TITLE:	**Planck-LFI CPV: Drain currents verification** (P_PVP_LFI_0002_01, P_PVP_LFI_0001_02)
DOC. TYPE:	**Test Report**
PROJECT REF.:	**PL-LFI-PST-RP-063**
ISSUE/REV.:	**1.0**
PAGE:	**I of IV, 11**
DATE:	**October 10th, 2009**

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	10 October 09	All	First issue	

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)

3 Introduction

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 the specific, It was aimed at investigating possible changes in the response from radiometers due to ground shift or any other possible non ideal effect.
In the case that any results were sensibly different respect to the same test in CSL, the new I -V curves shall be used to modify/correct the drain current model used to draw the PRE- Tuning hyper-matrixes, according to the measured bias shift.

3.1 Test description

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.

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 performed in CSL during on ground tests at satellite level.

In order to save time in the case that, basing on results, some changes will be required on the drain current model providing input conditions for the Pre Hyper Matrix Tuning,, for each detector also the complete drain current hyper matrix will be automatically computed.

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

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 two task:

a) It is a viewer, displaying i-V curves and comparing with those from the same CSL 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: 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 calculated with 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.

b) It is a calculator: basing on results it calculates again the drain current hyper matrixes (mixing results from Vg1 Vg2 bias changes over a bias pair) associating the two drain currents corresponding to all the possible bias quadruplets. This can be used, in the case that results require that, as new input for the Pre Tuning analysis code.

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

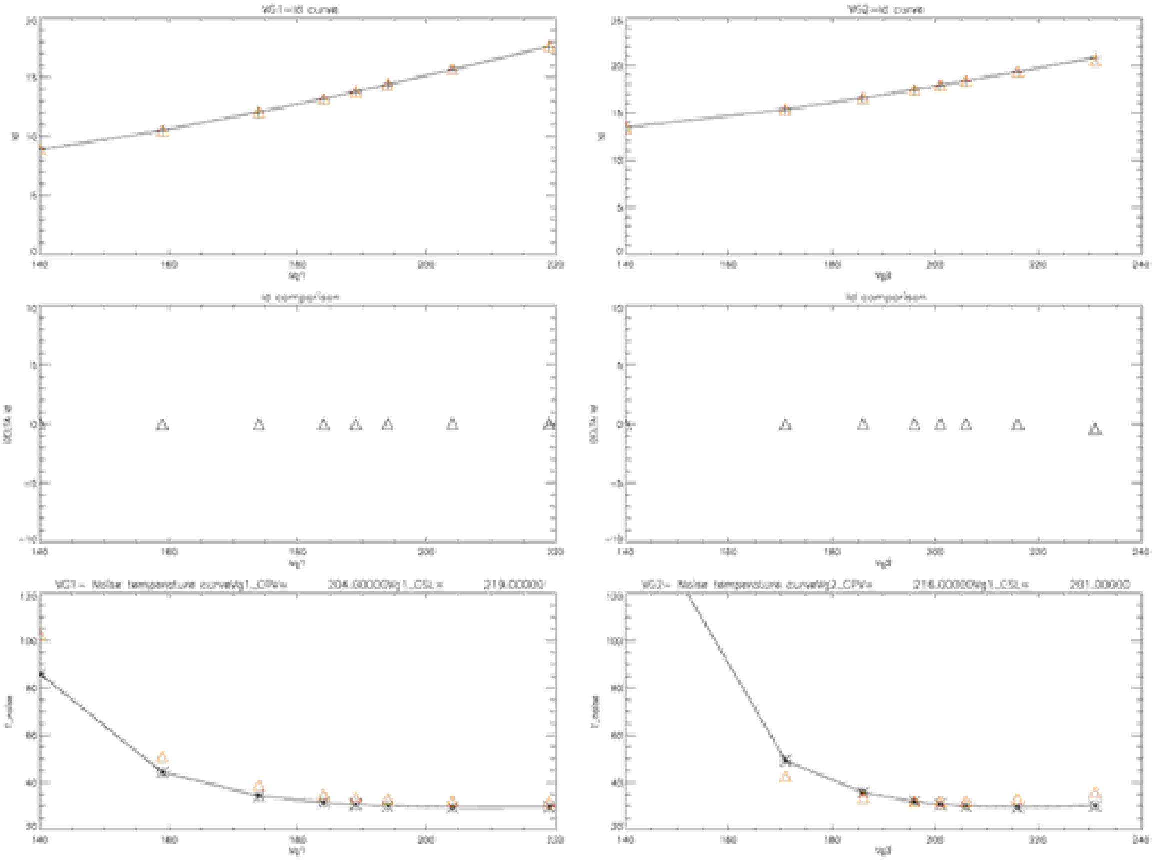

Figure 1 I-V curves comparison for Vg1 (left panel) and Vg2 (right panels) Solid lines are the results from CPV test while CSL results are flagged with red triangles. The difference is shown in the middle plots (very close to 0 mA) while the optimal Vg1Vg2 pairs are guessed in the bottom plots.

4 Test Execution

The full test took about three hours , performed during day 14-06-2009 in visibility. It started on June 14th at 21.15 UTC and was completed on June 15th at 00.16.

The 4K reference Load temperature (sensor HD028260) measured temperature in the range 22.64K : 22.54K . The requirement was very week :

$$22K < Tref < 35K$$

depending on the 4K cooldown profile.
This is because the drain current is independent on the 4K temperature but depends only on the FPU temperature (hence on the Sorption Cooler status).

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_01**	
June, 14 2009 21:20z	**DoY 165**	**OD 32**
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. Eventually correct Hyper Matrix tables accounting for bias shift. 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 unexpected features	Yes		The agreement with on ground tests was very good. Hyper matrix tables were not corrected		
Real time data available	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

The complete test procedure, is provided in APPENDIX 1 ; the check list follows here below.

Step	Description	START REF.	DURATION	RCA	YES	NO
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	√	
7.3.1	ACA 1-vg1	0:03:45	0:03:41	18, 21 -1	√	
7.3.2	ACA 2-vg1	0:07:25	0:03:40	18, 21 -2	√	
7.3.3	ACA 3-vg1	0:11:05	0:03:40	18, 21 -3	√	
7.3.4	ACA 4-vg1	0:14:45	0:03:40	18, 21 -4	√	
7.3.5	ACA 1-vg2	0:18:25	0:03:40	18, 21 -1	√	
7.3.6	ACA 2-vg2	0:22:05	0:03:40	18, 21 -2	√	
7.3.7	ACA 3-vg2	0:25:45	0:03:40	18, 21 -3	√	
7.3.8	ACA 4-vg2	0:30:24	0:04:39	18, 21 -4	√	
	RCA 19 and 22	0:30:25		19, 22		
7.4	Vg1, Vg2 tuning for each ACA of RCA19, 22	0:30:25	0:30:00	19, 22	√	
7.4.1	ACA 1-vg1	0:34:06	0:03:41	19, 22 -1	√	
7.4.2	ACA 2-vg1	0:37:46	0:03:40	19, 22 -2	√	
7.4.3	ACA 3-vg1	0:41:26	0:03:40	19, 22 -3	√	
7.4.4	ACA 4-vg1	0:45:06	0:03:40	19, 22 -4	√	
7.4.5	ACA 1-vg2	0:48:46	0:03:40	19, 22 -1	√	
7.4.6	ACA 2-vg2	0:52:26	0:03:40	19, 22 -2	√	
7.4.7	ACA 3-vg2	0:56:06	0:03:40	19, 22 -3	√	
7.4.8	ACA 4-vg2	1:00:45	0:04:39	19, 22 -4	√	
	RCA 20 and 23	1:00:46		20, 23		
7.5	Vg1, Vg2 tuning for each ACA of RCA20, 23	1:00:46	0:30:00	20, 23	√	
7.5.1	ACA 1-vg1	1:04:27	0:03:41	20, 23 -1	√	
7.5.2	ACA 2-vg1	1:08:07	0:03:40	20, 23 -2	√	
7.5.3	ACA 3-vg1	1:11:47	0:03:40	20, 23 -3	√	
7.5.4	ACA 4-vg1	1:15:27	0:03:40	20, 23 -4	√	
7.5.5	ACA 1-vg2	1:19:07	0:03:40	20, 23 -1	√	
7.5.6	ACA 2-vg2	1:22:47	0:03:40	20, 23 -2	√	
7.5.7	ACA 3-vg2	1:26:27	0:03:40	20, 23 -3	√	
7.5.8	ACA 4-vg2	1:31:06	0:04:39	20, 23 -4	√	

	RCA 25 and 24	1:31:07		24, 25		
7.6	Vg1, Vg2 tuning for each ACA of RCA25, 24	1:31:07	0:30:00	24, 25	√	
7.6.1	ACA 1-vg1	1:34:48	0:03:41	24, 25 -1	√	
7.6.2	ACA 2-vg1	1:38:28	0:03:40	24, 25 -2	√	
7.6.3	ACA 3-vg1	1:42:08	0:03:40	24, 25 -3	√	
7.6.4	ACA 4-vg1	1:45:48	0:03:40	24, 25 -4	√	
7.6.5	ACA 1-vg2	1:49:28	0:03:40	24, 25 -1	√	
7.6.6	ACA 2-vg2	1:53:08	0:03:40	24, 25 -2	√	
7.6.7	ACA 3-vg2	1:56:48	0:03:40	24, 25 -3	√	
7.6.8	ACA 4-vg2	2:01:27	0:04:39	24, 25 -4	√	
	RCA 26 and 27	2:01:28		26, 27		
7.7	Vg1, Vg2 tuning for each ACA of RCA26, 27	2:01:28	0:30:00	26, 27	√	
7.7.1	ACA 1-vg1	2:05:09	0:03:41	26, 27 -1	√	
7.7.2	ACA 2-vg1	2:08:49	0:03:40	26, 27 -2	√	
7.7.3	ACA 3-vg1	2:12:29	0:03:40	26, 27 -3	√	
7.7.4	ACA 4-vg1	2:16:09	0:03:40	26, 27 -4	√	
7.7.5	ACA 1-vg2	2:19:49	0:03:40	26, 27 -1	√	
7.7.6	ACA 2-vg2	2:23:29	0:03:40	26, 27 -2	√	
7.7.7	ACA 3-vg2	2:27:09	0:03:40	26, 27 -3	√	
7.7.8	ACA 4-vg2	2:31:48	0:04:39	26, 27 -4	√	
	RCA 28	2:31:49		28		
7.8	Vg1, Vg2 tuning for each ACA of RCA28	2:31:49	0:30:00	28	√	
7.8.1	ACA 1-vg1	2:35:30	0:03:41	28 -1	√	
7.8.2	ACA 2-vg1	2:39:10	0:03:40	28 -2	√	
7.8.3	ACA 3-vg1	2:42:50	0:03:40	28 -3	√	
7.8.4	ACA 4-vg1	2:46:30	0:03:40	28 -4	√	
7.8.5	ACA 1-vg2	2:50:10	0:03:40	28 -1	√	
7.8.6	ACA 2-vg2	2:53:50	0:03:40	28 -2	√	
7.8.7	ACA 3-vg2	2:57:30	0:03:40	28 -3	√	
7.8.8	ACA 4-vg2	3:02:09	0:04:39	28 -4	√	
		3:02:10				
7.10	Set DAE Gain values (default 1, 0 h)	3:02:10	0:00:02	All	√	
7.11	Set DAE offset values (default 0, FFh)	3:02:12	0:00:02	All		
7.11	end of the test	3:02:14				

Figure 4 Check list Only at the end of the procedure, after the completion of all runs, the DAE offset default was not reset. However this is irrelevant in the purpose of this test.

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 can also be not tuned yet.
LFI mode :	nominal science production TYPE 1.
4K cooler state	Tref ~ 22K < T< 35K (depending on the 4K cooldown profile)
Spacecraft state:	Nominal Mode of the Satellite
Pointing requirements:	Baseline

4.3.3 Pass fail criteria

- *No unexpected event packets*
- *Every ACA is responding as expected from CSL results*
- *Correct biases Applied and checked.*

4.3.4 Default bias

The default bias configuration used for the test is reported in **Errore. L'origine riferimento non è stata trovata.**. Gain and Offset were set to 0 in order to prevent radiometers from DAE saturation

					vg1	vg2	vd	I1	I2	G	O
CH27	00	00	M1	LP001320	240	108	156	178	180	0	0
CH27	01	01	M2	LP002320	244	90	157	144	214	0	0
CH27	02	10	S1	LP003320	237	102	157	138	192	0	0
CH27	03	11	S2	LP004320	246	114	156	128	200	0	0
CH24	04	00	M2	LP005320	227	213	183	91	255	0	0
CH24	05	01	M1	LP006320	219	217	183	128	250	0	0
CH24	06	10	S2	LP007320	225	213	152	86	215	0	0
CH24	07	11	S1	LP008320	219	219	157	84	235	0	0
CH21	08	00	S2	LP009320	216	223	132	255	255	0	0
CH21	09	01	S1	LP010320	181	197	136	255	255	0	0
CH21	0A	10	M1	LP011320	198	207	141	255	255	0	0
CH21	0B	11	M2	LP012320	196	197	136	255	255	0	0
CH22	0C	00	S2	LP013320	206	204	130	255	255	0	0
CH22	0D	01	S1	LP014320	204	189	128	255	255	0	0
CH22	0E	10	M1	LP015320	203	194	125	255	255	0	0
CH22	0F	11	M2	LP016320	178	176	130	255	255	0	0
CH23	10	00	S2	LP017320	190	208	122	255	255	0	0
CH23	11	01	S1	LP018320	181	211	118	255	255	0	0
CH23	12	10	M1	LP019320	207	192	120	255	255	0	0
CH23	13	11	M2	LP020320	210	195	119	255	255	0	0
CH25	14	00	M1	LP021320	227	212	184	174	235	0	0
CH25	15	01	M2	LP022320	219	212	185	89	250	0	0
CH25	16	10	S1	LP023320	224	216	167	93	255	0	0
CH25	17	11	S2	LP024320	223	212	166	119	225	0	0
CH28	18	00	M1	LP025320	243	101	157	132	162	0	0
CH28	19	01	M2	LP026320	240	112	156	117	188	0	0
CH28	1A	10	S1	LP027320	240	84	157	111	168	0	0
CH28	1B	11	S2	LP028320	245	121	158	99	173	0	0
CH20	1C	00	S2	LP029320	188	201	127	255	255	0	0
CH20	1D	01	S1	LP030320	199	221	132	255	255	0	0
CH20	1E	10	M1	LP031320	209	219	121	255	255	0	0
CH20	1F	11	M2	LP032320	215	221	127	255	255	0	0
CH19	20	00	S2	LP033320	204	216	125	255	255	0	0
CH19	21	01	S1	LP034320	215	209	120	255	255	0	0
CH19	22	10	M1	LP035320	213	206	124	255	255	0	0
CH19	23	11	M2	LP036320	211	208	126	255	255	0	0
CH18	24	00	S2	LP037320	208	205	114	255	255	0	0
CH18	25	01	S1	LP038320	192	197	138	255	255	0	0
CH18	26	10	M1	LP039320	190	194	126	255	255	0	0
CH18	27	11	M2	LP040320	198	201	125	255	255	0	0
CH26	28	00	M2	LP041320	226	217	170	153	210	0	0
CH26	29	01	M1	LP042320	232	209	169	98	245	0	0
CH26	2A	10	S2	LP043320	232	217	169	93	230	0	0
CH26	2B	11	S1	LP044320	228	226	172	135	230	0	0

Figure 5 default CRYO bias table applied for the test

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 tests in CSL .
As output, the test produced:

- 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: . It was verified that these points (one per ACA) were covered by the Pre tuning bias regions drawn for the Pre Tuning., otherwise these quadruplets were explicitly added to the combinations used for the HYPER Matrix Tuning Step 1 to 4.

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

- Each LNA stage respond as expected to the Vg bias changes.
- I-V curves are exactly the same as measured in CSL
- There was no reason to use the new drain current matrixes instead of the old ones from CSL test to update the Matrixes used for the Pre Tuning phase.

RCA	CH	VG1 CSL	VG2 CSL	VG1 Id	VG2 Id	delta Vg1	delta Vg2
CH27	M1	240	108	237	102	3	6
CH27	M2	244	90	255	102	-11	-12
CH27	S1	237	102	240	107	-3	-5
CH27	S2	246	114	245	114	1	0
CH24	M2	227	213	240	213	-13	0
CH24	M1	219	217	240	204	-21	13
CH24	S2	225	213	236	220	-11	-7
CH24	S1	219	219	219	225	0	-6
CH21	S2	216	223	206	248	10	-25
CH21	S1	181	197	181	207	0	-10
CH21	M1	198	207	198	207	0	0
CH21	M2	196	197	211	187	-15	10
CH22	S2	206	204	196	199	10	5
CH22	S1	204	189	218	199	-14	-10
CH22	M1	203	194	193	219	10	-25
CH22	M2	178	176	173	176	5	0
CH23	S2	190	208	185	208	5	0
CH23	S1	181	211	196	181	-15	30
CH23	M1	207	192	222	182	-15	10
CH23	M2	210	195	210	195	0	0
CH25	M1	227	212	219	213	8	-1
CH25	M2	219	212	223	208	-4	4
CH25	S1	224	216	223	212	1	4
CH25	S2	223	212	223	216	0	-4
CH28	M1	243	101	241	80	2	21
CH28	M2	240	112	240	171	0	-59
CH28	S1	240	84	235	84	5	0
CH28	S2	245	121	255	104	-10	17
CH20	S2	188	201	172	191	16	10
CH20	S1	199	221	224	210	-25	11
CH20	M1	209	219	224	209	-15	10
CH20	M2	215	221	210	207	5	14
CH19	S2	204	216	219	201	-15	15
CH19	S1	215	209	217	209	-2	0
CH19	M1	213	206	213	196	0	10
CH19	M2	211	208	211	195	0	13
CH18	S2	208	205	210	205	-2	0
CH18	S1	192	197	181	195	11	2
CH18	M1	190	194	187	189	3	5
CH18	M2	198	201	207	206	-9	-5
CH26	M2	226	217	224	219	2	-2
CH26	M1	232	209	232	217	0	-8
CH26	S2	232	217	228	217	4	0
CH26	S1	228	226	232	240	-4	-14

Figure 6 First order guess of the optimal bias pairs for each ACA: results from the analysis are compared with the default bias coming from the CSL Tuning

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