient	Cold	Regen	Ambient	Cold
SM004540	H11 value	Bed 1 Variable Heater Voltage	V		N/A					
SM005540	H12 value	Bed 2 Variable Heater Voltage	V							
SM006540	H13 value	Bed 3 Variable Heater Voltage	V							
SM007540	H14 value	Bed 4 Variable Heater Voltage	V							
SM008540	H15 value	Bed 5 Variable Heater Voltage	V							
SM009540	H16 value	Bed 6 Variable Heater Voltage	V							
SM010540	H7 value	LPSB Heater Voltage	V							
SM011540	H31 value	Nominal LR3 Heater Voltage	V							
SM012540	H32 value	Redundant LR3 Heater Voltage	V							
SD028540	T1 OR T2 VALUE	LR1 Temperature	K	S	16	N/A	16****	25	N/A	25****
SD029540	T3 OR T4 VALUE	LR2 Temperature	K	S						
SD030540	T5 OR T6 VALUE	LR3 Temperature	K	S						
SD031540	T7 OR T30 VALUE	JT Temperature	K	S						
SM022540	T8 value	HX4 Out Temperature (PC3C)	K	S	40			325		
SM023540	T9 value	PC3 Out Temperature	K	S						
SM024540	T10 value	PC3 In Temperature	K	S						
SM025540	T11 value	PC2 Temperature	K	S	80					
SM026540	T12 value	PC1 Temperature	K	S	120					
SM027540	T13 value	HPSB right Temperature	K		N/A					
SM028540	T14 value	HPSB Left Temperature	K							
SM029540	T15 value	Bed 1 External Temperature	K	S	255	N/A	255	285	N/A	285
SM029540	T15 value	Bed 1 External Temperature	K	H	250		250	300		300
SM030540	T16 value	Bed 2 External Temperature	K	S	255		255	285		285
SM030540	T16 value	Bed 2 External Temperature	K	H	250		250	300		300
SM031540	T17 value	LPSB Left Temperature	K	S	240***			350	306	350
SM031540	T17 value	LPSB Left Temperature	K	H				370	307	370
SM032540	T18 value	LPSB Middle Temperature	K	S				350	306	350
SM032540	T18 value	LPSB Middle Temperature	K	H				370	307	370
SM034540	T20 value	Bed 1 Delta T (Internal/External)	K	S	-3			410	18	230
SM034540	T20 value	Bed 1 Delta T (Internal/External)	K	H	-6			430	20	255
SM035540	T21 value	Bed 2 Delta T (Internal/External)	K	S	-3			410	18	230
SM035540	T21 value	Bed 2 Delta T (Internal/External)	K	H	-6			430	20	255
SM036540	T22 value	Bed 3 Delta T (Internal/External)	K	S	-3			410	18	230
SM036540	T22 value	Bed 3 Delta T (Internal/External)	K	H	-6			430	20	255
SM037540	T23 value	Bed 4 Delta T (Internal/External)	K	S	-3			410	18	230
SM037540	T23 value	Bed 4 Delta T (Internal/External)	K	H	-6			430	20	255
SM038540	T24 value	Bed 5 Delta T (Internal/External)	K	S	-3			410	18	230
SM038540	T24 value	Bed 5 Delta T (Internal/External)	K	H	-6			430	20	255
SM039540	T25 value	Bed 6 Delta T (Internal/External)	K	S	-3			410	18	230
SM039540	T25 value	Bed 6 Delta T (Internal/External)	K	H	-6			430	20	255
SM040540	T26 value	Bed 3 External Temperature	K	S	255	N/A	255	320	N/A	320
SM040540	T26 value	Bed 3 External Temperature	K	H	250		250	330		330
SM041540	T27 value	Bed 4 External Temperature	K	S	255		255	320		320
SM041540	T27 value	Bed 4 External Temperature	K	H	250		250	330		330
SM042540	T28 value	Bed 5 External Temperature	K	S	255		255	320		320
SM042540	T28 value	Bed 5 External Temperature	K	H	250		250	330		330
SM043540	T29 value	Bed 6 External Temperature	K	S	255		255	320		320
SM043540	T29 value	Bed 6 External Temperature	K	H	250		250	330		330

SM044540	P1 value	Bed 1 Pressure	bar	S		53.8	1.93	53.8
SM044540	P1 value	Bed 1 Pressure	bar	H		55.2*	2.07	55.2*
SM045540	P2 value	Bed 2 Pressure	bar	S		53.8	1.93	53.8
SM045540	P2 value	Bed 2 Pressure	bar	H		55.2*	2.07	55.2*
SM046540	P3 value	Bed 3 Pressure	bar	S		53.8	1.93	53.8
SM046540	P3 value	Bed 3 Pressure	bar	H		55.2*	2.07	55.2*
SM047540	P4 value	Bed 4 Pressure	bar	S		53.8	1.93	53.8
SM047540	P4 value	Bed 4 Pressure	bar	H	0***	55.2*	2.07	55.2*
SM048540	P5 value	Bed 5 Pressure	bar	S		53.8	1.93	53.8
SM048540	P5 value	Bed 5 Pressure	bar	H		55.2*	2.07	55.2*
SM049540	P6 value	Bed 6 Pressure	bar	S		53.8	1.93	53.8
SM049540	P6 value	Bed 6 Pressure	bar	H		55.2*	2.07	55.2*
SM050540	P7 value	HPSB pressure	bar	S		53.8	1.93	53.8
SM050540	P7 value	HPSB pressure	bar	H		55.2*	2.07	55.2*
SM051540	P8 value	LPSB Pressure	bar	S		1.6**		
SM052540	voltage 28v	primary 28V/20A Voltage	V	H	23	31		
SM052540	voltage 28v	primary 28V/20A Voltage	V	S	25	29		
SM053540	voltage 12v	Secondary 12V Voltage	V	H	10	14		
SM053540	voltage 12v	Secondary 12V Voltage	V	S	11	13		
SM054540	voltage 5v	Secondary 5V Voltage	V	H	4	6		
SM054540	voltage 5v	Secondary 5V Voltage	V	S	4.5	5.5		
SM055540	voltage 15v	Secondary 15V Voltage	V	H	13	17		
SM055540	voltage 15v	Secondary 15V Voltage	V	S	14	16		
SM056540	Voltage - 15v	Secondary -15V Voltage	V	H	-17	-13		
SM056540	Voltage - 15v	Secondary -15V Voltage	V	S	-16	-14		
SM101540	voltage 31v	Secondary 31V Voltage	V	H	27	35		
SM101540	voltage 31v	Secondary 31V Voltage	V	S	29	33		
SM058540	intensity H7	LPSB Heater Current	mA		N/A			
SM059540	intensity H21	Bed 1 gas gap Current	A	H		0.9		
SM059540	intensity H21	Bed 1 gas gap Current	A	S		0.8		
SM060540	intensity H22	Bed 2 gas gap Current	A	H		0.9		
SM060540	intensity H22	Bed 2 gas gap Current	A	S		0.8		
SM061540	intensity H23	Bed 3 gas gap Current	A	H		0.9		
SM061540	intensity H23	Bed 3 gas gap Current	A	S		0.8		
SM062540	intensity H24	Bed 4 gas gap Current	A	H		0.9		
SM062540	intensity H24	Bed 4 gas gap Current	A	S	0***	0.8		
SM063540	intensity H25	Bed 5 gas gap Current	A	H		0.9		
SM063540	intensity H25	Bed 5 gas gap Current	A	S		0.8		
SM064540	intensity H26	Bed 6 gas gap Current	A	H		0.9		
SM064540	intensity H26	Bed 6 gas gap Current	A	S		0.8		
SM065540	intensity H31	Nominal LR3 heater Current	mA	H		100		
SM065540	intensity H31	Nominal LR3 heater Current	mA	S		70		
SM066540	intensity H32	Redondant LR3 heater Current	mA	H		100		
SM066540	intensity H32	Redondant LR3 heater Current	mA	S		70		
SM071540	T cold face	SCE temperature	K	H	253	323		
SM071540	T cold face	SCE temperature	K	S	263	313		
SM072540	T warmest face	SCE temperature	K	H	253	333		
SM072540	T warmest face	SCE temperature	K	S	263	323		
SM073540	T warm face	SCE temperature	K	H	253	353		
SM073540	T warm face	SCE temperature	K	S	263	343		

* *55.2 bar = 800 psi. Switch-off of 20A line is requested at this limit (53.8 bar = 780 psi)*

** *= 1200 torr*

*** *These low limits are set for those parameters that don't have physical low limit. This is not acceptable as if no low limit is set in OCP/OCF entries, then SCOS EGSE set it to 0, that might not be in the corresponding calibration curve. So values are defined as:*

- *0 for pressure sensors, even if it is out of limit*
- *for parameter whose numerical calibration curves depend on used model a specific range is defined (Planck SCE MIB User Guide)*
- *the minimum value of the calibration curve, when it is a numerical one*
- *0 if the calibration curve is a polynomial one*

**** Except in RUN Conditioning Mode, in which no monitoring limit is applied

For GGA Intensities other limits have been implemented using synthetic parameters:
Soft Limits [0;0.1] and [0.5;0.8]
Hard Limits [0;0.2] and [0.4;0.9]

A.4 PFM2 Test LookUpTable

Most of LookUpTable (LUT) parameters must be set with reference to SCS thermal boundary conditions. Main operational parameters will be checked and changed in real time before or during the test campaign. For this reason, the following tables have been built on the basis of present predictions of testing conditions and should be considered as preliminary.

All LUT parameters can be subject to changes due to environmental test conditions.

Orange shaded values are LIKELY to be changed.

A4.1 LUT Software

SOFTWARE

Pos	Parameter Name	Description		Engineering Values				Units	Comments
				SCS-R	SCS-N				
			bit		Hot	Cold	Cooldown		
0x00	SW_AUTO_FUNCTIONS Autonomous functions that can be enabled or disabled	Boot Mode ASW Transfer EEPROM→RAM	0	0	0	0	0	N/A	
		Boot Auto Hardware Tests	1	1	1	1	1	N/A	
		ASW Auto Hardware Tests	2	1	1	1	1	N/A	
		Run Diagnostic Sorption Cooler	3	1	1	1	1	N/A	
		Run Diagnostic Electronics	4	1	1	1	1	N/A	
		Run Diagnostic Bad Heaters	5	0	1	1	1	N/A	TBC
		Run Diagnostic Bad ADC	6	1	1	1	1	N/A	
		Run Diagnostic Bad Sensors	7	1	1	1	1	N/A	
		Auto GoTo Startup	8	1	1	1	1	N/A	
		Auto GoTo Defrost	9	0	1	1	1	N/A	
		Auto GoTo Off-Normal	10	1	1	1	1	N/A	
		TSA PID Regulation Enable	11	0	1	1	1	N/A	TBC if enabled in Ambient HC
		OPEN LOOP Enable	12	0	0	0	0	N/A	TBC whether it will be used
0x01	SW_ASW_ADR	Base address of the applicative software to use		8005000	8005000	8005000	8005000	Hexadecimal	
0x02	SW_CHECKSUM_1_ADR	Base address of the eeprom 1 checksums		8003000	8003000	8003000	8003000	Hexadecimal	
0x03	SW_CHECKSUM_N_ADR	Base address of the eeprom n checksums		8007000	8007000	8007000	8007000	Hexadecimal	
0x04	SW_TEST_EXT_TIMER_LENGTH	Test external timers duration		1	1	1	1	s	
0x05	SW_TEST_FPGA_TIMER_LENGTH	Test fpga timer duration		62.5	62.5	62.5	62.5	ns	
0x06	SENSORS_MEAN_T	Number of read to average sensor T1		30	30	30	30	Decimal	
0x07	SENSORS_MEAN_T+1	Number of read to average sensor T2		30	30	30	30	Decimal	
0x08	SENSORS_MEAN_T+2	Number of read to average sensor T3		30	30	30	30	Decimal	
0x09	SENSORS_MEAN_T+3	Number of read to average sensor T4		30	30	30	30	Decimal	
0x0A	SENSORS_MEAN_T+4	Number of read to average sensor T5		30	30	30	30	Decimal	
0x0B	SENSORS_MEAN_T+5	Number of read to average sensor T6		30	30	30	30	Decimal	
0x0C	SENSORS_MEAN_T+6	Number of read to average sensor T7		30	30	30	30	Decimal	
0x0D	SENSORS_MEAN_T+7	Number of read to average sensor T8		30	30	30	30	Decimal	
0x0E	SENSORS_MEAN_T+8	Number of read to average sensor T9		30	30	30	30	Decimal	
0x0F	SENSORS_MEAN_T+9	Number of read to average sensor T10		30	30	30	30	Decimal	
0x10	SENSORS_MEAN_T+10	Number of read to average sensor T11		30	30	30	30	Decimal	
0x11	SENSORS_MEAN_T+11	Number of read to average sensor T12		30	30	30	30	Decimal	
0x12	SENSORS_MEAN_T+12	Number of read to average sensor T13		30	30	30	30	Decimal	
0x13	SENSORS_MEAN_T+13	Number of read to average sensor T14		30	30	30	30	Decimal	
0x14	SENSORS_MEAN_T+14	Number of read to average sensor T15		30	30	30	30	Decimal	
0x15	SENSORS_MEAN_T+15	Number of read to average sensor T16		30	30	30	30	Decimal	
0x16	SENSORS_MEAN_T+16	Number of read to average sensor T17		30	30	30	30	Decimal	
0x17	SENSORS_MEAN_T+17	Number of read to average sensor T18		30	30	30	30	Decimal	
0x18	SENSORS_MEAN_T+18	Number of read to average sensor T20		30	30	30	30	Decimal	
0x19	SENSORS_MEAN_T+19	Number of read to average sensor T21		30	30	30	30	Decimal	
0x1A	SENSORS_MEAN_T+20	Number of read to average sensor T22		30	30	30	30	Decimal	
0x1B	SENSORS_MEAN_T+21	Number of read to average sensor T23		30	30	30	30	Decimal	
0x1C	SENSORS_MEAN_T+22	Number of read to average sensor T24		30	30	30	30	Decimal	
0x1D	SENSORS_MEAN_T+23	Number of read to average sensor T25		30	30	30	30	Decimal	
0x1E	SENSORS_MEAN_T+24	Number of read to average sensor T26		30	30	30	30	Decimal	
0x1F	SENSORS_MEAN_T+25	Number of read to average sensor T27		30	30	30	30	Decimal	
0x20	SENSORS_MEAN_T+26	Number of read to average sensor T28		30	30	30	30	Decimal	
0x21	SENSORS_MEAN_T+27	Number of read to average sensor T29		30	30	30	30	Decimal	
0x22	SENSORS_MEAN_T+28	Number of read to average sensor T30		30	30	30	30	Decimal	
0x23	SENSORS_MEAN_P	Number of read to average sensor P1		30	30	30	30	Decimal	
0x24	SENSORS_MEAN_P+1	Number of read to average sensor P2		30	30	30	30	Decimal	
0x25	SENSORS_MEAN_P+2	Number of read to average sensor P3		30	30	30	30	Decimal	
0x26	SENSORS_MEAN_P+3	Number of read to average sensor P4		30	30	30	30	Decimal	
0x27	SENSORS_MEAN_P+4	Number of read to average sensor P5		30	30	30	30	Decimal	
0x28	SENSORS_MEAN_P+5	Number of read to average sensor P6		30	30	30	30	Decimal	
0x29	SENSORS_MEAN_P+6	Number of read to average sensor P7		30	30	30	30	Decimal	
0x2A	SENSORS_MEAN_P+7	Number of read to average sensor P8		30	30	30	30	Decimal	
0x2B	SENSORS_MEAN_TEST	Number of read to average sensor VGAIN		30	30	30	30	Decimal	
0x2C	SENSORS_MEAN_TEST+1	Number of read to average sensor VOFF		30	30	30	30	Decimal	
0x2D	SENSORS_MEAN_TEST+2	Number of read to average sensor CAL1		30	30	30	30	Decimal	
0x2E	SENSORS_MEAN_TEST+3	Number of read to average sensor CAL2		30	30	30	30	Decimal	
0x2F	SENSORS_TRESEHOLD	Used for software averaged sensors : the first 'tresehold' values will not be taken into account		5	5	5	5	Decimal	

All LUT parameters can be changed due to variable test conditions.
Values shaded in orange are LIKELY to be changed.

A4.2 LUT Powers & Times

POWER AND TIMES

Pos	Parameter Name	Description	Engineering Values			Units	Comments
			Hot	Cold	Cooldown		
0x30	POWER_HEATUP_BEDS	Bed 0 Heatup power for normal operation	240	134	0	W	
0x31	POWER_HEATUP_BEDS+1	Bed 1 Heatup power for normal operation	240	134	0	W	
0x32	POWER_HEATUP_BEDS+2	Bed 2 Heatup power for normal operation	240	134	0	W	
0x33	POWER_HEATUP_BEDS+3	Bed 3 Heatup power for normal operation	240	134	0	W	
0x34	POWER_HEATUP_BEDS+4	Bed 4 Heatup power for normal operation	240	134	0	W	
0x35	POWER_HEATUP_BEDS+5	Bed 5 Heatup power for normal operation	240	134	0	W	
0x36	POWER_DESORB_BED	Bed 0 Desorb power for normal operation	192	130	0	W	
0x37	POWER_DESORB_BED+1	Bed 1 Desorb power for normal operation	192	130	0	W	
0x38	POWER_DESORB_BED+2	Bed 2 Desorb power for normal operation	192	130	0	W	
0x39	POWER_DESORB_BED+3	Bed 3 Desorb power for normal operation	192	130	0	W	
0x3A	POWER_DESORB_BED+4	Bed 4 Desorb power for normal operation	192	130	0	W	
0x3B	POWER_DESORB_BED+5	Bed 5 Desorb power for normal operation	192	130	0	W	
0x3C	POWER_HEATUP_BEDS_STARTUP	Bed 0 Heatup power for startup operation	240	134	0	W	
0x3D	POWER_HEATUP_BEDS_STARTUP+1	Bed 1 Heatup power for startup operation	240	134	0	W	
0x3E	POWER_HEATUP_BEDS_STARTUP+2	Bed 2 Heatup power for startup operation	240	134	0	W	
0x3F	POWER_HEATUP_BEDS_STARTUP+3	Bed 3 Heatup power for startup operation	240	134	0	W	
0x40	POWER_HEATUP_BEDS_STARTUP+4	Bed 4 Heatup power for startup operation	240	134	0	W	
0x41	POWER_HEATUP_BEDS_STARTUP+5	Bed 5 Heatup power for startup operation	240	134	0	W	
0x42	POWER_DESORB_BEDS_STARTUP	Bed 0 Desorb power for startup operation	192	130	0	W	
0x43	POWER_DESORB_BEDS_STARTUP+1	Bed 1 Desorb power for startup operation	192	130	0	W	
0x44	POWER_DESORB_BEDS_STARTUP+2	Bed 2 Desorb power for startup operation	192	130	0	W	
0x45	POWER_DESORB_BEDS_STARTUP+3	Bed 3 Desorb power for startup operation	192	130	0	W	
0x46	POWER_DESORB_BEDS_STARTUP+4	Bed 4 Desorb power for startup operation	192	130	0	W	
0x47	POWER_DESORB_BEDS_STARTUP+5	Bed 5 Desorb power for startup operation	192	130	0	W	
0x48	POWER_LPSB	Low Pressure Stabilization Bed Power	1.35	1.35	0	W	
0x49	TIME_CYCLE_NORMAL	Cycle Time in Normal Mode	482	940	667	s	
0x4A	TIME_GASGAP_ON_BEDS	Time delay for GGA switch ON	0	0	0	s	
0x4B	TIME_GASGAP_ON_BEDS+1	Time delay for GGA switch ON	0	0	0	s	
0x4C	TIME_GASGAP_ON_BEDS+2	Time delay for GGA switch ON	0	0	0	s	
0x4D	TIME_GASGAP_ON_BEDS+3	Time delay for GGA switch ON	0	0	0	s	
0x4E	TIME_GASGAP_ON_BEDS+4	Time delay for GGA switch ON	0	0	0	s	
0x4F	TIME_GASGAP_ON_BEDS+5	Time delay for GGA switch ON	0	0	0	s	
0x50	TIME_GASGAP_OFF_BEDS	Anticipated GGA switch OFF Time	60	60	60	s	
0x51	TIME_GASGAP_OFF_BEDS+1	Anticipated GGA switch OFF Time	60	60	60	s	
0x52	TIME_GASGAP_OFF_BEDS+2	Anticipated GGA switch OFF Time	60	60	60	s	
0x53	TIME_GASGAP_OFF_BEDS+3	Anticipated GGA switch OFF Time	60	60	60	s	
0x54	TIME_GASGAP_OFF_BEDS+4	Anticipated GGA switch OFF Time	60	60	60	s	
0x55	TIME_GASGAP_OFF_BEDS+5	Anticipated GGA switch OFF Time	60	60	60	s	

All LUT parameters can be changed due to variable test conditions.
Values shaded in orange are LIKELY to be changed.

A4.3 LUT HealthCheck & Regeneration

HEALTHCHECK REGENERATION

Pos	Parameter Name	Description	Engineering Values				Units	Comments
			Ambient HC		Cold HC			
			SCS-R	SCS-N	SCS-R	SCS-N		
0x56	HEALTHCHECK_DELTA_P_LP	Delta pressure low pressure	0.001	0.001	0.001	0.001	bar	These values are for the short HC. SCS-R Cold HC values are for an angle > 15 degrees
0x57	HEALTHCHECK_TIME_LIMIT	Health check time out	120	120	10	120	s	"
0x58	HEALTHCHECK_TLPSB	LPSB temperature limit	*	*	*	*	K	"
0x59	HEALTHCHECK_MAX_POWER	Maximum Power	130	130	10	130	W	"
0x5A	HEALTHCHECK_MIN_POWER	Minimum Power	5	5	5	5	W	"
0x5B	HEALTHCHECK_TBED_LIMIT	Bed temperature limit	305	305	2K above initial **	305	K	"
0x5C	HEALTHCHECK_PBED_LIMIT	Bed pressure limit	1.38	1.38	0.2 bar above initial ***	1.38	bar	"
0x5D	HEALTHCHECK_DELTAT_COLD	Delta temperature cold	0	0	0.5	0.5	K	"
0x5E	HEALTHCHECK_TIME_LIMIT_COLD	Cold End Heaters Time-out	0	0	2	2	s	"
0x5F	REGENERATION_POWER	CE heater power to run the regeneration procedure	15	15	150	150	W	
0x60	REGENERATION_TEMPERATURE	Temperature to be maintained for the regeneration process	300	300	350	350	K	
0x61	REGENERATION_MAX_PRESSURE	Maximum pressure in the HPST not to be exceeded	0.5	0.5	5	5	bar	
0x62	REGENERATION_TIME	Time needed to maintain the CE at REGEN_TEMPERATURE to complete the regeneration process	5	5	180	180	s	
0x63	REGENERATION_MAX_TIME	Maximum time allowed during a regeneration process	7	7	72000	72000	s	
0x64	REGENERATION_GGON_TEMPERATURE	maximum CE temperature that allows the GGA to be turned ON	298	298	320	320	K	
0x65	REGENERATION_DELTAT	set bang-bang level	10	10	2	2	K	

* LPSB T limit must be set to T17 reading before HC plus 0.5K
** This value has to be set on the basis of the average of bed temperatures (T20 to T25) reading
*** This value has to be set on the basis of the average of bed pressures (P1 to P6) reading

SCS-R Healthcheck will be performed only in Cryo conditions NOT at Ambient

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A4.4 LUT RUN Mode Transitions

RUN MODE TRANSITION							
Pos	Parameter Name	Description	Engineering Values			Units	Comments
			Hot	Cold	Cooldown		
0x66	STARTUP_TIME_ADJUST_MDP	Conditioning Maximum Desorption Pressure	52	34.5	52	bar	
0x67	STARTUP_TIME_ADJUST_MDT	Maximum Desorbing temperature	470	460	470	K	
0x68	STARTUP_TIME_ADJUST_MHT	Maximum Heatup Temperature	430	420	430	K	
0x69	STARTUP_TIME_ADJUST_MCTFIRST	Maximum cycle time (first cycle)	390	390	180	s	
0x6A	STARTUP_TIME_ADJUST_MCTNEXT	Maximum cycle time (next cycles)	1000	1200	180	s	
0x6B	STARTUP_ENTER_DEFROST_MTP	Maximum Tank Pressure	52	37.2	52	bar	
0x6C	STARTUP_ENTER_DEFROST_MJT_T7	Maximum JT Temperature (using T7)	100	100	100	K	
0x6D	STARTUP_ENTER_DEFROST_MJT_T30	Maximum JT Temperature (using T30)	100	100	100	K	
0x6E	STARTUP_ENTER_DEFROST_FLOW	Condition to enter in defrost : Flow Expected	65535	65535	65535	Decimal	
0x6F	STARTUP_EXIT_DEFROST_TIME	Defrost Time out (maximum defrost duration)	1000	1000	1000	s	
0x70	STARTUP_EXIT_DEFROST_MJT_T7	Exit Defrost Condition (using T7)	80	80	80	K	
0x71	STARTUP_EXIT_DEFROST_MJT_T30	Exit Defrost Condition (using T30)	80	80	80	K	
0x72	STARTUP_ENTER_NORMAL_MCONJT_T7	Maximum startup JT Temperature (using T7)	22	22	22	K	
0x73	STARTUP_ENTER_NORMAL_MCONJT_T30	Maximum startup JT Temperature (using T30)	22	22	22	K	
0x74	STARTUP_ENTER_NORMAL_MINCONJT	Minimum Tank Pressure In Startup operation	44.1	28.3	44.1	bar	
0x75	STARTUP_ENTER_NORMAL_MAXCONJT	Maximum Tank Pressure In Startup operation	52	36.5	52	bar	
0x76	NORMAL_ENTER_STARTUP_MINNTP	Minimum Tank Pressure in Normal operation	46.2	26.5	46.2	bar	
0x77	NORMAL_ENTER_STARTUP_MAXNTP	Maximum Tank Pressure in Normal operation	52	37.2	52	bar	
0x78	NORMAL_ENTER_STARTUP_MNCET	Maximum Normal compressor element temperature	480	480	480	K	
0x79	NORMAL_ENTER_STARTUP_MNJT_T7	Maximum normal JT Temperature (using T7)	23	23	23	K	
0x7A	NORMAL_ENTER_STARTUP_MNJT_T30	Maximum normal JT Temperature (using T30)	23	23	23	K	
0x7B	STARTUP_LPSB_HIGH_TEMPERATURE_LIMIT	LPSB 'bang bang' procedure higher limit	305	286	275	K	
0x7C	STARTUP_LPSB_LOW_TEMPERATURE_LIMIT	LPSB 'bang bang' procedure lower limit	304	285	276	K	
0x7D	STARTUP_HPST_PRESSURE_LIMIT	Startup HPST Pressure Limit	37.9	24.1	37.9	bar	
0x7E	NORMAL_H8_RATE_IF_H7_BAD	H8 on % when H7 is bad (see FMECA 6.2.4 ID#3)	5	5	5	Dec %	

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A4.5 LUT Faults

FAULTS							
Pos	Parameter Name	Description	Engineering Values			Units	Comments
			Hot	Cold	Cooldown		
0x7F	FAULT_COND_BED_TEMPERATURE_LIMIT	Fault condition bed temperature limit	525	525	525	K	
0x80	FAULT_COND_BED_PRESSURE_LIMIT	Fault condition bed pressure limit	54.1	54.1	54.1	bar	
0x81	FAULT_COND_LPSB_TEMPERATURE_LIMIT	Fault condition lpsb temperature limit	350	350	350	K	TBC by JPL for all 3 cases
0x82	FAULT_COND_PRT_TEMPERATURE_DEFAULT	Default temp. for all PRTs sensors in case of failure	270	270	270	K	
0x83	FAULT_COND_JT_TEMPERATURE_DEFAULT	Default temp. for JT sensors in case of failure	23	23	23	K	
0x84	BAD_BED_DETECT_COOL_TEMP_LIMIT	Bad Bed Detection : cooldown bed must be removed if its temperature is higher than this limit	330	330	330	K	
0x85	BAD_BED_DETECT_COOL_PRESSURE_LIMIT	Bad Bed Detection : cooldown bed must be removed if its pressure is higher than this limit	7.58	7.58	7.58	bar	
0x86	BAD_BED_DETECT_HEATUP_TEMP_LIMIT	Bad Bed Detection : heatup bed must be removed if its temperature is higher than this limit	330	290	330	K	
0x87	BAD_BED_DETECT_HEATUP_PRESSURE_LIMIT	Bad Bed Detection : heatup bed must be removed if its pressure is higher than this limit	7.58	2	7.58	bar	
0x88	BAD_BED_DETECT_CYCLE_PERIOD	Bad Bed Detection : Bad Bed Detection is enabled if cycle time is below this limit	390	390	390	s	
0x89	FAULT_ELECTRONIC_28V_DEFAULT	If 28 volts is wrong use this value to calculate the power	27.5	27.5	27.5	V	
0x8a	FAULT_ELECTRONIC_28V_UP_LIMIT	If 28 volts is greater than this value, 28 volts is wrong	32	32	32	V	
0x8b	FAULT_ELECTRONIC_28V_LOW_LIMIT	If 28 volts is lower than this value, 28 volts is wrong	25	25	25	V	
0x8c	FAULT_ELECTRONIC_12V_UP_LIMIT	If 12 volts is greater than this value, 12 volts is wrong	13	13	13	V	
0x8d	FAULT_ELECTRONIC_12V_LOW_LIMIT	If 12 volts is lower than this value, 12 volts is wrong	11	11	11	V	
0x8e	FAULT_ELECTRONIC_12V_TIME	See FMECA 6.3.2	120	120	120	s	
0x8f	FAULT_ELECTRONIC_TEMP_FIRST	See FMECA 6.3.1	333	333	333	K	
0x90	FAULT_ELECTRONIC_TEMP_SECOND	See FMECA 6.3.1	353	353	353	K	
0x91	FAULT_ELECTRONIC_ADC_REF	Digital output from reference sensor shall be compared to this value +- delta	60800	60800	60800	Decimal	
0x92	FAULT_ELECTRONIC_ADC_DELTA	Digital output from reference sensor shall be compared to reference value +- this parameter	250	250	250	Decimal	
0x93	FAULT_HEATERS_H2I_ON	Gas Gaps current must be up this limit when active	0.5	0.5	0.5	A	
0x94	FAULT_HEATERS_H2I_OFF	Gas Gap current must be lower than this limit when inactive	0.1	0.1	0.1	A	
0x95	FAULT_HEATERS_H7	I measured on H7 must be equal to I applied (from DAC value) ± this parameter	0.1	0.1	0.1	A	
0x96	FAULT_HEATERS_H31	I measured on H31/H32 must be equal to I applied (from DAC value) ± this parameter	0.01	0.01	0.01	A	
0x97	FAULT_HEATERS_H8	If T17 and T18 temperature are above this limit, H8 is always on (Failure from FDIR)	315	315	315	K	
0x98	FAULT_HEATERS_H34_H35_T_UP_T7	H33/H34 bad if JT temperature up this limit (using T7)	110	110	110	K	
0x99	FAULT_HEATERS_H34_H35_T_UP_T30	H33/H34 bad if JT temperature up this limit (using T30)	110	110	110	K	
0x9a	FAULT_HEATERS_H34_H35_DELTA_T	H33/H34 bad if this value is not reached within 'rise time'	25	25	25	K	
0x9b	FAULT_HEATERS_H34_H35_RISE_TIME	H33/H34 bad if 'delta T' is not reached within this time value	25	25	25	s	

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A4.6 LUT PID

PID							
Pos	Parameter Name	Description	Engineering Values			Units	Comments
			Hot	Cold	Cooldown		
0x9c	PID_SETPOINT_T5	Set Point of the L3 PID regulator (using T5)	19.7	18.05	19.7	K	
0x9d	PID_SETPOINT_T6	Set Point of the L3 PID regulator (using T6)	19.7	18.05	19.7	K	
0x9e	PID_P	P parameter of the L3 PID regulator	2	2	2	Decimal	
0x9f	PID_I	I parameter of the L3 PID regulator	0.1	0.1	0.1	Decimal	
0xa0	PID_D	D parameter of the L3 PID regulator	0	0	0	Decimal	
0xa1	PID_RATE	Sampling rate of the L3 PID regulator	1	1	1	Decimal	
0xa2	PID_UPPER_LIMIT	Upper Limit of the L3 PID regulator	22	22	22	K	
0xa3	PID_LOWER_LIMIT	Lower Limit of the L3 PID regulator	0	0	0	K	
0xa4	PID_TEMPERATURE_LIMIT_T5	Temperature Limit of the L3 PID regulator (using T5)	22	22	22	K	
0xa5	PID_TEMPERATURE_LIMIT_T6	Temperature Limit of the L3 PID regulator (using T6)	22	22	22	K	
0xa6	OPEN_LOOP_R1	R1 value from the open loop algorithm	1.63	1.63	1.63	K/W	
0xa7	OPEN_LOOP_N	Number of previous Q_LFI value to average from open loop	60	60	60	Decimal	

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A4.7 LUT Resistors

RESISTORS										
Pos	Parameter Name	Description	Engineering Values						Units	Comments
			SCS-R			SCS-N				
			Hot	Cold	Cooldown	Hot	Cold	Cooldown		
0xa8	HW_HEATERS_RB	Loss resistor 'rb' for bed 0 power calculation	5.00	5.00	5.00	5.01	5.01	5.01	Ω	
0xa9	HW_HEATERS_RB+1	Loss resistor 'rb' for bed 1 power calculation	5.00	5.00	5.00	4.99	4.99	4.99	Ω	
0xaa	HW_HEATERS_RB+2	Loss resistor 'rb' for bed 2 power calculation	5.10	5.10	5.10	4.98	4.98	4.98	Ω	
0xab	HW_HEATERS_RB+3	Loss resistor 'rb' for bed 3 power calculation	5.00	5.00	5.00	5.10	5.10	5.10	Ω	
0xac	HW_HEATERS_RB+4	Loss resistor 'rb' for bed 4 power calculation	5.00	5.00	5.00	4.94	4.94	4.94	Ω	
0xad	HW_HEATERS_RB+5	Loss resistor 'rb' for bed 5 power calculation	4.90	4.90	4.90	5.04	5.04	5.04	Ω	
0xae	HW_HEATERS_RBL	Loss resistor 'rbl' for bed 0 power calculation	5.10	5.10	5.10	5.11	5.11	5.11	Ω	
0xaf	HW_HEATERS_ RBL+1	Loss resistor 'rbl' for bed 1 power calculation	5.10	5.10	5.10	5.09	5.09	5.09	Ω	
0xb0	HW_HEATERS_RBL+2	Loss resistor 'rbl' for bed 2 power calculation	5.20	5.20	5.20	5.08	5.08	5.08	Ω	
0xb1	HW_HEATERS_RBL+3	Loss resistor 'rbl' for bed 3 power calculation	5.10	5.10	5.10	5.20	5.20	5.20	Ω	
0xb2	HW_HEATERS_RBL+4	Loss resistor 'rbl' for bed 4 power calculation	5.10	5.10	5.10	5.04	5.04	5.04	Ω	
0xb3	HW_HEATERS_RBL+5	Loss resistor 'rbl' for bed 5 power calculation	5.00	5.00	5.00	5.14	5.14	5.14	Ω	
0xb4	HW_HEATERS_RV	Loss resistor 'rv' for bed 0 power calculation	5.40	5.40	5.40	5.38	5.38	5.38	Ω	
0xb5	HW_HEATERS_RV+1	Loss resistor 'rv' for bed 1 power calculation	5.40	5.40	5.40	5.30	5.30	5.30	Ω	
0xb6	HW_HEATERS_RV+2	Loss resistor 'rv' for bed 2 power calculation	5.40	5.40	5.40	5.37	5.37	5.37	Ω	
0xb7	HW_HEATERS_RV+3	Loss resistor 'rv' for bed 3 power calculation	5.20	5.20	5.20	5.43	5.43	5.43	Ω	
0xb8	HW_HEATERS_RV+4	Loss resistor 'rv' for bed 4 power calculation	5.40	5.40	5.40	5.30	5.30	5.30	Ω	
0xb9	HW_HEATERS_RV+5	Loss resistor 'rv' for bed 5 power calculation	5.30	5.30	5.30	5.43	5.43	5.43	Ω	
0xba	HW_HEATERS_RVL	Loss resistor 'rvl' for bed 0 power calculation	5.50	5.50	5.50	5.48	5.48	5.48	Ω	
0xbb	HW_HEATERS_RVL+1	Loss resistor 'rvl' for bed 1 power calculation	5.50	5.50	5.50	5.40	5.40	5.40	Ω	
0xbc	HW_HEATERS_RVL+2	Loss resistor 'rvl' for bed 2 power calculation	5.50	5.50	5.50	5.47	5.47	5.47	Ω	
0xbd	HW_HEATERS_RVL+3	Loss resistor 'rvl' for bed 3 power calculation	5.30	5.30	5.30	5.53	5.53	5.53	Ω	
0xbe	HW_HEATERS_RVL+4	Loss resistor 'rvl' for bed 4 power calculation	5.50	5.50	5.50	5.40	5.40	5.40	Ω	
0xbf	HW_HEATERS_RVL+5	Loss resistor 'rvl' for bed 5 power calculation	5.40	5.40	5.40	5.53	5.53	5.53	Ω	
0xc0	HW_HEATERS_RH7	H7 resistor for LPSB power H7 calculation	32.60	32.60	32.60	32.60	32.60	32.60	Ω	
0xc1	HW_HEATERS_RH31	H31 resistor for LR3 (nominal) power calculation	488.00	488.00	488.00	488.00	488.00	488.00	Ω	
0xc2	HW_HEATERS_RH32	H32 resistor for LR3 (redundant) power calculation	488.00	488.00	488.00	488.00	488.00	488.00	Ω	

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A4.8 LUT Calibration 1

CALIBRATION 1								
Pos	Parameter Name	Description	Engineering Values SCS-R Ambient	SCS-R Cryo	SCS-N Ambient	SCS-N Cryo	Units	Comments
0xc3	HW_CAL_ADC_V31	Calibration ADC to volts for 31 volts	1310.7	1310.7	1310.7	1310.7	Decimal	
0xc4	HW_CAL_ADC_V28	Calibration ADC to volts for 28 volts	2184.5	2184.5	2184.5	2184.5	Decimal	
0xc5	HW_CAL_ADC_V12	Calibration ADC to volts for 12 volts	3276.75	3276.75	3276.75	3276.75	Decimal	
0xc6	HW_CAL_GAIN_H7	GAINh7 part of Ih7 = GAINh7 + OFFSETh7	0.9736	0.9736	0.9736	0.9736	Decimal	
0xc7	HW_CAL_OFFSET_H7	OFFSETh7 part of Ih7 = GAINh7 + OFFSETh7	0	0	0	0	Decimal	
0xc8	HW_CAL_GAIN_H31	GAINh31 part of Ih31 = GAINh31 + OFFSETh31	0.0812	0.0812	0.0812	0.0812	Decimal	
0xc9	HW_CAL_OFFSET_H31	OFFSETh31 part of Ih31 = GAINh31 + OFFSETh31	0	0	0	0	Decimal	
0xca	HW_CAL_GAIN_H32	GAINh32 part of Ih32 = GAINh32 + OFFSETh32	0.0812	0.0812	0.0812	0.0812	Decimal	
0xcb	HW_CAL_OFFSET_H32	OFFSETh32 part of Ih32 = GAINh32 + OFFSETh32	0	0	0	0	Decimal	
0xcc	HW_CAL_T3_R0	T3(ADC) → T3(K). Resistance = T3(ADC) * R0 / 65535 + R1	4399.58	4399.58	4400.51	4400.51	Decimal	
0xcd	HW_CAL_T3_R1	T3(ADC) → T3(K). Resistance = T3(ADC) * R0 / 65535 + R1	123.48	123.48	121.57	121.57	Decimal	
0xce	HW_CAL_T3_ZL	T3(ADC) → T3(K). Chebychev ZL coefficient	2.907696155	2.907696155	3.067725563	3.06772556	Decimal	
0xcf	HW_CAL_T3_ZU	T3(ADC) → T3(K). Chebychev ZU coefficient	4.03298032	4.03298032	4.358324119	4.35832412	Decimal	
0xd0	HW_CAL_T3_A0	T3(ADC) → T3(K). Chebychev A0 coefficient	11.962971	11.962971	11.918839	11.918839	Decimal	
0xd1	HW_CAL_T3_A1	T3(ADC) → T3(K). Chebychev A1 coefficient	-11.194584	-11.194584	-11.124553	-11.124553	Decimal	
0xd2	HW_CAL_T3_A2	T3(ADC) → T3(K). Chebychev A2 coefficient	3.515801	3.515801	3.48778	3.48778	Decimal	
0xd3	HW_CAL_T3_A3	T3(ADC) → T3(K). Chebychev A3 coefficient	-0.783545	-0.783545	-0.782669	-0.782669	Decimal	
0xd4	HW_CAL_T3_A4	T3(ADC) → T3(K). Chebychev A4 coefficient	0.113076	0.113076	0.119087	0.119087	Decimal	
0xd5	HW_CAL_T3_A5	T3(ADC) → T3(K). Chebychev A5 coefficient	-0.006186	-0.006186	-0.010445	-0.010445	Decimal	
0xd6	HW_CAL_T4_R0	T4(ADC) → T4(K). Resistance = T4(ADC) * R0 / 65535 + R1	4404.46	4404.46	4401.31	4401.31	Decimal	
0xd7	HW_CAL_T4_R1	T4(ADC) → T4(K). Resistance = T4(ADC) * R0 / 65535 + R1	123.69	123.69	121.69	121.69	Decimal	
0xd8	HW_CAL_T4_ZL	T4(ADC) → T4(K). Chebychev ZL coefficient	2.76194118	2.76194118	2.842756794	2.84275679	Decimal	
0xd9	HW_CAL_T4_ZU	T4(ADC) → T4(K). Chebychev ZU coefficient	3.938180357	3.938180357	3.93386007	3.93386007	Decimal	
0xda	HW_CAL_T4_A0	T4(ADC) → T4(K). Chebychev A0 coefficient	11.837288	11.837288	11.929172	11.929172	Decimal	
0xdb	HW_CAL_T4_A1	T4(ADC) → T4(K). Chebychev A1 coefficient	-11.036423	-11.036423	-11.28089	-11.28089	Decimal	
0xdc	HW_CAL_T4_A2	T4(ADC) → T4(K). Chebychev A2 coefficient	3.529423	3.529423	3.512276	3.512276	Decimal	
0xdd	HW_CAL_T4_A3	T4(ADC) → T4(K). Chebychev A3 coefficient	-0.86858	-0.86858	-0.758478	-0.758478	Decimal	
0xde	HW_CAL_T4_A4	T4(ADC) → T4(K). Chebychev A4 coefficient	0.169652	0.169652	0.102641	0.102641	Decimal	
0xdf	HW_CAL_T4_A5	T4(ADC) → T4(K). Chebychev A5 coefficient	-0.026502	-0.026502	-0.004946	-0.004946	Decimal	
0xe0	HW_CAL_T4_A6	T4(ADC) → T4(K). Chebychev A6 coefficient	0.003555	0.003555	0	0	Decimal	

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A4.9 LUT Calibration 2

Calibration 2								
Pos	Parameter Name	Description	Engineering Values				Units	Comments
			SCS-R		SCS-N			
			Ambient	Cryo	Ambient	Cryo		
0xe1	HW_CAL_T5_R0	T5(ADC) → T5(K). Resistance = T5(ADC) * R0 / 65535 + R1	1762.21	1762.21	1758.53	1758.53	Decimal	
0xe2	HW_CAL_T5_R1	T5(ADC) → T5(K). Resistance = T5(ADC) * R0 / 65535 + R1	665.64	665.64	665.49	665.49	Decimal	
0xe3	HW_CAL_T5_ZL	T5(ADC) → T5(K). Chebychev ZL coefficient	2.822024226	2.82202423	2.855945561	2.85594556	Decimal	
0xe4	HW_CAL_T5_ZU	T5(ADC) → T5(K). Chebychev ZU coefficient	3.759289252	3.75928925	3.963267678	3.96326768	Decimal	
0xe5	HW_CAL_T5_A0	T5(ADC) → T5(K). Chebychev A0 coefficient	11.86822	11.86822	11.918305	11.918305	Decimal	
0xe6	HW_CAL_T5_A1	T5(ADC) → T5(K). Chebychev A1 coefficient	-11.125414	-11.125414	-11.274393	-11.274393	Decimal	
0xe7	HW_CAL_T5_A2	T5(ADC) → T5(K). Chebychev A2 coefficient	3.568656	3.568656	3.521261	3.521261	Decimal	
0xe8	HW_CAL_T5_A3	T5(ADC) → T5(K). Chebychev A3 coefficient	-0.809943	-0.809943	-0.765057	-0.765057	Decimal	
0xe9	HW_CAL_T5_A4	T5(ADC) → T5(K). Chebychev A4 coefficient	0.107181	0.107181	0.1047	0.1047	Decimal	
0xea	HW_CAL_T5_A5	T5(ADC) → T5(K). Chebychev A5 coefficient	0.003469	0.003469	-0.004926	-0.004926	Decimal	
0xeb	HW_CAL_T5_A6	T5(ADC) → T5(K). Chebychev A6 coefficient	-0.004578	-0.004578	0	0	Decimal	
0xec	HW_CAL_T5_A7	T5(ADC) → T5(K). Chebychev A7 coefficient	0.000383	0.000383	0	0	Decimal	
0xed	HW_CAL_T6_R0	T6(ADC) → T6(K). Resistance = T6(ADC) * R0 / 65535 + R1	1762.57	1762.57	1758.6	1758.6	Decimal	
0xee	HW_CAL_T6_R1	T6(ADC) → T6(K). Resistance = T6(ADC) * R0 / 65535 + R1	665.84	665.84	665.34	665.34	Decimal	
0xef	HW_CAL_T6_ZL	T6(ADC) → T6(K). Chebychev ZL coefficient	2.995075652	2.99507565	3.093303734	3.09330373	Decimal	
0xf0	HW_CAL_T6_ZU	T6(ADC) → T6(K). Chebychev ZU coefficient	4.313704991	4.31370499	4.461153937	4.46115394	Decimal	
0xf1	HW_CAL_T6_A0	T6(ADC) → T6(K). Chebychev A0 coefficient	11.714016	11.714016	11.793828	11.793828	Decimal	
0xf2	HW_CAL_T6_A1	T6(ADC) → T6(K). Chebychev A1 coefficient	-11.039031	-11.039031	-11.093765	-11.093765	Decimal	
0xf3	HW_CAL_T6_A2	T6(ADC) → T6(K). Chebychev A2 coefficient	3.722686	3.722686	3.667011	3.667011	Decimal	
0xf4	HW_CAL_T6_A3	T6(ADC) → T6(K). Chebychev A3 coefficient	-0.938237	-0.938237	-0.916537	-0.916537	Decimal	
0xf5	HW_CAL_T6_A4	T6(ADC) → T6(K). Chebychev A4 coefficient	0.158954	0.158954	0.168287	0.168287	Decimal	
0xf6	HW_CAL_T6_A5	T6(ADC) → T6(K). Chebychev A5 coefficient	-0.007817	-0.007817	-0.019377	-0.019377	Decimal	
0xf7	HW_CAL_T6_A6	T6(ADC) → T6(K). Chebychev A6 coefficient	-0.00354	-0.00354	0	0	Decimal	
0xf8	HW_CAL_T7_R0	T7(ADC) → T7(K). Resistance = T7(ADC) * R0 / 65535 + R1	4397.49	4397.49	4402.4	4402.4	Decimal	
0xf9	HW_CAL_T7_R1	T7(ADC) → T7(K). Resistance = T7(ADC) * R0 / 65535 + R1	123.6	123.6	121.66	121.66	Decimal	
0xfa	HW_CAL_T7_A	T7(K) from T7(ADC). R=ADC * R0 / 65535 + R1. X = log R. T (Kelvin) = exp(A – B . x)	9.7955	9.7955	9.7955	9.7955	Decimal	
0xfb	HW_CAL_T7_B	T7(K) from T7(ADC). R=ADC * R0 / 65535 + BR1 X = log R. T (Kelvin) = exp(A – B . x)	0.9856	0.9856	0.9856	0.9856	Decimal	
0xfc	HW_CAL_T30_R0	T30(ADC) → T30(K). Resistance = T30(ADC) * R0 / 65535 + R1	4399.47	4399.47	4398.04	4398.04	Decimal	
0xfd	HW_CAL_T30_R1	T30(ADC) → T30(K). Resistance = T30(ADC) * R0 / 65535 + R1	123.58	123.58	121.64	121.64	Decimal	
0xfe	HW_CAL_T30_A	T30(K) from T3(ADC). R=ADC * R0 / 65535 + R1. X = log R. T (Kelvin) = exp(A – B . x)	9.7955	9.7955	9.0919	9.0919	Decimal	
0xff	HW_CAL_T30_B	T30(K) from T3(ADC). R=ADC * R0 / 65535 + R1. X = log R. T (Kelvin) = exp(A – B . x)	0.9856	0.9856	0.755	0.755	Decimal	
0x100	HW_CAL_TBED_UVA	UVA term for bed temperature calculation : uV = tThermocouple * UVA / 65535 - UVB	20	20	20	20	Decimal	
0x101	HW_CAL_TBED_UVB	UVB term for bed temperature calculation : uV = tThermocouple * UVA / 65535 - UVB	1.3954	1.3954	1.3954	1.3954	Decimal	
0x102	HW_CAL_TBED_TRA	TRA term for bed temp. calc. r = tReferenceK * TRA / 65535 - (tReferenceK -65535)* TRB / 65535	139	139	139	139	Decimal	
0x103	HW_CAL_TBED_TRB	TRB term for bed temp. calc. r = tReferenceK * TRA / 65535 - (tReferenceK -65535)* TRB / 65535	78.8	78.8	78.8	78.8	Decimal	
0x104	RATE_BED_POWER_ADJUST	Bed heaters power readjustment frequencey (number of sensors set between two power adjustment)	1	1	3	3	Decimal	

All LUT parameters can be changed due to variable test conditions.
Values shaded in orange are LIKELY to be changed.