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Planck LFI

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	12 October 09	All	First issue	1.0

TABLE OF CONTENTS

1 ACRONYMS

AIV	Assembly, Integration, Verification
ASW	Application Software
BEM	Back End Module
BEU	Back End Unit
CCS	Central Check-out System
CDMU	Central Data Management Unit
CPV	Calibration Performance Verification
CSL	Centre Spatiale de Liège
DAE	Data Acquisition Electronics
DPU	Digital Processing Unit
EGSE	Electrical ground Support Equipment
FEM	Front End Module
I-EGSE	Instrument EGSE
IST	Integrated Satellite Test
OBC	On Board Clock
RAA	Radiometer Array Assembly
REBA	Radiometric Electronic Box Assembly
S/C	Spacecraft
SCOE	Spacecraft Control and Operation System
SCS	Sorption Cooler System
SPU	Signal Processing Unit
SUSW	Start- Up Software
SVM	Service Module
TBC	To Be Checked
TBW	To Be Written
TC	Telecommand
TM	Telemetry
UFT	Unit Functional Test

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 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

[AD5] Data analysis and scientific performance of the LFI FM instrument, PL-LFI-PST-AN-006 3.0

[AD6] Planck-LFI TV-TB test report: executive summary, PL-LFI-PST-RP-040 1.1

2.2 Reference Documents

[RD1] Planck Instrument Testing at PFM S/C levels, H-P-3-ASP-TN-0676, Issue 1.0

[RD2] Planck LFI User Manual, PL-LFI-PST-MA-001 Issue 2.1

[RD3] Data analysis and of LFI switch on and cryogenic functionality test (Ph-5-01-c of TV/TB tests) PL-LFI-PST-RP-036

[RD4] Testing Plan of the LFI instrument during the Planck Commissioning and CPV phase
PL-LFI-PST-PL-013, Issue 4.3 (04-2009)

[RD4] Planck-LFI CPV: Drain currents verification before HYM Tuning.
PL-LFI-PST-RP-063, Issue 1.0

3 Introduction

As for the same test performed before the Hyper matrix tuning (REF XXX) , this test was devoted to characterise the i-V response of LNAs when Vg1 and Vg2 are independently changed over a defined set of values.

In particular , it is aimed at two main purposes:

a) compare the radiometers i-V response with data acquired before Hyper Matrix Tuning: this check allows to sort out any possible problems related with the functionality of the LNAs, after the many bias changes characterizing the HYM Tuning procedure.
b) Provide a detailed characterization of the radiometer response, with respect to bias changes, in the final operative conditions, that is when the optimal tuned bias are set. In fact, the accurate knowledge of the i-V curves could be useful in order to check, at any time of the Planck mission, possible changes in the radiometers response due to aging , bias fluctuation or to any other criticality.

3.1 Test description

The test procedure is exactly the same as in the previous run performed before the HYM Tuning: Vg1 and Vg2 bias are separately changed over each ACA. Bias are instead changed simultaneously on several radiometers, grouping in a wise to minimize electric cross talks.

Channels were grouped in six groups following the scheme:

Group 1: RCA 18 + RCA 21

Group 2: RCA 19 + RCA 22

Group 3: RCA 20 + RCA 23

Group 4: RCA 25 + RCA 24

Group 5: RCA 26 + RCA 27

Group 6: RCA 28

Once one the bias run over the first ACA is completed, we pass to the coupled ACA and hence to the coupled radiometer, until all the ACAs are tested.

The only difference is represented by the default bias condition for the channels not under test: in fact, the default bias table set for this test is the result of the HYM Tuning and of its further improvements . Because the optimal bias have been refined several times, also this test had to be repeated several times (17-07-2009, 25-07-2009, 28-07-2009)

Moreover , some refuses from the old procedure (in particular the command restoring the bias default at any bias run) affected the tests, complicating the possibility to accurately compare data with the previous test.

However, from the point of view of the test execution, it is relevant only the last test, performed on OD 76: in fact, this is the only one performed with the final bias configuration.

However, for completeness, also the test P_PVP_LFI_0002_02 performed on July 17th (OD 65) is here analysed and compared with the previous test P_PVP_LFI_0002_01.

3.2 Expected Output

For each radiometer drain current – voltage curves must be produced, changing firstly Vg1 and second Vg2 with sequence and bias points that are the same as in the test P_PVP_LFI_0002_01 performed before the HYM Tuning.

As a sub-product of this analysis, the Pre tuning method is applied to the bias points scanned, in order to get a rough estimation of the location of the optimal bias region and to compare with the previous analysis.

3.3 Analysis and HYM matrix production.

The analysis was done by running two dedicated IDL codes:

The first code, similar to that used to analyse the pre tuning and the tuning , looks for bias changes in the data and writes output files containing the following information :

```
#18   -    1
      Vg1  Vg2     Id       Vsky_Det1   Vref_det1  Vsky_Det2   Vref_det2
      192  197   19.8554    1.2469939   2.105961   1.0740993   1.689241
       70  197   5.824975  0.93549958   0.936158   0.82802024  0.82906473
        .    .      .           .           .          .           .
        .    .      .           .           .          .           .
```

That is the channel number, Vg1 and Vg2 bias (changed one per time keeping the other still until the full sequence is completed) , voltage output (sky and ref) from the two diodes coupled with that ACAs pair.

The second code has is here used as a viewer : it displays i-V curves and compare with those from the same P_PVP_LFI_0002_01 test.

Before doing that, an offset is removed in the drain current, taking into account the two different boundary bias frames of the two tests (CSL default CRYO bias and CPV optimal bias) : in fact, while the CSL test was run setting as default bias those coming from the LNAs tuning performed in the RAA test campaign (TAS-I , Milan, 2006), here the default bias configuration is represented by the optimal bias coming from the LNAs Tuning in CSL (2008).

As a sub-product the code provides also a guess of the noise temperature, calculating it by applying the pre tuning method, compared for the two data sets considered. It can happen that the two curves were sharply separated: this is due to our capability to estimate the 4k temperature during the cooldown and to the different environmental conditions of the two tests. However, what can be compared is the position of the bias expected to provide the best noise temperature.

A typical output from this code is displayed in the fig below.

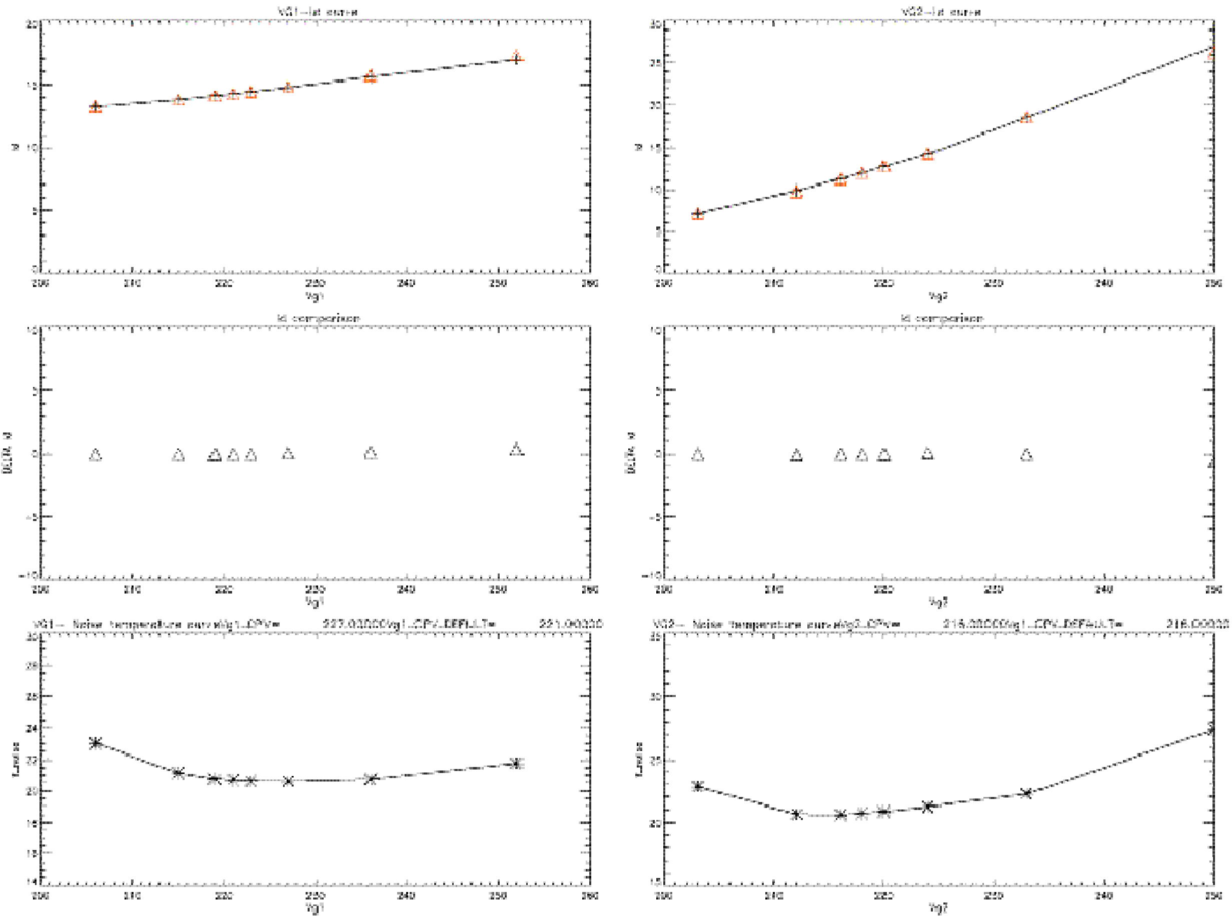

Figure 1 I-V curves comparison for Vg1 (left panel) and Vg2 (right panels) Solid lines are the results from CPV test while CSL results are flagged with red triangles. The difference is shown in the middle plots (very close to 0 mA) while the optimal Vg1Vg2 pairs are guessed in the bottom plots.

4 Test Execution

The full test took about three hours: it was performed three times on OD 65, 73, 76.
For the purpose of the test , the representative run is the last (OD 76) run in the time window 209.14.00.00 - 209.17.02.02.

DAE was biased with maximum offset removed (2.5 V) on all channels, in order to avoid possible saturations.

4.1 Test configuration

The test configuration is the following:

SCOS 2 K HPCCS Version 2.0.787
LFI Gateway Version V0R9P1
TQL 3.1.2
LIFE Machine version OM 3.00

LFI Personnel involved during the test is:

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Industry support	Paola Battaglia

4.2 Pass - fail criteria, verification matrix

CPV	**P_PVP_LFI_0002_02, P_PVP_LFI_0002_03, P_PVP_LFI_0002_04**
July, 17, 25, 28th 2009	**DoY 198, 206, 209 OD 65, 73, 76**
Duration	**3:02:14**
Test name:	**Drain current verification**
Test objectives:	Characterise the I-V response of LNAs when Vg1 and Vg2 are independently changed over a defined set of values. It allows to investigate possible drain chganges due to ground shift or any other possible non ideal response of LNAs. Channels are grouped in six groups.

Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	Yes				
TC procedure	Yes	No	The procedure has been repeated every time new biases have been applied	Yes	
No unexpected features	Yes				
Data saved and stored at DPC	Yes				

Figure 2 Verification matrix

4.3 Procedure/ Test sequence and environmental conditions

4.3.1 Test procedure

Step	Description	START REF.	DURATION	Time	RCA
7	Drain Current Verification (UM § 13.1.2.4)	0:00:00			
7.1	Set DAE Gain values (default 1, 0 h)	0:00:00	0:00:02		All
7.2	Set DAE offset values (max, 0h)	0:00:02	0:00:02		All
	RCA 18 and 21	0:00:04			18, 21
7.3	Vg1, Vg2 tuning for each ACA of RCA18, 21	0:00:04	0:29:56		18, 21
	RCA 19 and 22	0:30:00			19, 22
7.4	Vg1, Vg2 tuning for each ACA of RCA19, 22	0:30:00	0:30:00		19, 22
	RCA 20 and 23	1:00:00			20, 23
7.5	Vg1, Vg2 tuning for each ACA of RCA20, 23	1:00:00	0:30:00		20, 23
	RCA 25 and 24	1:30:00			24, 25
7.6	Vg1, Vg2 tuning for each ACA of RCA25, 24	1:30:00	0:30:00		24, 25
	RCA 26 and 27	2:00:00			26, 27
7.7	Vg1, Vg2 tuning for each ACA of RCA26, 27	2:00:00	0:30:00		26, 27
	RCA 28	2:30:00			28
7.8	Vg1, Vg2 tuning for each ACA of RCA28	2:30:00	0:30:00		28
		3:00:00			
7.1	Set DAE Gain values (default 1, 0 h)	3:00:00	0:00:02		All
7.11	Set DAE offset values (default 0, FFh)	3:00:02	0:00:02		All
7.11	end of the test	3:00:04			

Figure 3Test Procedure

4.3.2 Temperatures and test specifications

The sensors used to track the relevant temperatures and to perform the data analysis are:

4K temperature

HD028260 (SCOS name)

FH28, FH26, FH25 (LIFE name) to characterise the FPU temperature

All the constraints have been met:
Constraints:

SCS:	around 20 K, TSA tuned.
LFI mode :	nominal science production TYPE 1.
4K cooler state	Tref ~ 4K
Spacecraft state:	Nominal Mode of the Satellite
Pointing requirements:	Baseline

4.3.3 Pass fail criteria

The two following requirements have been met in both runs P_PVP_LFI_0002_02 and P_PVP_LFI_0002_04.

- *No unexpected event packets*
- *Every ACA is responding as expected from results obtained before the HYM tuning*

The last requirement :

- *Correct biases Applied and checked.*

was met only for the P_PVP_LFI_0002_04. In fact , the test P_PVP_LFI_0002_02 was wrongly performed changing the bias default on the channel under tuning at the end of each bias run, restoring the CSL CRYO bias default. Hence the test was run applying a mixed bias default changing at the end of each bias run.

4.3.4 Default bias

The default bias configuration used for the test is reported in Figure 4 and . Gain and Offset were set to 0 in order to prevent radiometers from DAE saturation.

The default table was changed twice. In fact, the first time the bias table coming from the HYM Tuning was set. A few days after, the bias optimal table was modified because of some changes aimed at minimizing 1/f effects on 44 GHz channels.

Hence the I-V verification was repeated using this last table

				vg1	vg2	vd	Id
CH27	00	M1	LP001320	242	97	156	7.98
CH27	01	M2	LP002320	255	96	157	7.57
CH27	02	S1	LP003320	235	86	157	8.26
CH27	03	S2	LP004320	248	113	156	8.04
CH24	04	M2	LP005320	227	204	183	7.24
CH24	05	M1	LP006320	219	204	183	7.36
CH24	06	S2	LP007320	225	208	152	7.8
CH24	07	S1	LP008320	218	207	157	8.3
CH21	08	S2	LP009320	205	243	132	22.18
CH21	09	S1	LP010320	170	221	136	19.24
CH21	0A	M1	LP011320	192	231	147	21.54
CH21	0B	M2	LP012320	191	224	136	23.87
CH22	0C	S2	LP013320	193	231	130	19.25
CH22	0D	S1	LP014320	210	221	128	21.41
CH22	0E	M1	LP015320	208	218	130	18.87
CH22	0F	M2	LP016320	188	188	135	18.53
CH23	10	S2	LP017320	198	213	127	17.74
CH23	11	S1	LP018320	180	222	123	21.7
CH23	12	M1	LP019320	211	206	120	17.04
CH23	13	M2	LP020320	190	228	119	17.25
CH25	14	M1	LP021320	231	203	177	6.29
CH25	15	M2	LP022320	218	200	178	6.29
CH25	16	S1	LP023320	231	196	167	6.07
CH25	17	S2	LP024320	223	199	166	5.96
CH28	18	M1	LP025320	243	101	150	8.99
CH28	19	M2	LP026320	240	112	163	9.77
CH28	1A	S1	LP027320	235	81	157	8.81
CH28	1B	S2	LP028320	249	90	158	9.36
CH20	1C	S2	LP029320	169	215	127	16.99
CH20	1D	S1	LP030320	179	230	132	17.62
CH20	1E	M1	LP031320	191	244	121	21.38
CH20	1F	M2	LP032320	209	231	127	21.3
CH19	20	S2	LP033320	207	222	125	17.97
CH19	21	S1	LP034320	202	226	120	18.19
CH19	22	M1	LP035320	205	221	124	20.19
CH19	23	M2	LP036320	196	216	126	19.63
CH18	24	S2	LP037320	216	182	114	18.53
CH18	25	S1	LP038320	155	215	138	16.2
CH18	26	M1	LP039320	195	189	126	13.21
CH18	27	M2	LP040320	198	201	125	14.51
CH26	28	M2	LP041320	226	200	170	8.22
CH26	29	M1	LP042320	247	203	169	7.86
CH26	2A	S2	LP043320	240	197	169	6.07
CH26	2B	S1	LP044320	227	194	172	6.29

Figure 4 default CRYO bias table applied for the test P_PVP_LFI_0002_02

	Vg1	Vg2	Vd	I1	I2	Id
27M1	240	108	156	148	220	8.12
27M2	244	90	157	145	205	7.22
27S1	237	102	157	127	184	8.44
27S2	246	114	156	148	195	7.99
24M2	225	225	185	205	206	15
24M1	225	225	191	205	205	16.53
24S2	225	225	159	205	205	16.46
24S1	225	225	158	205	205	15.58
21S2	205	243	132	255	255	22.04
21S1	170	221	136	255	255	19.11
21M1	198	207	141	255	255	18.49
21M2	196	197	136	255	255	19.43
22S2	206	204	130	255	255	15.1
22S1	204	189	128	255	255	16.35
22M1	203	194	125	255	255	14.07
22M2	178	176	130	255	255	14.88
23S2	190	208	122	255	255	14.79
23S1	181	211	118	255	255	20.57
23M1	207	192	120	255	255	14.71
23M2	210	195	119	255	255	14.2
25M1	225	225	185	205	205	14.37
25M2	225	225	187	205	205	14.87
25S1	225	225	169	205	205	14.81
25S2	225	225	167	205	205	14.67
28M1	243	101	157	130	160	9.63
28M2	240	112	156	127	228	9.19
28S1	240	84	157	127	222	9.11
28S2	245	121	158	103	165	10.49
20S2	188	201	127	255	255	18.62
20S1	199	221	132	255	255	18.82
20M1	209	219	121	255	255	20.63
20M2	215	221	127	255	255	20.63
19S2	204	216	125	255	255	17.02
19S1	215	209	120	255	255	17.9
19M1	213	206	124	255	255	18.19
19M2	211	208	126	255	255	19.92
18S2	216	182	114	255	255	18.45
18S1	155	215	138	255	255	15.92
18M1	195	189	126	255	255	13.11
18M2	198	201	125	255	255	14.43
26M2	225	225	178	205	205	14.72
26M1	225	225	176	205	205	12.85
26S1	225	225	176	205	205	13.4
26S1	225	225	178	205	205	13.72

Figure 5 default CRYO bias table applied for the test P_PVP_LFI_0002_04

4.4 Results and Conclusions

The procedure was successfully run without any problem. All the bias foreseen were effectively applied in the correct order.

Results have shown an impressive repeatability of the behaviour already measured during the previous test;
Moreover, despite of the very ambiguous bias setup, also results from P_PVP_LFI_0002_02 show a general agreement with P_PVP_LFI_0002_01.

The test output is:

- A complete check of the functionality of each stage (Vg1 or Vg2) of the LNAs.
- 88 i-V Curves (44 X Vg1 + 44 X Vg2)
- The comparison with the same curves in CSL
- The new drain currents matrixes to be used as input for the Pre – Tuning in the case some behaviour was different w.r.t. the CSL results (used to draw the Pre – Tuning matrixes)
- A guess of the optimal bias region for each radiometer. Moreover, from this first order Noise analysis, Vg1 Vg2 pairs possibly providing optimal noise were individuated.
-

From a qualitative point of view, the test showed that :

- Each LNA stage responds as expected to the Vg bias changes.
- I-V curves are very similar to the corresponding curves measured in the previous test P_PVP_LFI_0002_01

run	P_PVP_LFI_0002_01		P_PVP_LFI_0002_02		P_PVP_LFI_0002_04	
CH	Vg1	Vg2	Vg1	Vg2	Vg1	Vg2
180	210	205	210	205	210	205
181	181	197	181	140	181	140
182	187	189	187	189	187	189
183	198	206	140	206	140	206
190	204	216	219	201	219	201
191	217	209	217	209	217	209
192	213	140	213	196	213	196
193	201	140	211	140	211	140
200	178	201	178	191	178	191
201	199	221	224	140	224	140
202	209	219	224	209	224	209
203	205	221	140	140	140	140
210	196	203	206	248	206	248
211	211	222	181	140	181	140
212	198	207	198	207	198	207
213	196	197	211	187	211	187
220	196	204	196	199	196	199
221	203	199	218	199	218	199
222	203	189	193	219	193	219
223	183	186	173	176	173	176
230	195	223	185	208	185	208
231	181	201	196	181	196	181
232	197	187	222	182	222	182
233	140	160	140	160	140	160
240	227	213	240	213	240	213
241	225	213	240	204	240	204
242	223	252	236	252	236	252
243	215	225	219	225	219	225
250	227	212	219	213	219	213
251	219	199	223	208	223	208
252	215	203	223	212	223	212
253	227	216	223	216	223	216
260	215	210	224	219	224	219
261	245	213	232	217	232	217
262	228	217	228	217	228	217
263	232	240	232	240	232	240
270	233	102	237	102	237	102
271	255	102	255	102	255	102
272	238	94	240	107	240	107
273	254	114	254	114	254	114
280	241	80	241	80	241	80
281	240	171	240	171	240	171
282	233	96	235	84	235	84
283	255	119	255	104	255	104

Figure 6 First order guess of the optimal bias pairs for each ACA: the three runs (one before and two after tuning) are here displayed and compared. Vg values of 140 DEC must not be considered because come from code mistakes.

5 APPENDIX

Here follows the list of all the arguments described in the Appendix sections. They are annexed as separate documents in order to make it easier the reading of this document.

5.1 Appendix 1 – I- V curves for P_PVP_LFI_0002_02

5.2 Appendix 1 – I- V curves for P_PVP_LFI_0002_04