DEC/MEC Housekeeping Calibration Report

Test article : DMC nominal section

Date started : 28/11/06

Operator : JMG

PACS-CL-RP-041, issue V1.11,
5 April 2007

Prepared by J.-M. Gillis

Verified by A Mazy, E Callut

Approved by E Renotte

Document Change Record

Issue	Date	Comments
Draft	12 oct 2006	initial issue (from TN-041)
V1.0	29 nov 2006	Blank Issue for FM
V1.1	29 nov 2006	Prepare report for FM DMCn
V1.11	5 apr 2007	First issue

Table of Contents

1 Scope

This document contains the data recorded using the step by step procedure for calibrating the housekeeping measurement channels of the DEC/MEC main unit (not including the DEC subsystems)

2 Documents

2.1 Applicable Documents

[AD1]	ESA PT-IID-A-04624	Herschel/Planck Instrument Interface Document - Part A
[AD2]	ESA PT-PACS-02126	Instrument Interface Document - Part B - Instrument "PACS"
[AD3]	PACS-CL-RS-003	DEC/MEC Requirements Specifications (issue 3)
[AD4]	PACS-MA-SP-001	PACS Cryo Harness Specification
[AD5]	PACS-CL-RS-010	Specifications for the Warm Interconnecting Harness
[AD6]	PACS-ME-LI-006	PACS System Grounding Diagrams (issue 1.3)
[AD7]	PACS-CL-ID-009	PACS DECMEC EM ICD, issue 2.1

2.2 Reference Documents

[RD1]	PACS-CL-ID-003	DEC/MEC-to-DPU Interface Control Document
[RD2]	PACS-CL-ID-004	DEC/MEC-to-SPU Interface Control Document
[RD3]	Sap-PACS-CCa-0046-01	BOLC to DMC Electrical Interface Control Document
[RD4]	PACS-MA-ID-001	Chopper Electrical Interface Control Document
[RD5]	PACS-CL-ID-002	Grating to MEC Interface Control Document
[RD6]	PACS-KT-ID-006	Filter Wheel Interface Control Document
[RD7]	PACS-KT-ID-007	Calibration Source Interface Control Document
[RD8]	PACS-ME-ID-003	Temperature Sensors Interface Control Document
[RD9]	PACS-CL-TN-041	DEC/MEC Housekeeping data and calibration
[RD10]	PACS-CL-TP-041	DEC/MEC Housekeeping calibration procedure

3 DMC calibration report

3.1 Health check

ADC	range	Ref channels (ADC inputs)	Should be (decimal)	EQM measured (units)	FM measured Min/avg/max (units)	HK IDs
housekeeping	+10V/-10V	101101 = 0V 010101 = 2.5V 011101 = 5V	0 8192 16384	-22 8185 16364	-10/-5.87/-1 8194/8198/8203 16387/16392/16397	428 566 430
Calibration sources	+5V/-5V	Channel 0 = 0V Channel 1 = -4V Channel 2 = +4V Channel 8 = 0V	0 -26214 26214 0		9/9.44/10 -26201/-26201.4/-26202 26215/26215/26215 9/9.5/10	522 523 524 538
SG1	+5V/-5V	Channel 1 = 0V Channel 16 = ref	0 16384		16/22.17/24 16382/16388/16396	351 608
SG2	+5V/-5V	Channel 1 = 0V Channel 16 = ref	0 16384		9/12/15 16347/16351/16357	385 618
SG3	+5V/-5V	Channel 1 = 0V Channel 16 = ref	0 16384		3/12/14 16325/16332.8/16335	283 588
SG4	+5V/-5V	Channel 1 = 0V Channel 16 = ref	0 16384		3/12/14 16370/16377.7/16381	317 598

Condition : switch ON calibration sources
Script name : diagRefV
HK file : diagRefV.xls
21582 records

3.2 MIM1

3.2.1 Calibration sources

3.2.1.1 Health check :

HK ID	name	Expected value	Recorded value	deviation	5%FS limit
522	CS1_VOLT_0V	0	8	8	1638
523	CS1_VOLT_N5V	-4V = -26214	-26205 +/-1	9	1638
524	CS1_VOLT_P5V	+4V = +26214	+26216 +/-1	2	1638
538	CS2_VOLT_0V	0	8	8	1638

Script name : diagCS1
HK file : diagCS1.xls
Deviation : between recorded and expected values (in HK units)
5% FS limit : the number of HK units corresponding to 5% of the full scale value

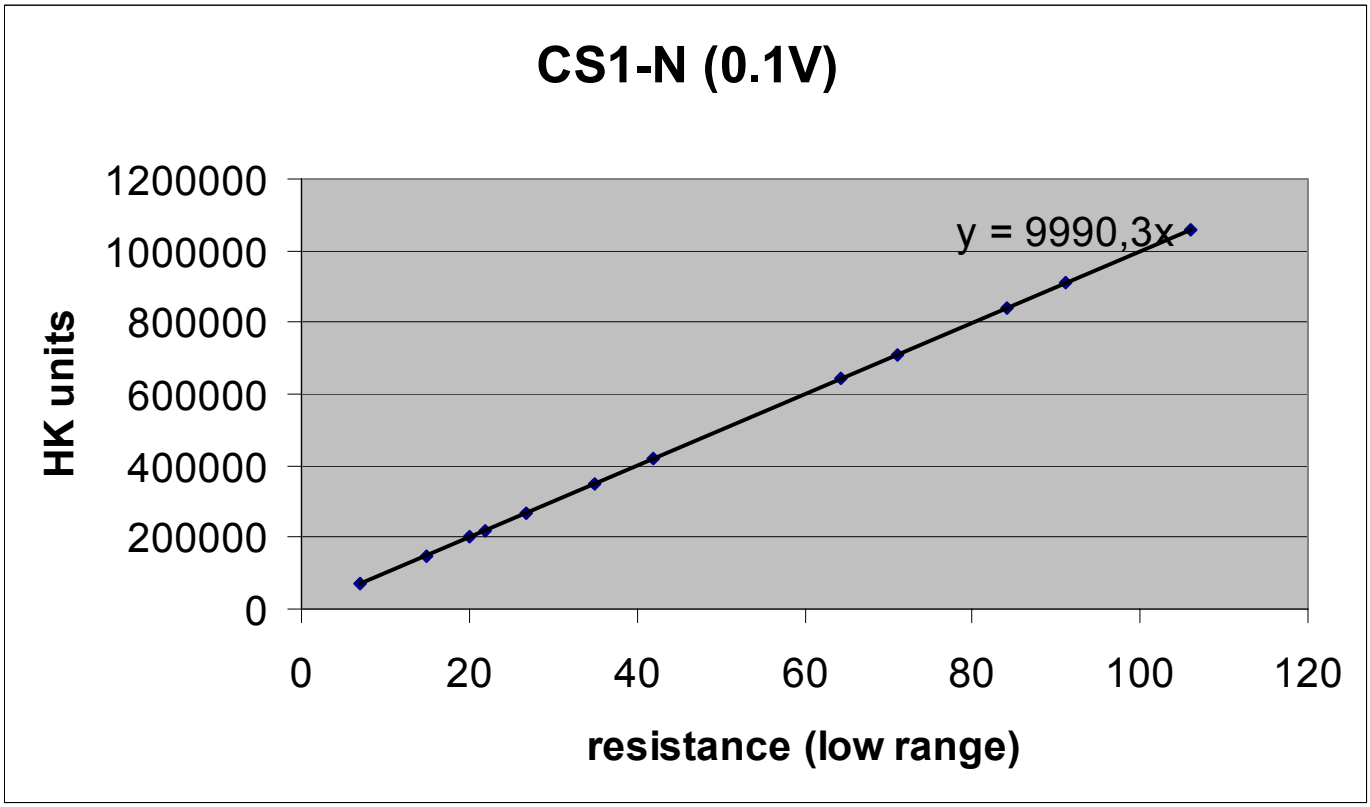
3.2.1.2 Measurement table for CS1 – measurement only

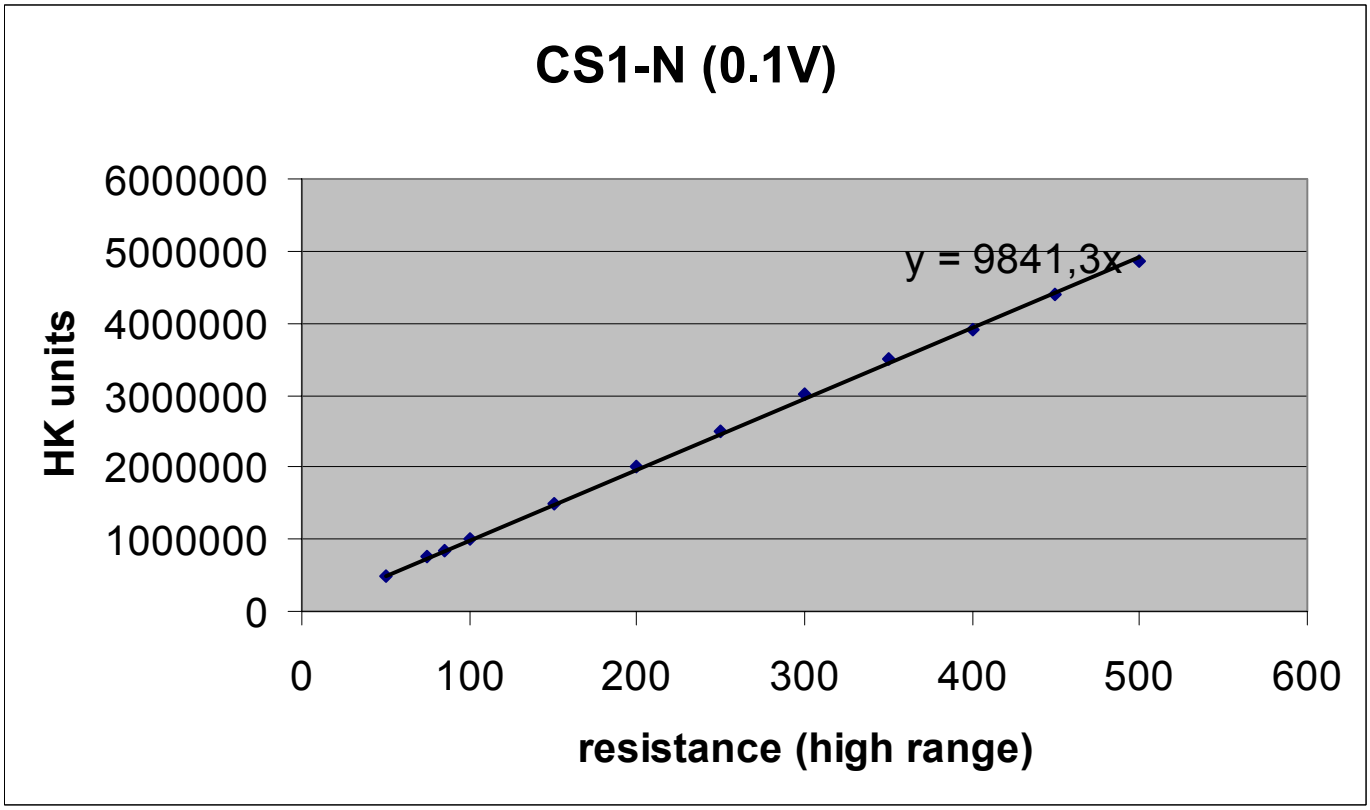
Specified R	Verified R	CS1 R (HK 445)	CS1_volt_dac_out (HK 525)	CS1_VOLT_SG (HK 526)	CS1_VOLT_BG (HK 527)	CS1_CUR_SG (HK 528)	CS1_CUR_BG (HK 529)
106R1	106,105	1060552					
99R2	99,205	missed					
91R1	91,104	909931					
84R2	84,204	841229					
71R1	71,104	710723					
64R2	64,203	641628					
41R9	41,903	417974					
35R	35,003	348909					
6R9	6,901	68942					
15R	15,003	149633					
20R	20,001	199681					
21R9	21,903	218447					
26R9	26,902	268539					
100R	100,002	998294					
150R	150,000	1498788					
200R	199,988	1997251					
250R	249,988	2497050					
300R	299,978	3004712					
350R	349,978	3501803					
400R	399,982	3901335					
450R	449,982	4387572					
500R	499,977	4869335					
50R	50,012	499054					
75R	75,013	748705					
85R	85,014	848524					

Note : specified operating range is 50 to 100 Kelvin, extended range is for information (500 ohms = 20°C)
Use precision resistors with soldered 4 wire connection for the range 0-100 ohms
Use the decade reistor box for the higher values (accuracy limited to 0.1 ohms due to contact resistances)

Script name : diagCS2.txt
HK file : diagCS1_01V.xls

Test resistor verified with Datron multimeter in 4 wires configuration before “diagCS2” script execution


CS1-N (0.1V)
HK units
1200000
1000000
800000
600000
400000
200000
0
y = 9990,3x
0
20
40
60
80
100
120
resistance (low range)

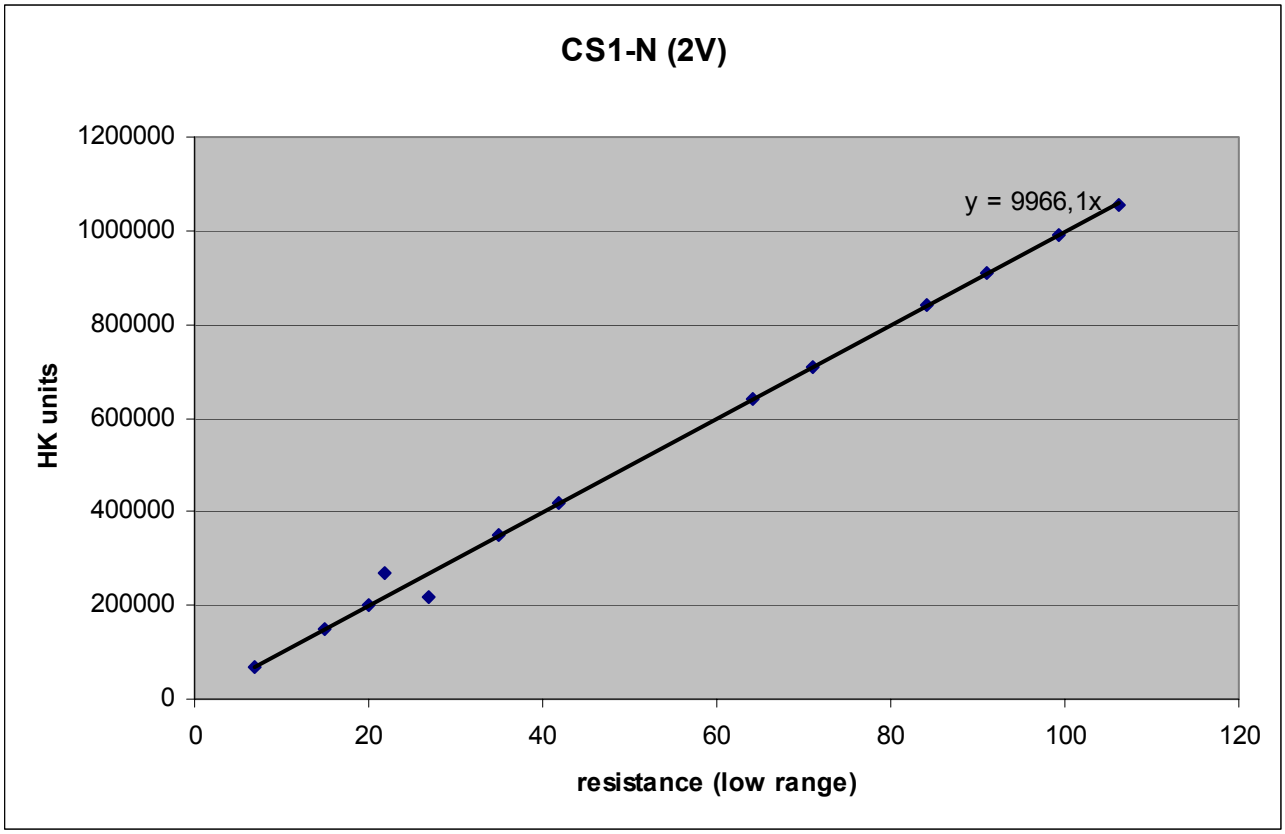

CS1-N (0.1V)
HK units
6000000
5000000
4000000
3000000
2000000
1000000
0
y = 9841,3x
0
100
200
300
400
500
600
resistance (high range)

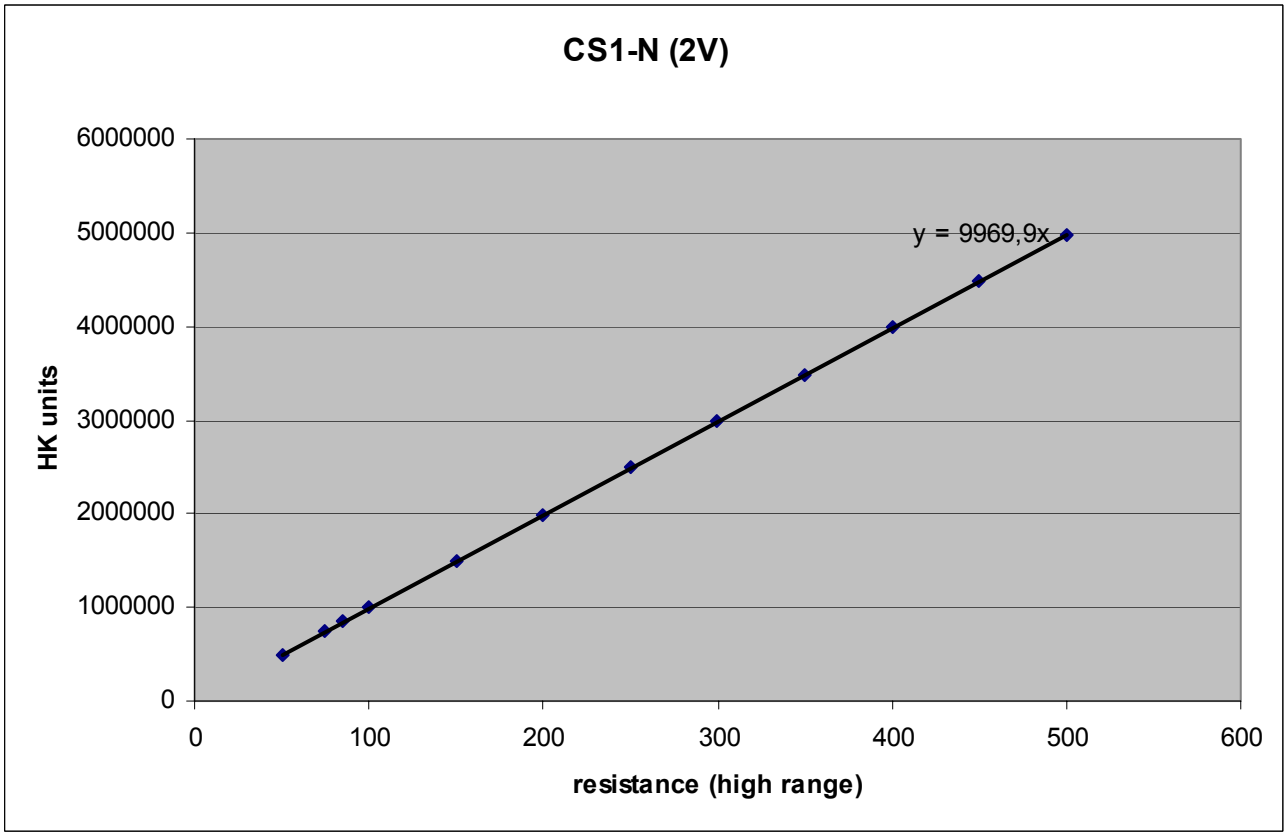
3.2.1.3 Measurement table for CS1 – drive voltage = 2V

Specified R	connect	CS1 R (HK 445)	CS1_volt_dac_out (HK 525)	CS1_VOLT_SG (HK 526)	CS1_VOLT_BG (HK 527)	CS1_CUR_SG (HK 528)	CS1_CUR_BG (HK 529)
106R1	A-G	1056684					
99R2	A-F	989156					
91R1	A-E	908078					
84R2	A-D	839451					
71R1	A-C	709134					
64R2	A-B	640407					
41R9	G-B	418620					
35R	F-B	349967					
6R9	F-G	69817					
15R	F-D	150633					
20R	B-D	200314					
26R9	C-D	269247					
21R9	G-D	219441					
100R	box	997173					
150R	box	1495136					
200R	box	1994045					
250R	box	2492898					
300R	box	2990910					
350R	box	3489789					
400R	box	3988235					
450R	box	4486232					
500R	box	4983565					
50R	box	499355					
75R	box	748026					
85R	box	847605					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)
Use precision resistors with soldered 4 wire connection for the range 0-100 ohms
Use the decade resistor box for the higher values (accuracy limited to 0.1 ohms due to contact resistances)

Script name : diagCS1_2V


CS1-N (2V)
y = 9966,1x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

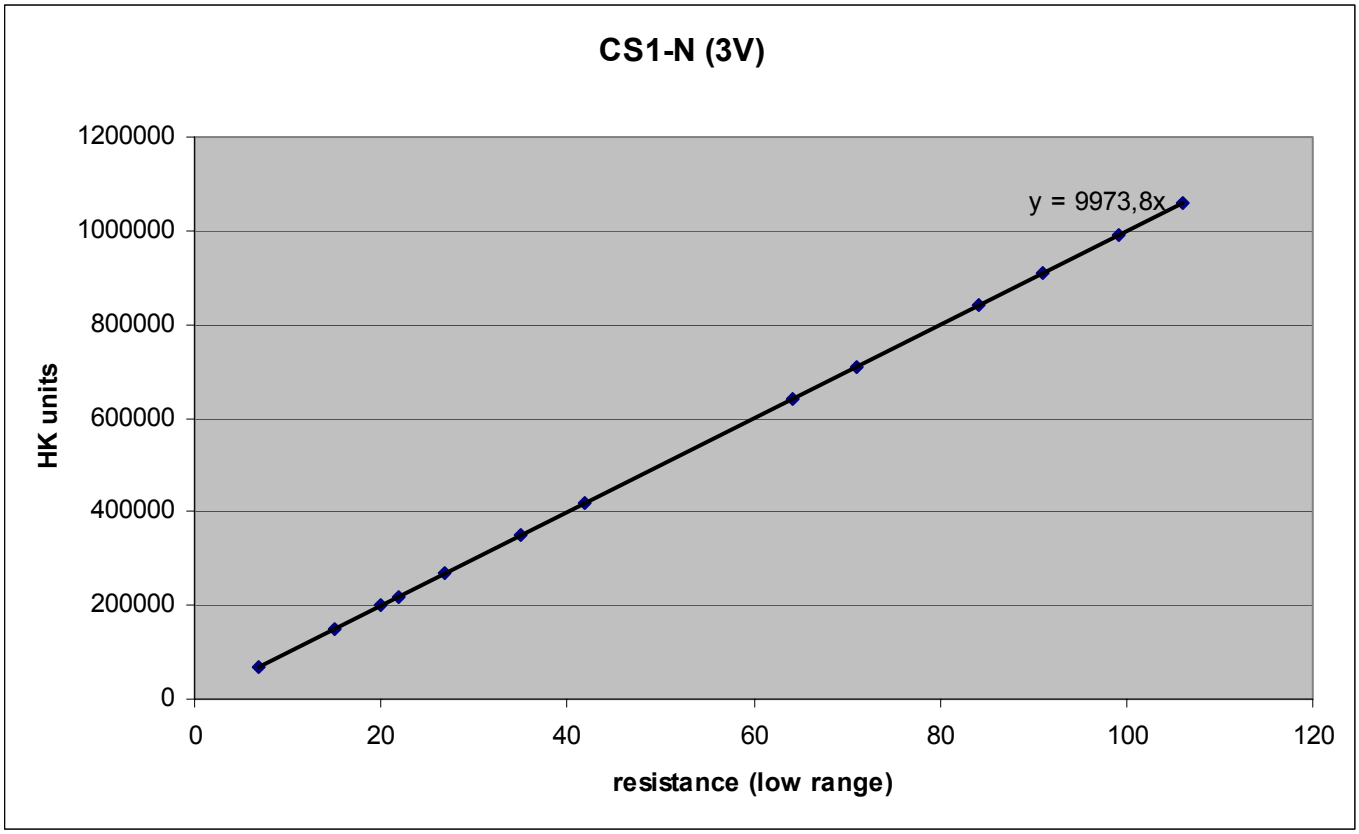

CS1-N (2V)
y = 9969,9x
HK units
resistance (high range)
0
1000000
2000000
3000000
4000000
5000000
6000000
0
100
200
300
400
500
600

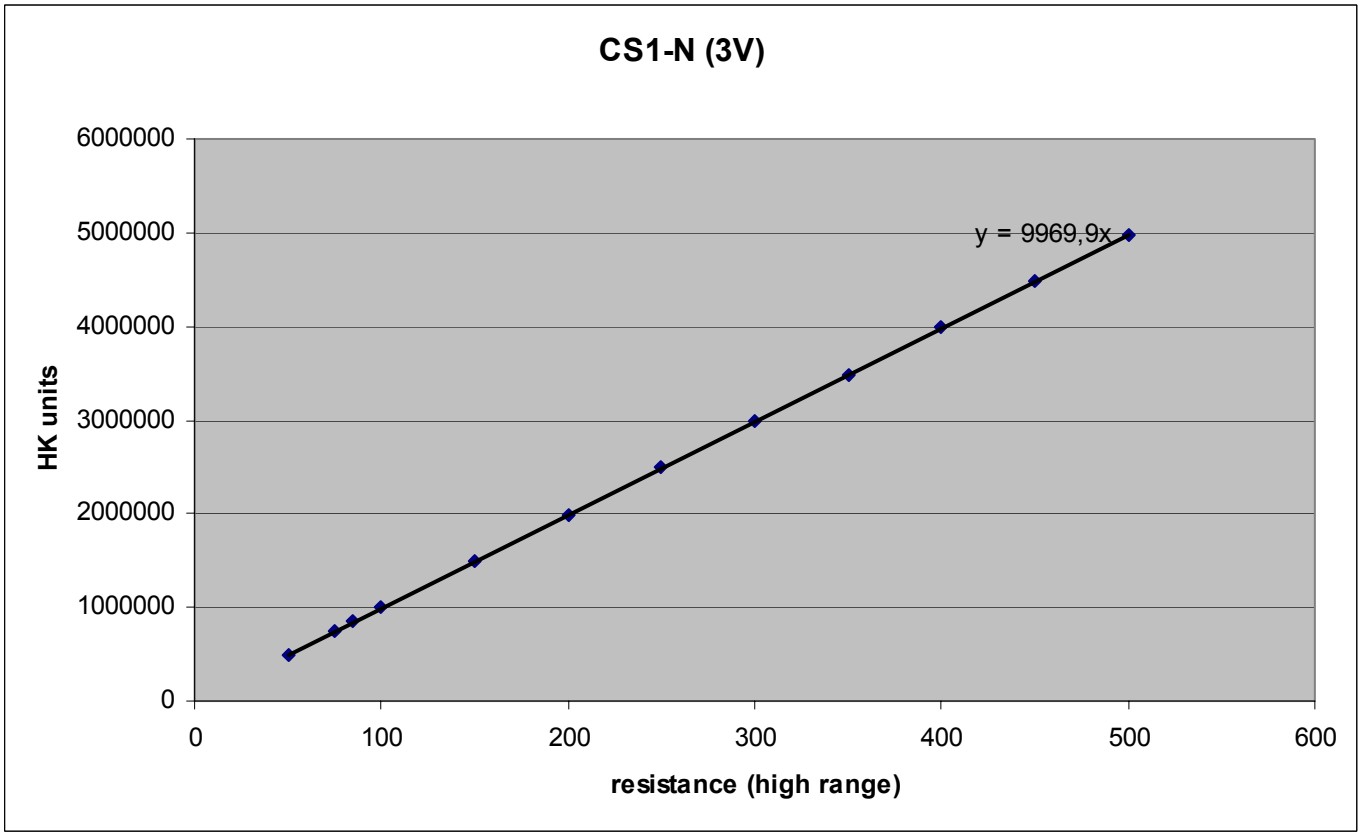
3.2.1.4 Measurement table for CS1 – drive voltage = 3V

Specified R	CS1 R (HK 445)	CS1_volt_dac_out (HK 525)	CS1_VOLT_SG (HK 526)	CS1_VOLT_BG (HK 527)	CS1_CUR_SG (HK 528)	CS1_CUR_BG (HK 529)
106R1	1057943					
99R2	989169					
91R1	908510					
84R2	839759					
71R1	709222					
64R2	640446					
41R9	418122					
35R	349497					
6R9	69471					
15R	150292					
20R	200068					
21R9	219025					
26R9	268879					
100R	997049					
150R	1495933					
200R	1993917					
250R	2492343					
300R	2991256					
350R	3489419					
400R	3987719					
450R	4486438					
500R	4983982					
50R	498756					
75R	748181					
85R	847806					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)
Use precision resistors with soldered 4 wire connection for the range 0-100 ohms
Use the decade reistor box for the higher values (accuracy limited to 0.1 ohms due to contact resistances)

Script name : diagCS1_3V


CS1-N (3V)
y = 9973,8x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

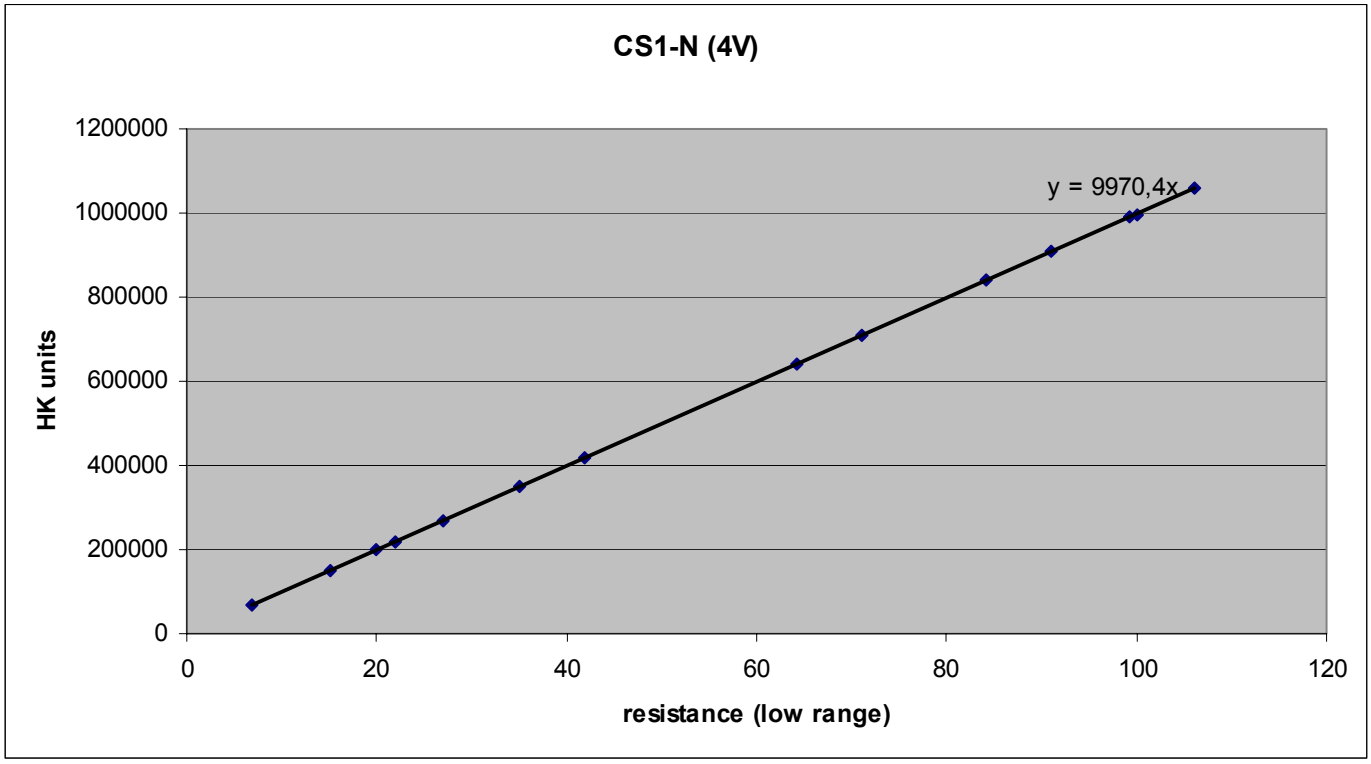

CS1-N (3V)
y = 9969,9x
HK units
resistance (high range)
0
1000000
2000000
3000000
4000000
5000000
6000000
0
100
200
300
400
500
600

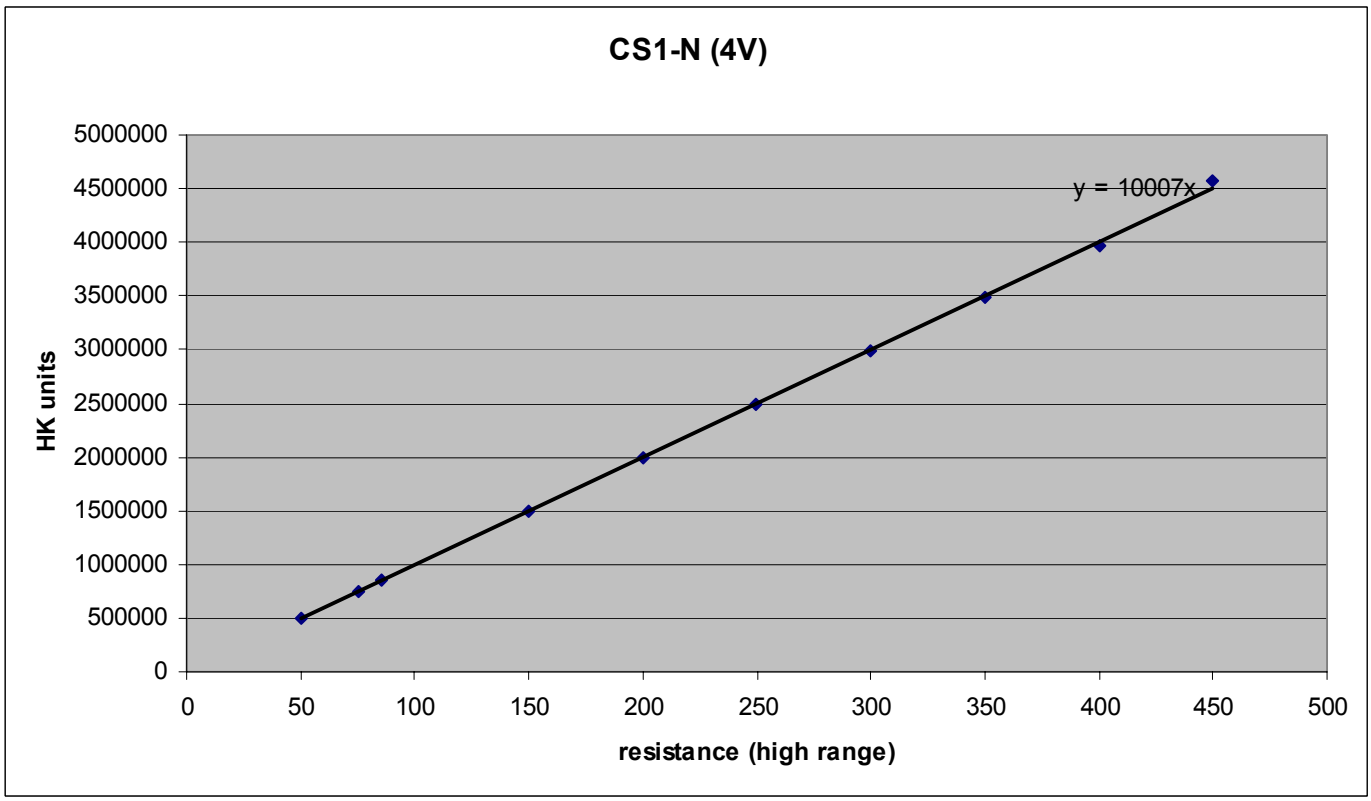
3.2.1.5 Measurement table for CS1 – drive voltage = 4V

Specified R	CS1 R (HK 445)	CS1_volt_dac_out (HK 525)	CS1_VOLT_SG (HK 526)	CS1_VOLT_BG (HK 527)	CS1_CUR_SG (HK 528)	CS1_CUR_BG (HK 529)
106R1	1057925					
99R2	989180					
91R1	908090					
84R2	839371					
71R1	708812					
64R2	640137					
41R9	417774					
35R	349118					
6R9	69374					
15R	150060					
20R	199832					
21R9	218817					
26R9	268492					
100R	997063					
150R	1495392					
200R	1994141					
250R	2493013					
300R	2991584					
350R	3489453					
400R	3964478					
450R	4564577					
500R						
50R	498647					
75R	747662					
85R	847318					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)
Use precision resistors with soldered 4 wire connection for the range 0-100 ohms
Use the decade reistor box for the higher values (accuracy limited to 0.1 ohms due to contact resistances)

Script name : diagCS1_4V


CS1-N (4V)
y = 9970,4x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

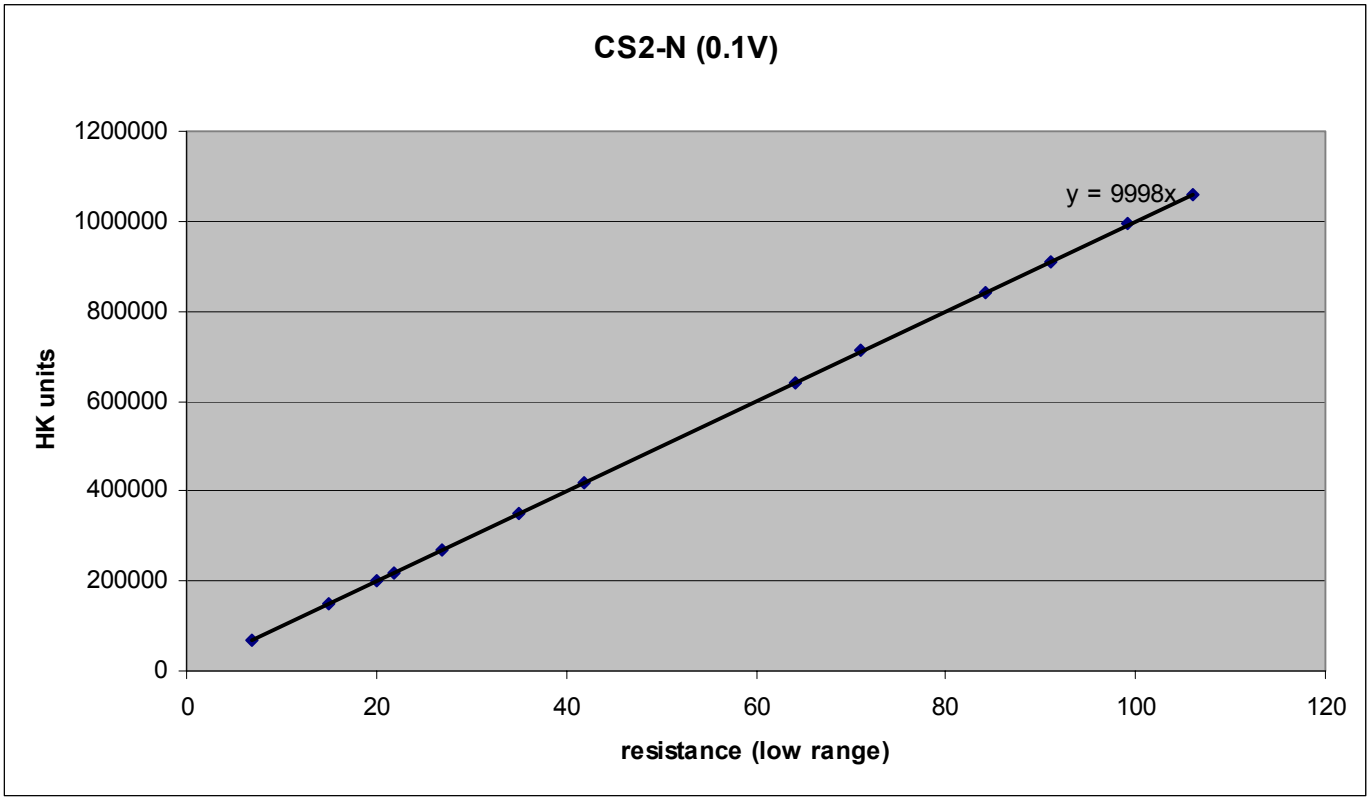

CS1-N (4V)
y = 10007x
HK units
resistance (high range)
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
4500000
5000000
0
50
100
150
200
250
300
350
400
450
500

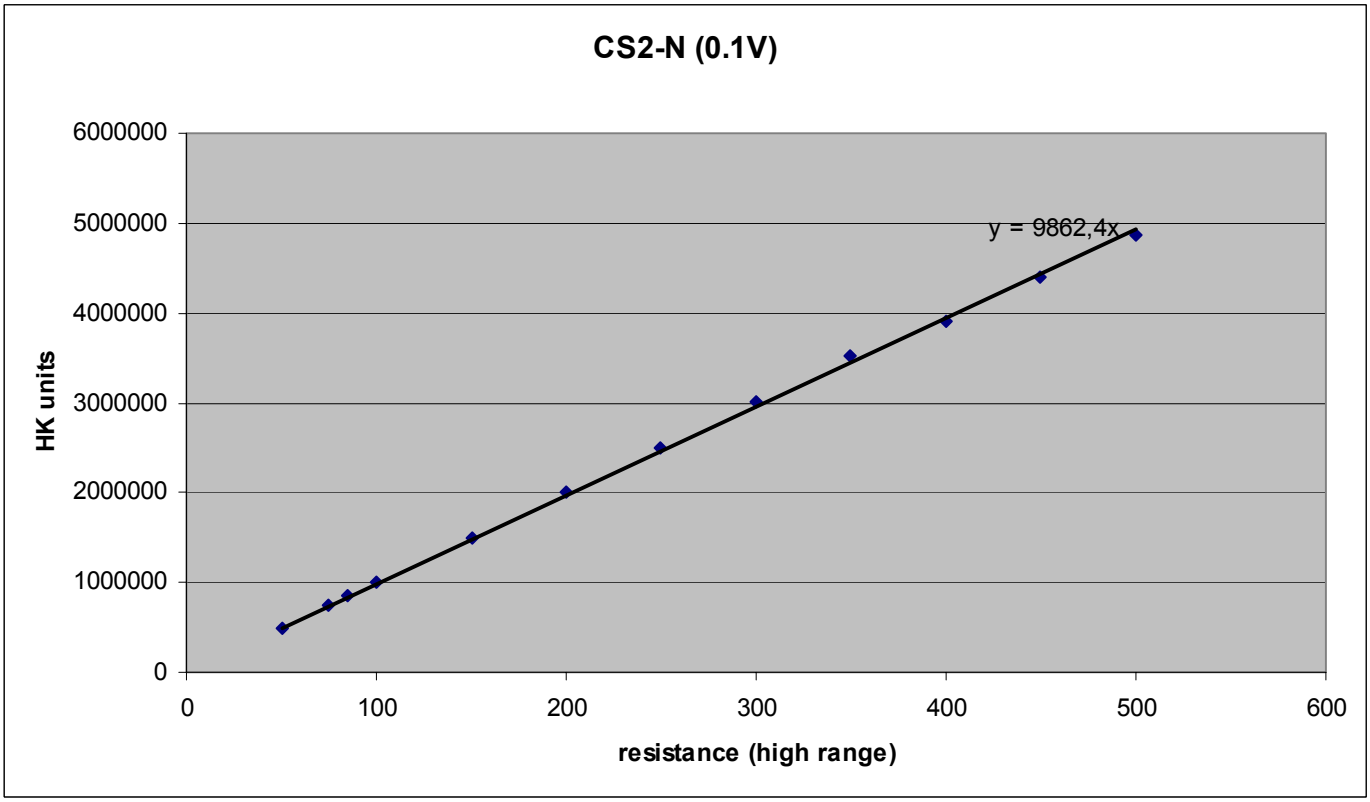
3.2.1.6 Measurement table for CS2 – measurement mode only

Specified R	CS2 R (HK 447)	CS2_volt_dac_out (HK 541)	CS2_VOLT_SG (HK 542)	CS2_VOLT_BG (HK 543)	CS2_CUR_SG (HK 544)	CS2_CUR_BG (HK 545)
106R1	1060229					
99R2	993578					
91R1	909845					
84R2	841120					
71R1	712691					
64R2	641665					
41R9	418150					
35R	349848					
6R9	68897					
15R	149749					
20R	199555					
21R9	218649					
26R9	268777					
100R	1000583					
150R	1504589					
200R	2000949					
250R	2500221					
300R	3006557					
350R	3517242					
400R	3913700					
450R	4394792					
500R	4876352					
50R	499708					
75R	749647					
85R	851210					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)

Script name : diagCS3 (diagCS2_01V)


CS2-N (0.1V)
y = 9998x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

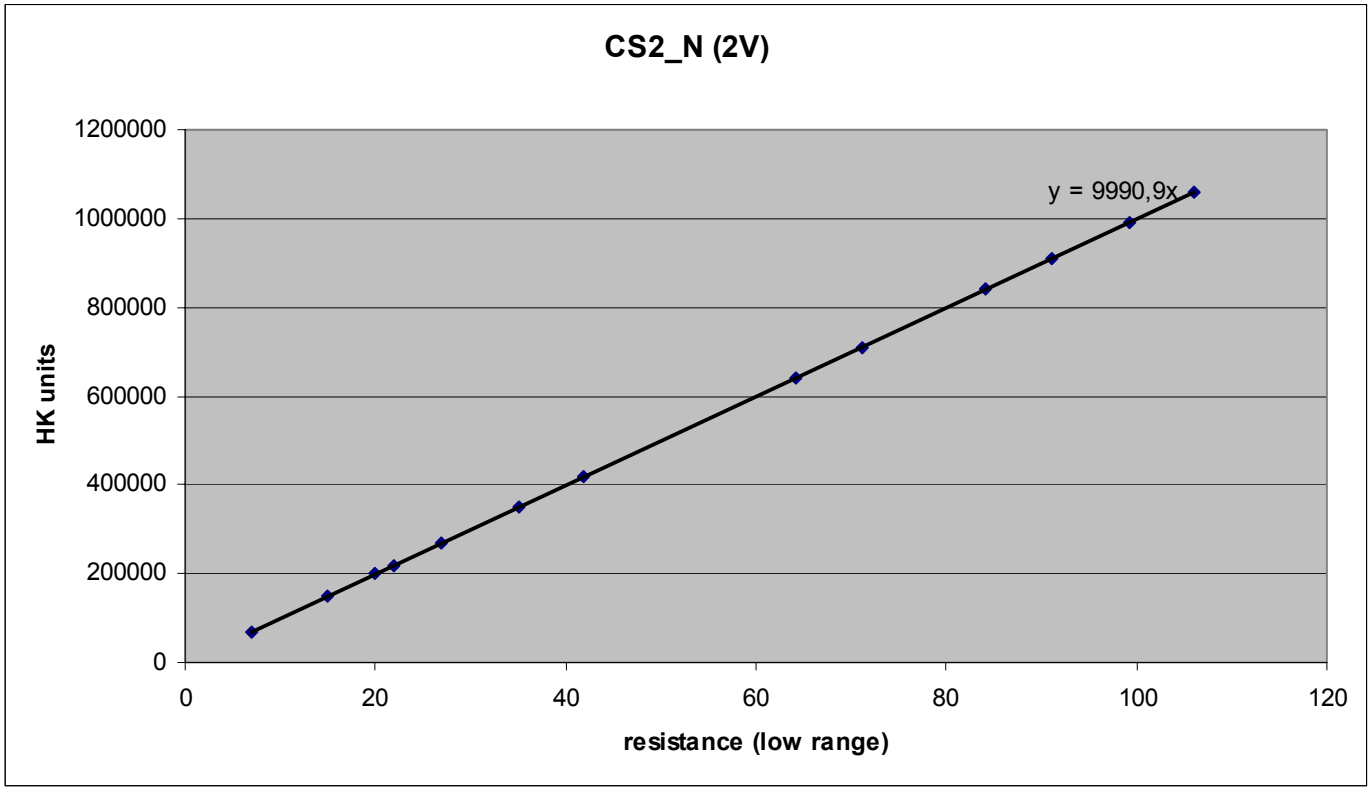

CS2-N (0.1V)
y = 9862,4x
HK units
resistance (high range)
0
1000000
2000000
3000000
4000000
5000000
6000000
0
100
200
300
400
500
600

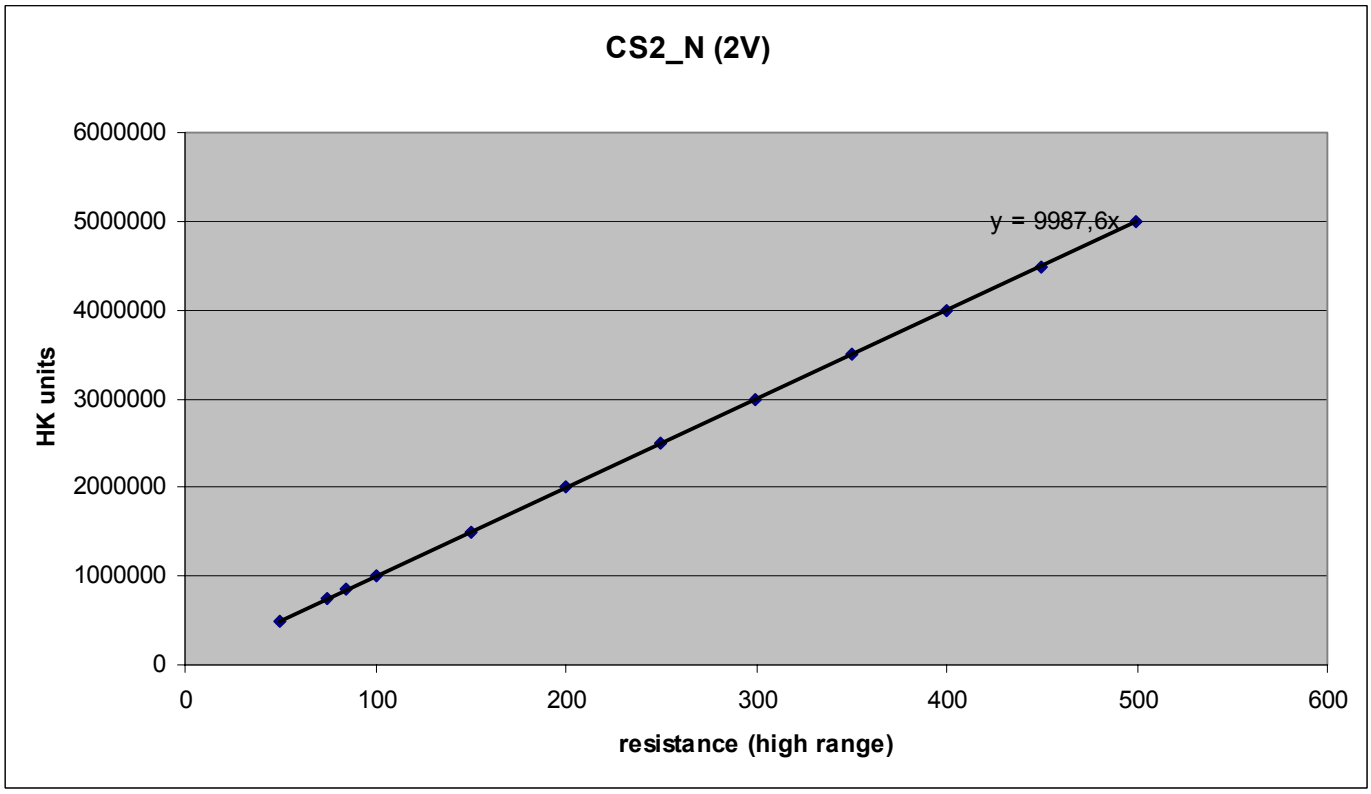
3.2.1.7 Measurement table for CS2 – drive voltage = 2V

Specified R	CS2 R (HK 447)	CS2_volt_dac_out (HK 541)	CS2_VOLT_SG (HK 542)	CS2_VOLT_BG (HK 543)	CS2_CUR_SG (HK 544)	CS2_CUR_BG (HK 545)
106R1	1059756					
99R2	990797					
91R1	909752					
84R2	840995					
71R1	710271					
64R2	641532					
41R9	419389					
35R	350522					
6R9	69914					
15R	150858					
20R	200597					
21R9	219701					
26R9	269595					
100R	998848					
150R	1497688					
200R	1997443					
250R	2497120					
300R	2995969					
350R	3495609					
400R	3995259					
450R	4494516					
500R	4992804					
50R	500110					
75R	749325					
85R	849045					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)

Script name : diagCS2_2V


CS2_N (2V)
y = 9990,9x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

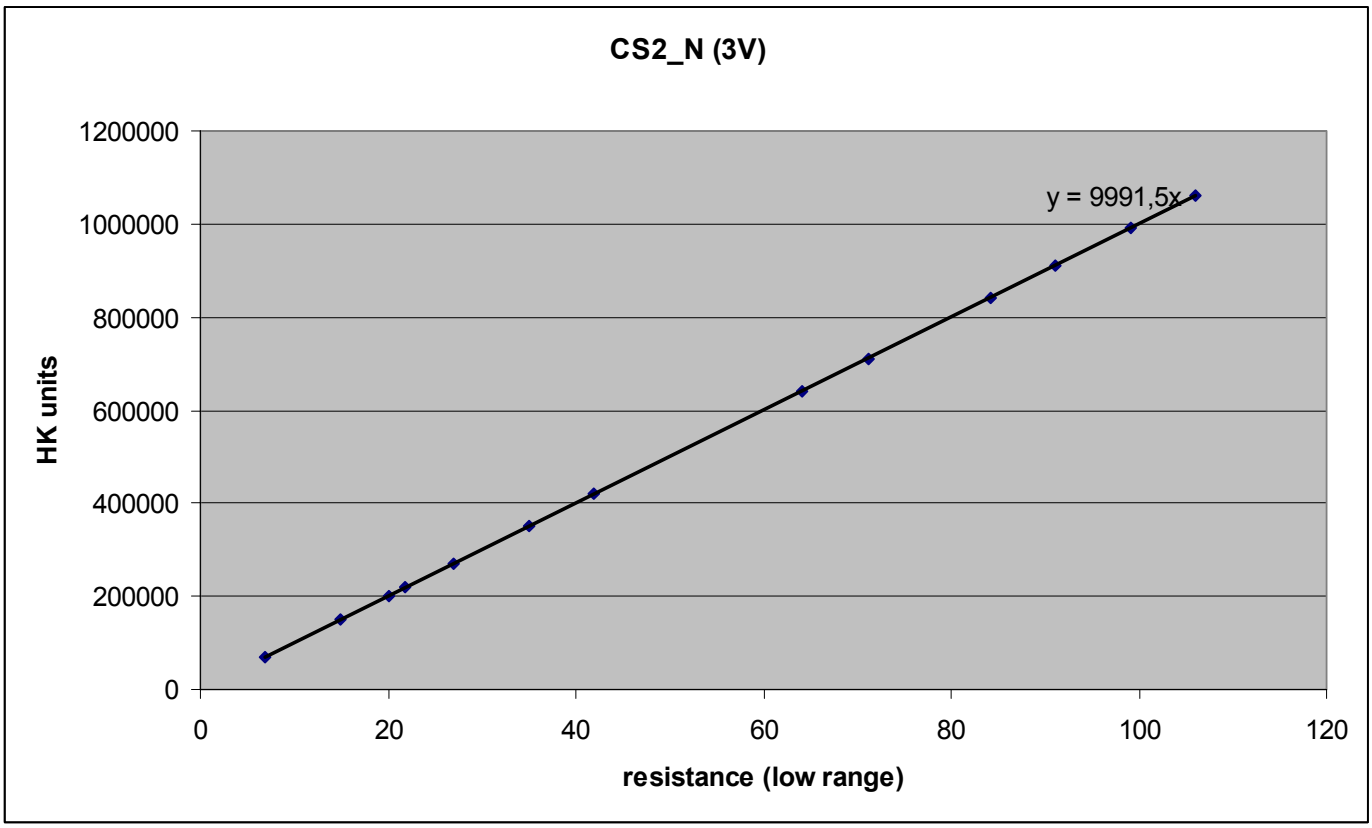

CS2_N (2V)
y = 9987,6x
HK units
resistance (high range)
0
1000000
2000000
3000000
4000000
5000000
6000000
0
100
200
300
400
500
600

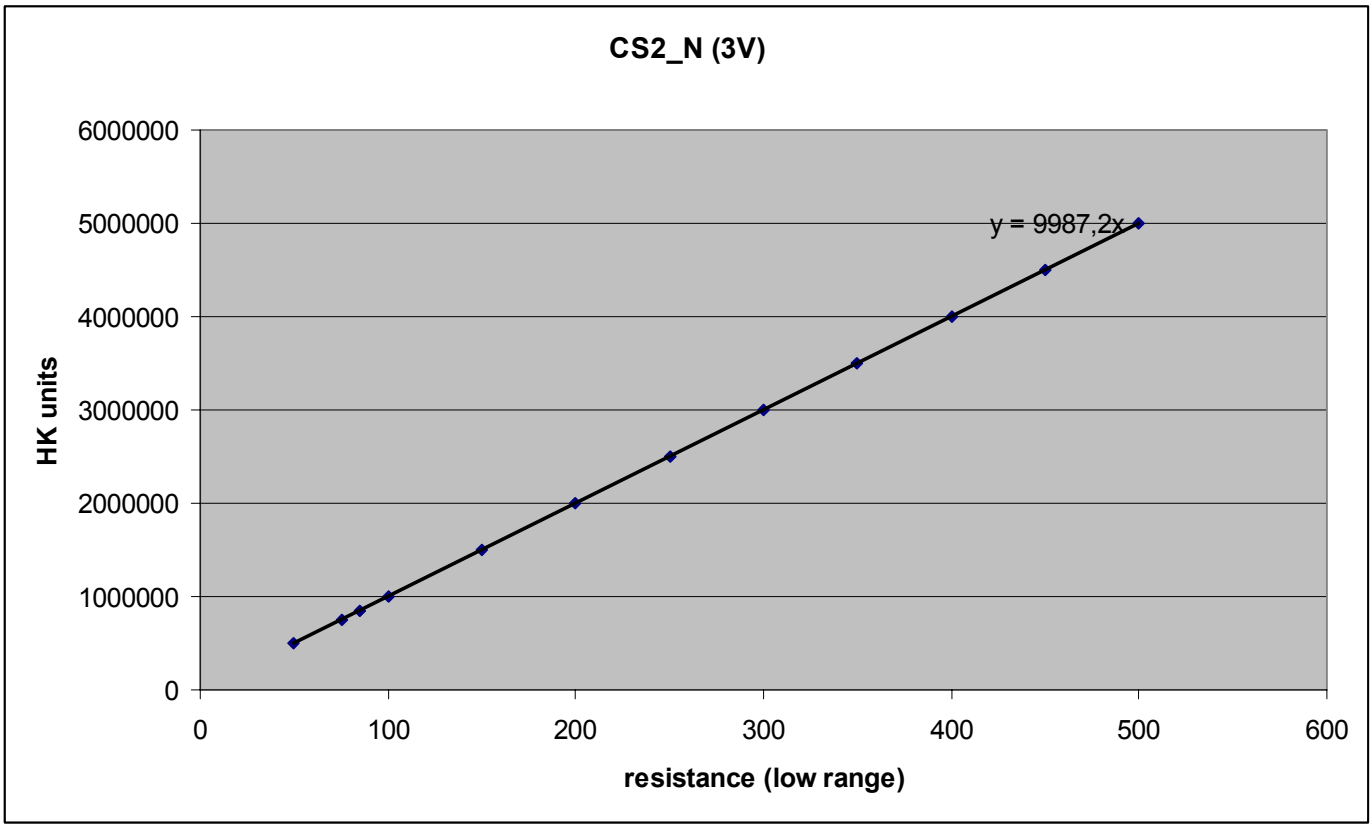
3.2.1.8 Measurement table for CS2 – drive voltage = 3V

Specified R	CS2 R (HK 447)	CS2_volt_dac_out (HK 541)	CS2_VOLT_SG (HK 542)	CS2_VOLT_BG (HK 543)	CS2_CUR_SG (HK 544)	CS2_CUR_BG (HK 545)
106R1	1059891					
99R2	990919					
91R1	910160					
84R2	841187					
71R1	710544					
64R2	641525					
41R9	418817					
35R	350071					
6R9	69556					
15R	150496					
20R	200383					
21R9	219454					
26R9	269270					
100R	998796					
150R	1498621					
200R	1997380					
250R	2496478					
300R	2996139					
350R	3495372					
400R	3994822					
450R	4494039					
500R	4992864					
50R	499644					
75R	749462					
85R	849255					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)

Script name : diagCS2_3V


CS2_N (3V)
y = 9991,5x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120

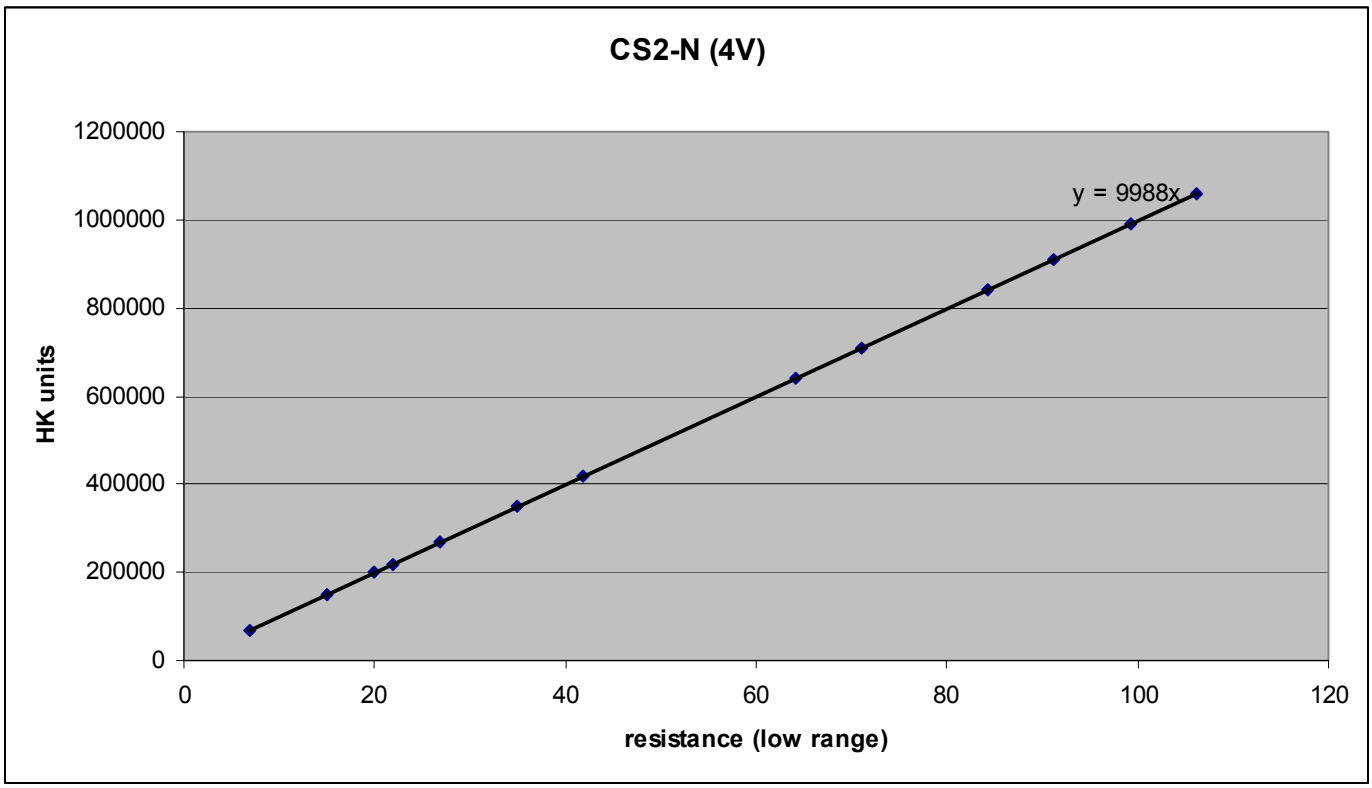

CS2_N (3V)
y = 9987,2x
HK units
resistance (low range)
0
1000000
2000000
3000000
4000000
5000000
6000000
0
100
200
300
400
500
600

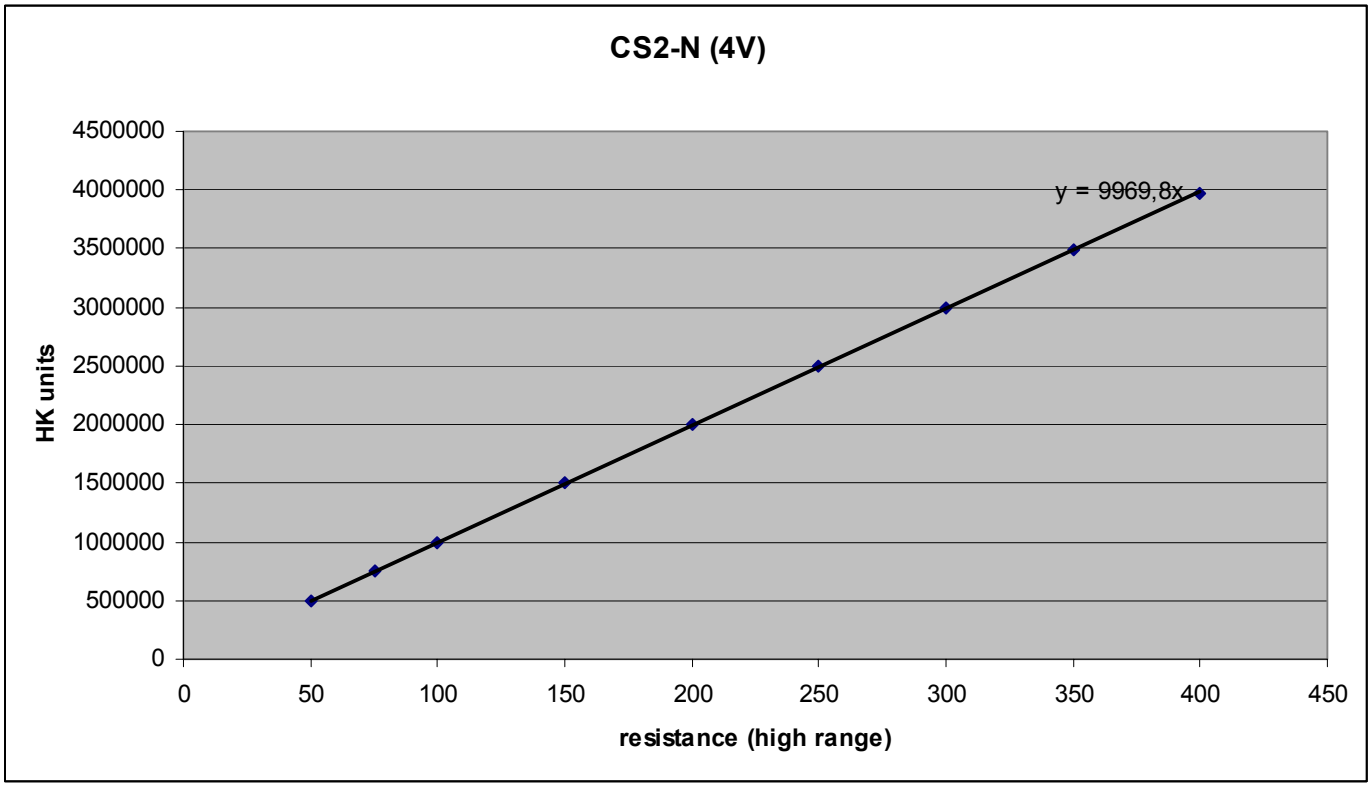
3.2.1.9 Measurement table for CS2 – drive voltage = 4V

Specified R	CS2 R (HK 447)	CS2_volt_dac_out (HK 541)	CS2_VOLT_SG (HK 542)	CS2_VOLT_BG (HK 543)	CS2_CUR_SG (HK 544)	CS2_CUR_BG (HK 545)
106R1	1059798					
99R2	990860					
91R1	909732					
84R2	840825					
71R1	710080					
64R2	641318					
41R9	418521					
35R	349688					
6R9	69449					
15R	150310					
20R	200179					
21R9	219243					
26R9	268921					
100R	998864					
150R	1498068					
200R	1997692					
250R	2497356					
300R	2996859					
350R	3495469					
400R	3970823					
450R	4324023 ??					
500R	4570056 ??					
50R	499535					
75R	749070					
85R	missed					

Note : specified operating range is 50 to 100 Kelvin, extended range for information (500 ohms = 20°C)
Script name : diagCS2_4V

Note : the measurements for R = 450 and 500 ohms have been excluded from the plot for the straight line approximation (complete data set below)


CS2-N (4V)
y = 9988x
HK units
resistance (low range)
0
200000
400000
600000
800000
1000000
1200000
0
20
40
60
80
100
120


CS2-N (4V)
y = 9969,8x
HK units
resistance (high range)
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
4500000
0
50
100
150
200
250
300
350
400
450

3.2.2 Inductosyn readout voltages

Input RMS value (V)	amplified waveform peak to peak amplitude (V, calculated)	Input mV p/p	Detected voltage	Expected value	Recorded value SIN (HK 539)	Recorded value COS (HK 540)
0,040	11.8	113,12	5.0	32767	32767	32490
0,034	10,0	96,152	4,23	27720	29049	27928
0,0306	9,00	86,5368	3,78	24772	25665	24554
0,0270	7,94	76,356	3,26	21364	22328	21208
0,0235	6,91	66,458	2,81	18415	18990	17871
0,0204	6,00	57,6912	2,58	16908	15966	14868
0,0192	5,66 (measured 5.8V)	54,2976	2,22	14548	14860	13774
0,0170	5,00	48,076	1,87	12255	12781	11685
0,0152	4,47	42,9856	1,66	10879	11122	10031
0,0136	4,00	38,4608	1,42	9306	9717	8614
0,0119	3,50	33,6532	1,21	7929	8061	6977
0,0102	3,00	28,8456	0,98	6422	6554	5481
0,0085	2,50	24,038	0,71	4653	5010	3943
0,0069	2,03	19,5132	0,50	3277		
0,0051	1,516	14,4228	0,28	1835		
0,0034	1,00	9,6152	0,08	524		

Script name : diagInduct

Note : lowest steps not done (noise) ; HK file ends with 1 minute at 54.3 mV pp (nominal input)

The grey line shows the setting for nominal position readout electronics operation.
Increase drive voltage is readout is too low, decrease drive voltage if readout is too high (see procedure in User Manual)

3.2.3 Grating motor Hall effect sensors

3.2.3.1 Drive current verification

Send the OBSW command to select the grating (2,38,0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.74	2.35

Send the OBSW command to deselect the grating (2,39,0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

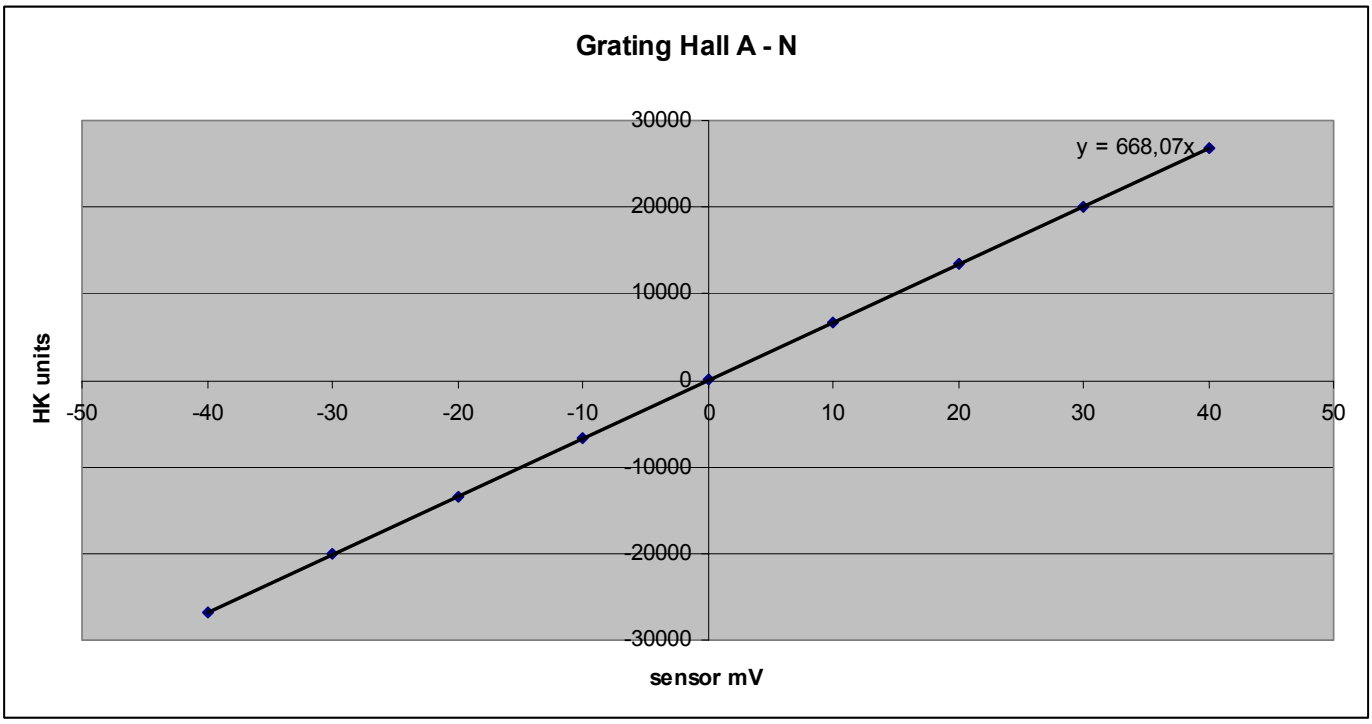
3.2.3.2 Readout amplifier calibration

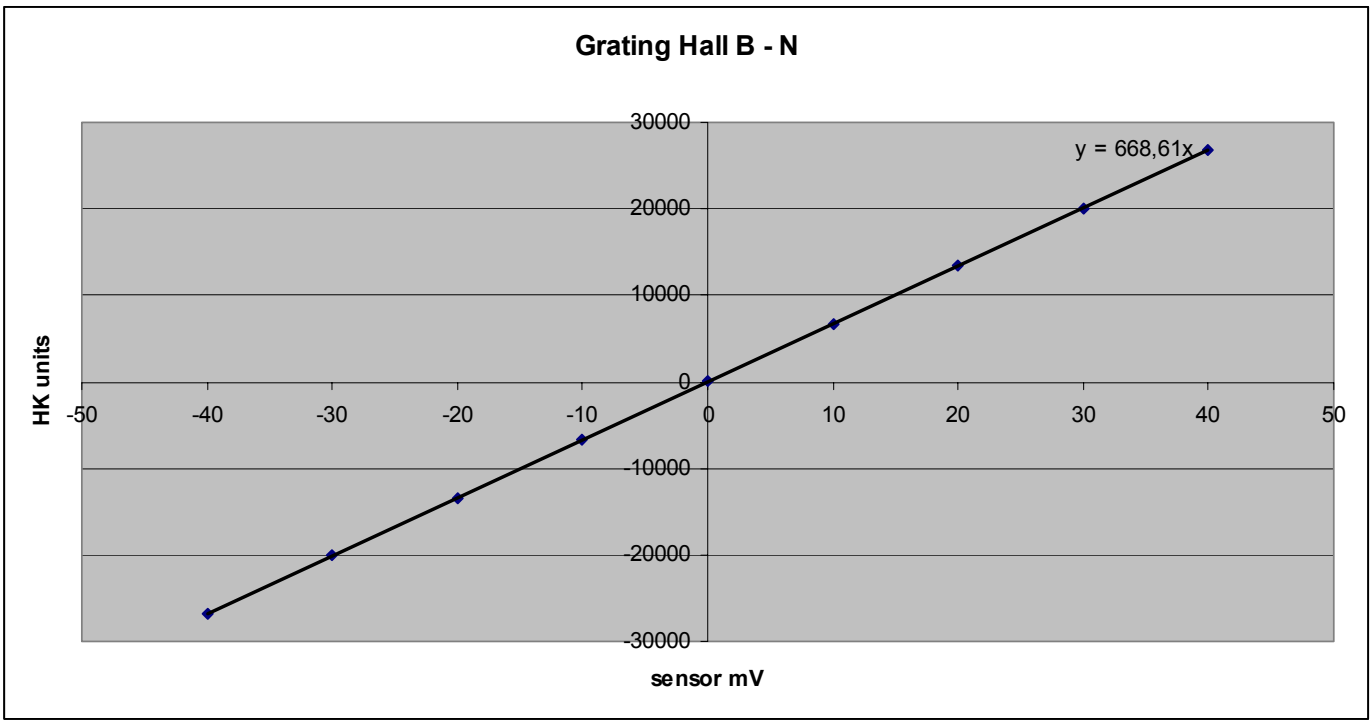
Send OBSW the command to power on the grating (2,38,0)
Record the HK measurements from HK ID 256 (A) and 257 (B) for several input levels

Input DC (mV)	Designed ADC input (V)	expected value	Recorded value A (HK 256)	Recorded value B (HK 257)	ADC offset (HK 428)
-40	-8.24	-27000	-26721	-26747	-7
-30	-6.18	-20246	-20036	-20060	-8
-20	-4.12	-13500	-13399	-13413	-10
-10	-2.04	-6750	-6686	-6694	-7
0	0	0	-5	0	-8
10	2.04	6750	6670	6675	-7
20	4.08	13500	13389	13394	-6
30	6.12	20246	20026	20036	-6
40	8.16	27000	26715	26731	-6

Script name : diagGratHall.txt

Send the OBSW command to deselect the grating (2,39,0)


Grating Hall A - N
y = 668,07x
HK units
sensor mV
30000
20000
10000
0
-10000
-20000
-30000
-50
-40
-30
-20
-10
0
10
20
30
40
50


Grating Hall B - N
y = 668,61x
HK units
sensor mV
30000
20000
10000
0
-10000
-20000
-30000
-50
-40
-30
-20
-10
0
10
20
30
40
50

3.3 MIM2

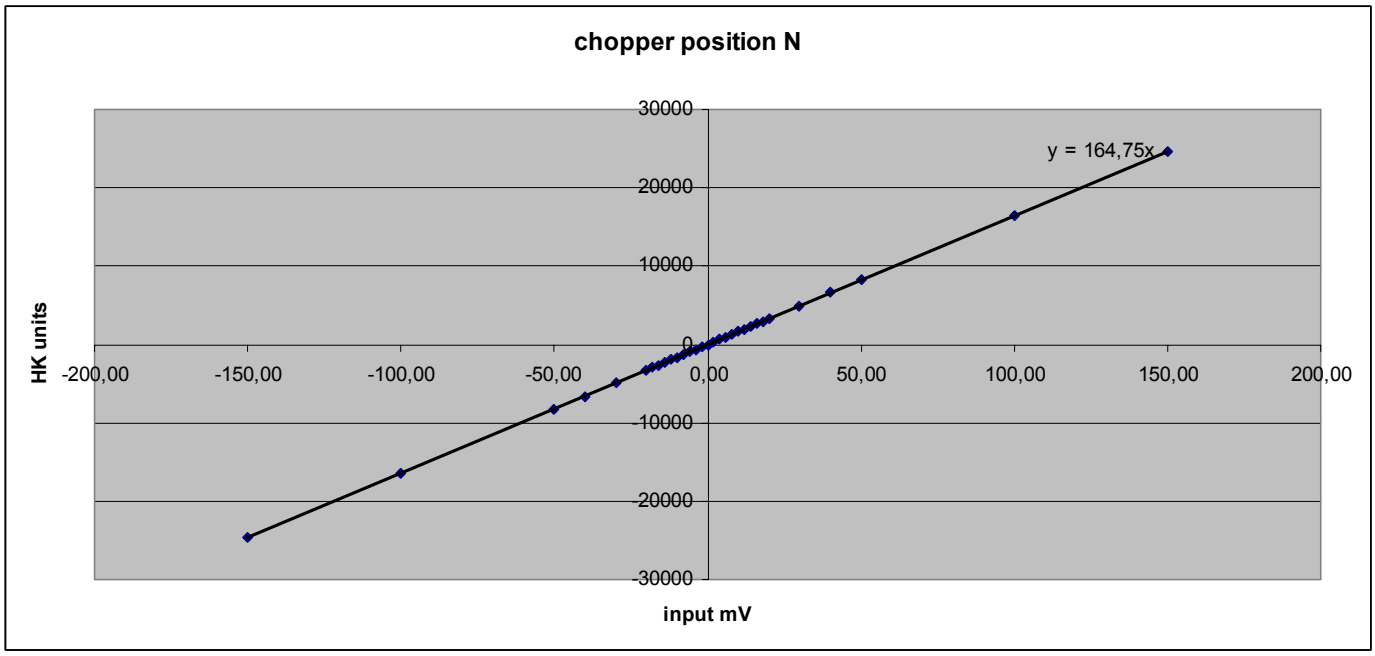
3.3.1 Chopper position readout

3.3.1.1 measurements

Drive voltage : 316.53 mV ; ADC offset : avg -4.6 stdev 1.0 / 12000 values (not subtracted from data below)
Script name : diagChopPos.txt ; levels +/50, +/100 & +/-150 done with second decade box, HK file diagChopPos2

Specified Input (mV)	Actual Input (mV)	Expected HK units	raw HK units ID 244	ADC offset ID 428	Average HK units ID 244 from file	Number of measurements from file	Std Dev measurements from file
-150	-149.935	24575	-24713	-6	-24714	3600	5.3
-100	-99.873	16384	-16465	-5	-16467	2200	4.4
-50	-50.001	8192	-8246	-4	-8245	3480	2.7
-40	-40.00	6553	-6593	-5			Off end of file
-30	-30.00	4915	-4907	-4	-4912	1800	4.9
-20	-20.00	3277	-3274	-5	-3277	2000	8.0
-18	-18.00	2949	-2950	-6	-2949	2400	5.9
-16	-16.00	2621	-2622	-4	-2626	1260	7.2
-14	-14.00	2294	-2294	-6	-2293	1900	2.0
-12	-12.00	1966	-1964	-3	-1965	2300	9.7
-10	-10.00	1638	-1653	-5	-1647	2900	6.2
-8	-8.00	1310	-1313	-3	-1312	1650	3.4
-6	-6.00	983	-982	-3	-982.5	1000	0.7
-4	-4.00	655	-656	-6	-658.0	4600	1.9
-2	-2.00	328	-330	-6	-331.4	2200	2.0
0	Short circuit	0	-2	-5	-4.14	12000	4.0
2	2.00	-328	329	-3	326.9	3800	1.6
4	4.00	-655	656	-5	654.5	2100	2.0
6	6.00	-983	982	-3	981.1	4100	1.8
8	8.00	-1310	1306	-5	1307	3200	1.8
10	10.00	-1638	1636	-6	1638	1090	4.2
12	12.00	-1966	1962	-5	1962	2700	2.5
14	14.00	-2294	2289	-4	2294	1350	6.3
16	16.00	-2621	2618	-3	2618	2200	3.2
18	18.00	-2949	2946	-5	2948	1600	7.5
20	20.00	-3277	3270	-3	3271	2900	1.9
30	30.00	-4915	4914	-5	4910	1900	10
40	40.00	-6553	6592	-5			Off end of file
50	50.001	-8192	8241	-3	8237	1680	8.2
100	99.873	-16384	16450	-5	16457	6000	3.9
150	149.935	-24575	24711	-4	24707	7500	5

3.3.1.2 offset corrected and averaged response



Straight line approximation (through origin)

y = 164.75 x	Deviation units	Deviation %
-24701,7913	-139	0,56%
-16454,0768	-83	0,50%
-8237,66475	-53	0,64%
-6590	-40	0,61%
-4942,5	3	-0,06%
-3295	0	0,00%
-2965,5	0	0,00%
-2636	-5	0,19%
-2306,5	1	-0,04%
-1977	1	-0,05%
-1647,5	-9	0,55%
-1318	-2	0,15%
-988,5	0,5	-0,05%
-659	-3	0,46%
-329,5	-3,4	1,03%
0	-4,14	
329,5	-1,1	-0,33%
659	-0,5	-0,08%
988,5	-1,9	-0,19%
1318	-3	-0,23%
1647,5	0	0,00%
1977	-4	-0,20%
2306,5	0	0,00%
2636	-3	-0,11%
2965,5	-1	-0,03%
3295	-6	-0,18%
4942,5	-5	-0,10%
6590	39	0,59%
8237,66475	45	0,55%
16454,07675	73	0,44%
24701,79125	132	0,53%

3.3.1.3 alternative straight line choice

offset corrected	slope(0,P)	output with average slope	error	error %
-4,14				
-24709,9	164,8038	-24609,4	100,5093	-0,40842
-16462,9	164,8379	-16392,5	70,3587	-0,42921
-8240,86	164,8139	-8206,84	34,02274	-0,41457
-6597	164,925	-6565,34	31,6615	-0,48225
-4907,86	163,5953	-4924	-16,1439	0,327861
-3272,86	163,643	-3282,67	-9,80925	0,298819
-2944,86	163,6033	-2954,4	-9,54233	0,322987
-2621,86	163,8663	-2626,14	-4,2754	0,162802
-2288,86	163,49	-2297,87	-9,00848	0,392036
-1960,86	163,405	-1969,6	-8,74155	0,443823
-1642,86	164,286	-1641,33	1,525375	-0,09294
-1307,86	163,4825	-1313,07	-5,2077	0,396606
-978,36	163,06	-984,801	-6,44078	0,654018
-653,86	163,465	-656,534	-2,67385	0,407268
-327,26	163,63	-328,267	-1,00693	0,30674
0		0	0	
331,04	165,52	328,2669	-2,77307	-0,84476
658,64	164,66	656,5339	-2,10615	-0,3208
985,24	164,2067	984,8008	-0,43922	-0,0446
1311,14	163,8925	1313,068	1,9277	0,146809
1642,14	164,214	1641,335	-0,80537	-0,04907
1966,14	163,845	1969,602	3,46155	0,175749
2298,14	164,1529	2297,868	-0,27152	-0,01182
2622,14	163,8838	2626,135	3,9954	0,15214
2952,14	164,0078	2954,402	2,262325	0,076575
3275,14	163,757	3282,669	7,529251	0,229364
4914,14	163,8047	4924,004	9,863876	0,200322
6588	164,7	6565,339	-22,6615	-0,34517
8241,14	164,8195	8206,837	-34,3027	-0,41798
16461,14	164,8207	16392,5	-68,6387	-0,41872
24711,14	164,8124	24609,35	-101,789	-0,41362
average	164,1335			

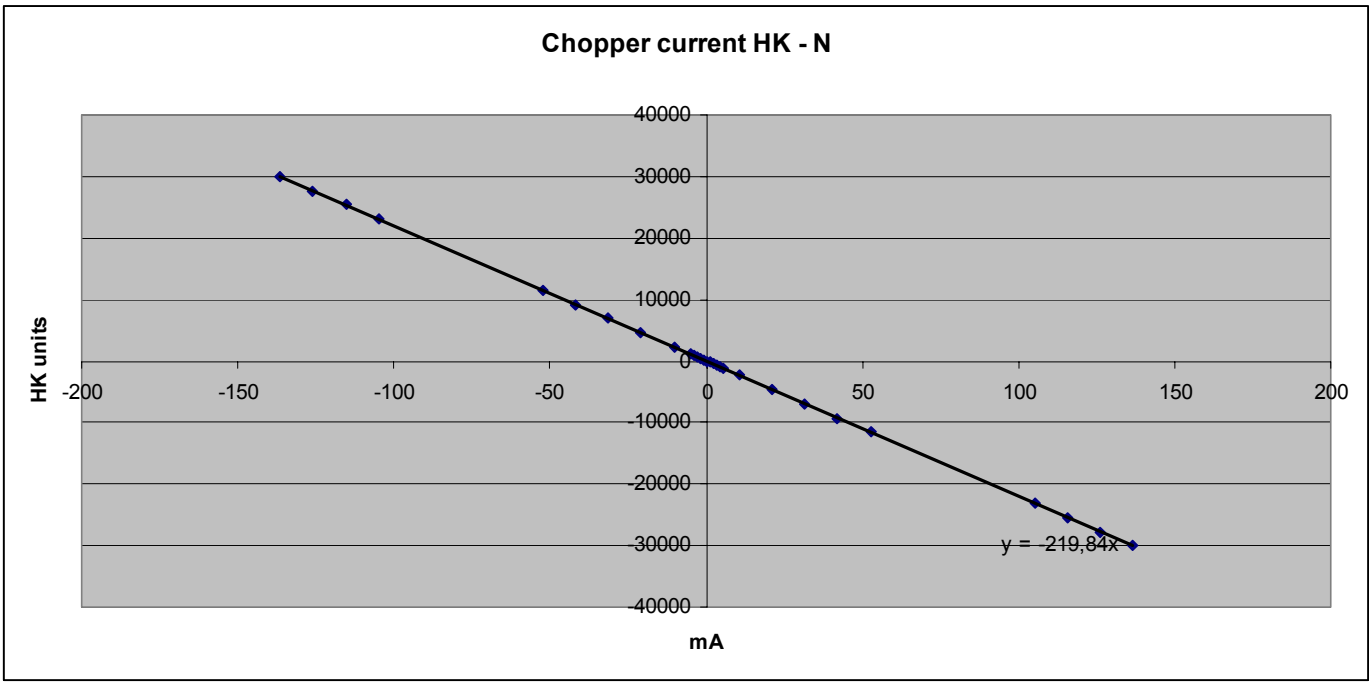
For each data point, the above table shows the slope of the line (origin, data point)
Using the average of the slopes as the calibration constant :
Output (offset corrected ADC units) = input (mV) * 164.1335
The deviation from this straight line is less than 1%

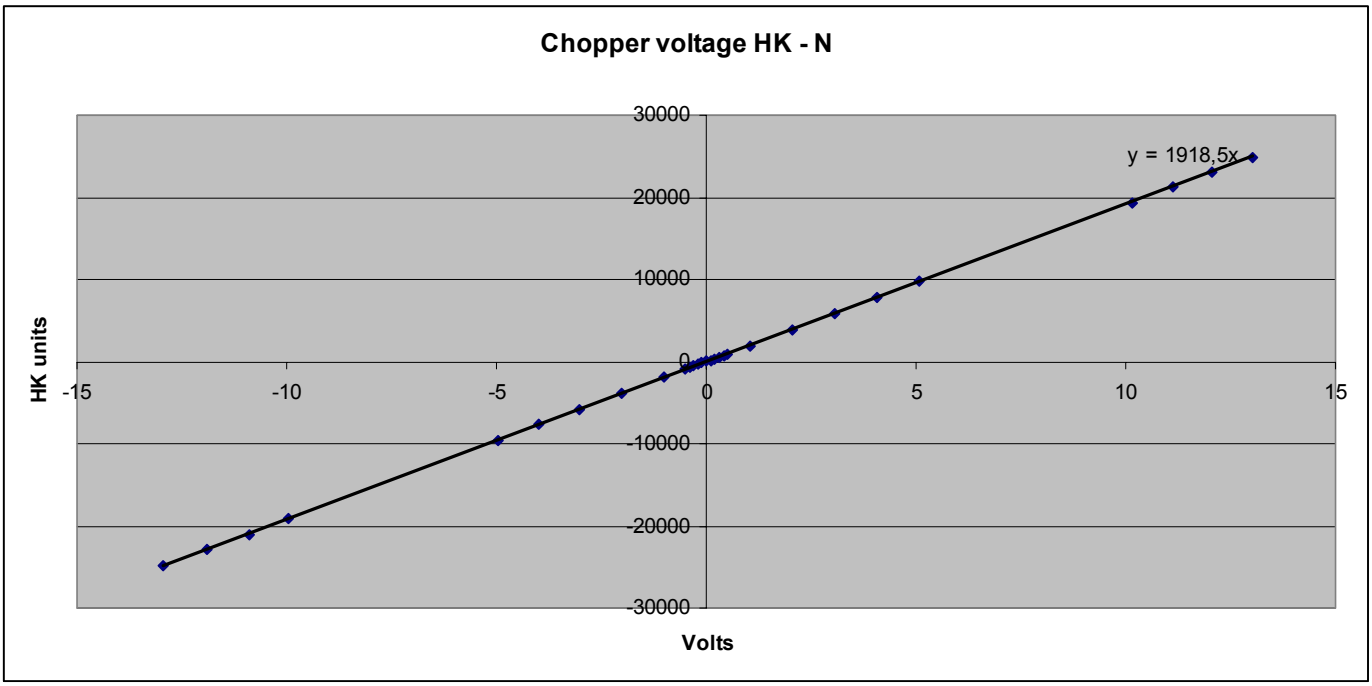
3.3.2 Chopper current output, current and voltage HK

Command HK ID 258	Current Exp (mA)	Current meas (mA)	ICHOPA Expected HK units	I (HK) units avg	Vload Exp (V)	Vload meas	VCHOPA Expected HK units	VCHOPA HK ID 557 (signed)	VCHOPB HK ID 565 (signed)	Difference (Vb – Va)
32767	130	136.644	28966	-30041	13	13.01	12566	-11634,6	13297,82	24932,37
30246	120	126.143	26738	-27734	12	12.07	11600	-10717,1	12376,05	23093,17
27726	110	115.646	24510	-25427	11	11.12	10633	-9792,16	11447,22	21239,38
25205	100	105.145	22282	-23119	10	10.15	9666	-8867,32	10518,51	19385,82
12603	50	52.634	11141	-11575	5	5.09	4833	-4042,64	5676,46	9719,11
10082	40	42.129	8913	-9265,9	4	4.08	3867	-3075,02	4706,7	7781,72
7562	30	31.629	6684	-6957,5	3	3.06	2900	-2105,74	3734,27	5840,01
5041	20	21.125	4456	-4648,5	2	2.04	1933	-1134	2761,49	3895,5
2521	10	10.622	2228	-2339,6	1	1.03	967	-163,29	1786,86	1950,15
1260	5	5.368	1114	-1183,9	0,5	0.519	483	324,02	1299,27	975,25
1008	4	4.317	891	-953,73	0,4	0.417	387	421,56	1201,78	780,22
756	3	3.268	668	-722,71	0,3	0.315	290	518,5	1103,89	585,39
504	2	2.217	446	-491,54	0,2	0.21	193	615,47	1006,87	391,4
252	1	1.168	223	-260,92	0,1	0.11	97	712,87	909,57	196,7
0	0	0.117	0	-29,7	0	0.01	0	810,45	811,81	1,36
-252	-1	-0.9433	-223	202,17	-0,1	-0.1	-97	909,57	715,11	-194,46
-504	-2	-1.9939	-446	433,25	-0,2	-0.192	-193	1006,94	616,93	-390,01
-756	-3	-3.038	-668	664,08	-0,3	-0.294	-290	1102,11	521,21	-580,91
-1008	-4	-4.089	-891	894,59	-0,4	-0.395	-387	1198,81	424,12	-774,68
-1260	-5	-5.138	-1114	1128,2	-0,5	-0.49	-483	1296,55	326,08	-970,47
-2521	-10	-10.390	-2228	2280,6	-1	-1.00	-967	1778,7	-158,92	-1937,62
-5041	-20	-20.891	-4456	4588,9	-2	-2.00	-1933	2744,01	-1126,98	-3870,98
-7562	-30	-31.395	-6684	6898,4	-3	-3.01	-2900	3704,57	-2092,68	-5797,25
-10082	-40	-41.894	-8913	9206,2	-4	-4.00	-3867	4660,46	-3051,74	-7712,2
-12603	-50	-52.395	-11141	11514	-5	-4.98	-4833	5604,51	-4000,02	-9604,52
-25205	-100	-104.898	-22282	23057	-10	-9.95	-9666	10362,44	-8778,05	-19140,5
-27726	-110	-115.401	-24510	25366	-11	-10.9	-10633	11304,12	-9723,61	-21027,7
-30246	-120	-125.903	-26738	27674	-12	-11.9	-11600	12253,3	-10677,6	-22930,9
-32767	-130	-136.413	-28966	29985	-13	-12.96	-12566	13220,93	-11649,3	-24870,2

Script name : diagChop.txt

Note : calibration done in absolute values, without regard to current flow direction. Consistency of signs in HK variables to be checked on actual FM setup. See formula for computing actual coil voltage in User Manual.





Note : vertical axis is the difference between HK variables VCHOPB and VCHOPA
Horizontal axis is the voltage measured at the DEC/MEC connector

3.3.3 SPU housekeeping

3.3.3.1 Quick functional test

pin	signal	interface	Test signal	HK units	HK value	HK ID	measured
1	TH_SPU_SWL_A	T° sensor SWL DSP	2.20 K	-360	80.3°C	420	
9	TH_SPU_SWL_B						
2	TH_SPU_LWL_A	T° sensor LWL DSP	10.0 K	-1638	35.3°C	421	
10	TH_SPU_LWL_B						
3	TH_SPU _A	T° sensor DC/DC	200 K	-32767	-10°	422	
11	TH_SPU_B						
4	VCC_CUR_HK_P	VCC current monitoring	10K, 0V (apply 75 mV)	0 => 24575	0 => 5A	423	
12	VCC_CUR_HK_N						
5	VCC_VOL_HK_P	VCC voltage monitoring	10K, 0V (apply 3 V)	0 => 9830	0 => 15 V	424	
13	VCC_VOL_HK_N						
6	VP_CUR_HK_P	VP current monitoring	10K, 0V (apply 75mV)	0 => 24211	0 => 133 mA	425	
14	VP_CUR_HK_N						
7	VP_VOL_HK_P	VP voltage monitoring	10K, 0V (apply 4 V)	0 => 26214	0 => 5 V	419	
15	VP_VOL_HK_N						
8	NC	NC	NA	NA	NA		

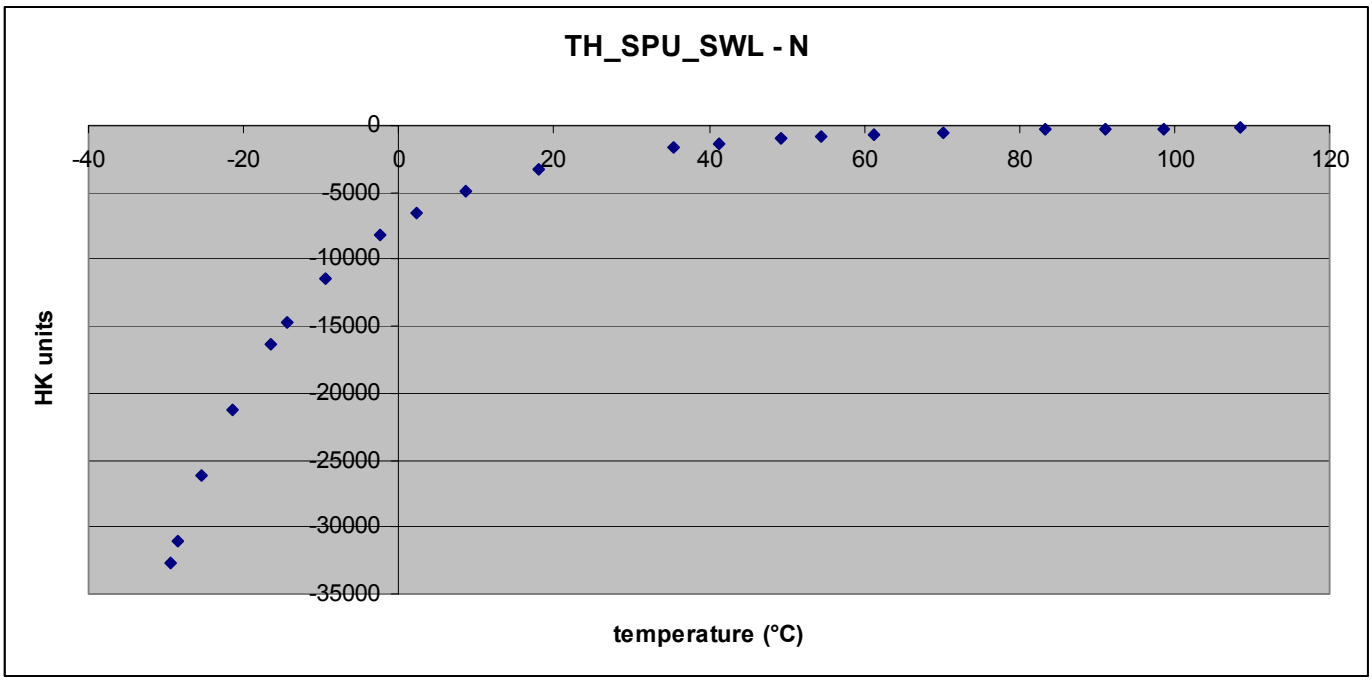
3.3.3.2 Temperature channels measurements

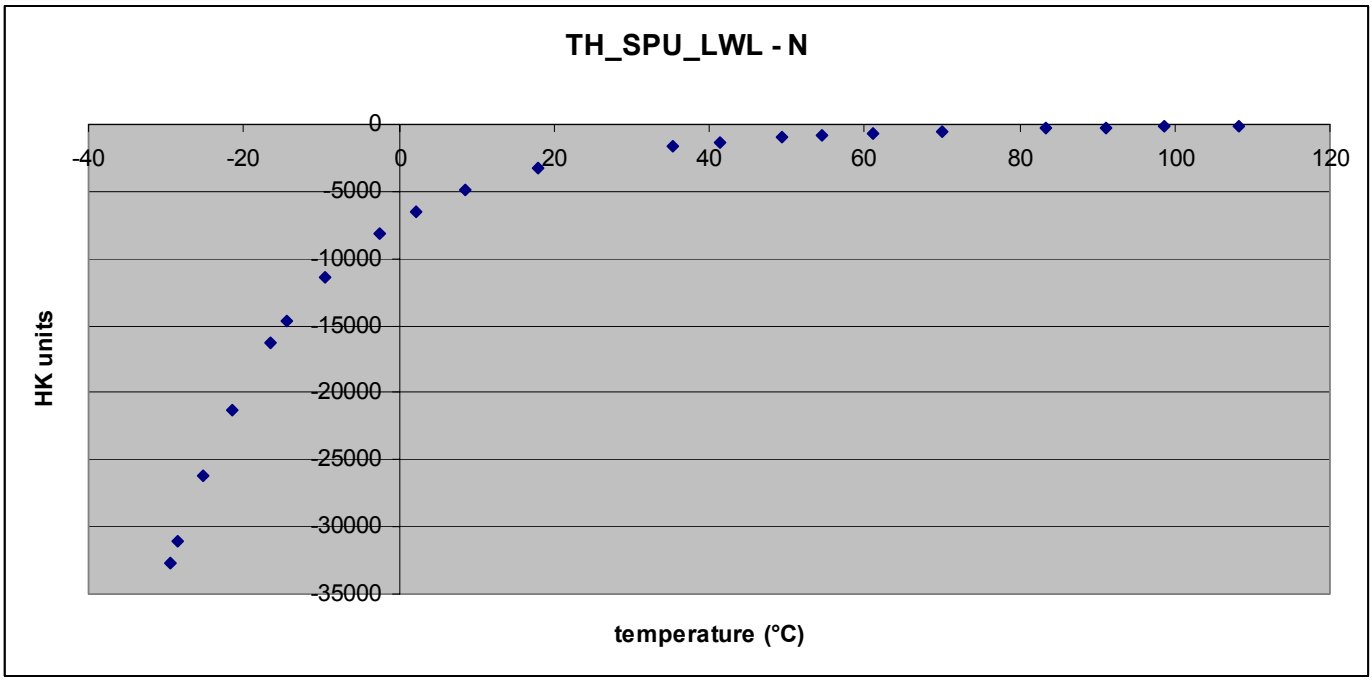
Connect decade resistor box to pins 1-9 then 2-10 then 3-11
Record diagnostic HK on channels 420-421-422-428 at 64 Hz (16 ms)
Perform the following measurements :

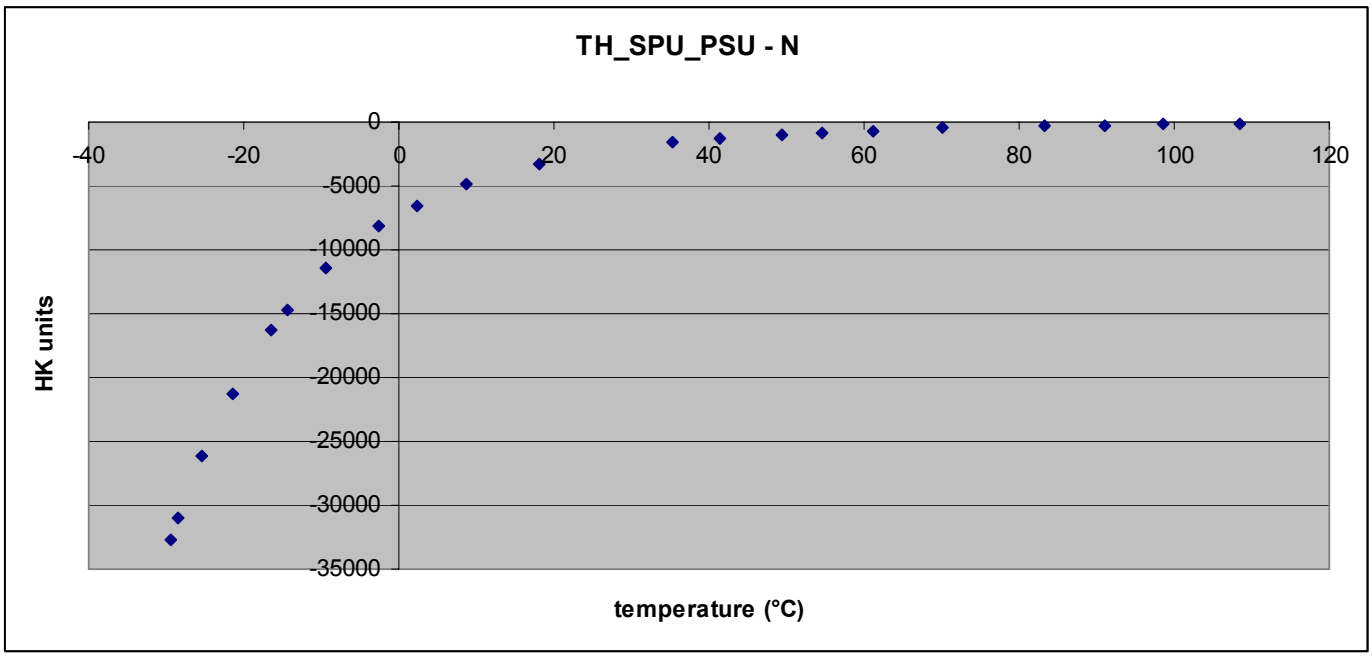
Resistance value	Simulated T°	Expected HK value	Pins 1-9 TH_SPU_SWL HK_ID 420	Pins 2-10 TH_SPU_LWL HK_ID 421	Pins 3-11 TH_PSU HK_ID 422	
0	NA	0	-4.70	-3,5	-5	
1000	108.38	-164	-168	-170	-168	
1300	98.56	-213	-217	-207,5	-216,5	
1600	91.11	-262	-267	-267	-266	
2000	83.39	-328	-332	-332	-331,5	
3000	70.10	-492	-496	-494,5	-494,5	
4000	61.19	-655	-660	-658,5	-658	
5000	54.56	-819	-823	-820,5	-820,5	
6000	49.30	-983	-987	-984,5	-984,5	
8000	41.31	-1311	-1314	-1310	-1310,5	
10000	35.35	-1638	-1642	-1638,5	-1636,5	
20000	18	-3277	-3279	-3272	-3268,5	
30000	8.61	-4915	-4918	-4907	-4902,5	
40000	2.25	-6553	-6556	-6541	-6535,5	
50000	-2.52	-8912	-8194	-8175	-8168	
70000	-9.46	-11468	-11468	-11443	-11433	
90000	-14.45	-14745	-14744	-14714	-14698	
100000	-16.50	-16384	-16382	-16345	-16331	
130000	-21.48	-21299	-21295	-21251	-21227	
160000	-25.32	-26214	-26206	-26148	-26124	
190000	-28.42	-31129	-31120	-31051	-31021	
200000	-29.33	-32767	-32755	-32684	-32655	
0V offset HK ID 428 (averaged)			-4.70	-4,5	-5	

Script file diagSpuHk.txt

Note : one HK file per channel , all other channels shorted
Figures in table are raw HK values, offset not subtracted, averaged over the available number of readings
(xls files : DiagSpuSWL, DiagSpuLWL, DiagSpuPSU)


TH_SPU_SWL - N
HK units
temperature (°C)
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40
-20
0
20
40
60
80
100
120


TH_SPU_LWL - N
HK units
temperature (°C)
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40
-20
0
20
40
60
80
100
120



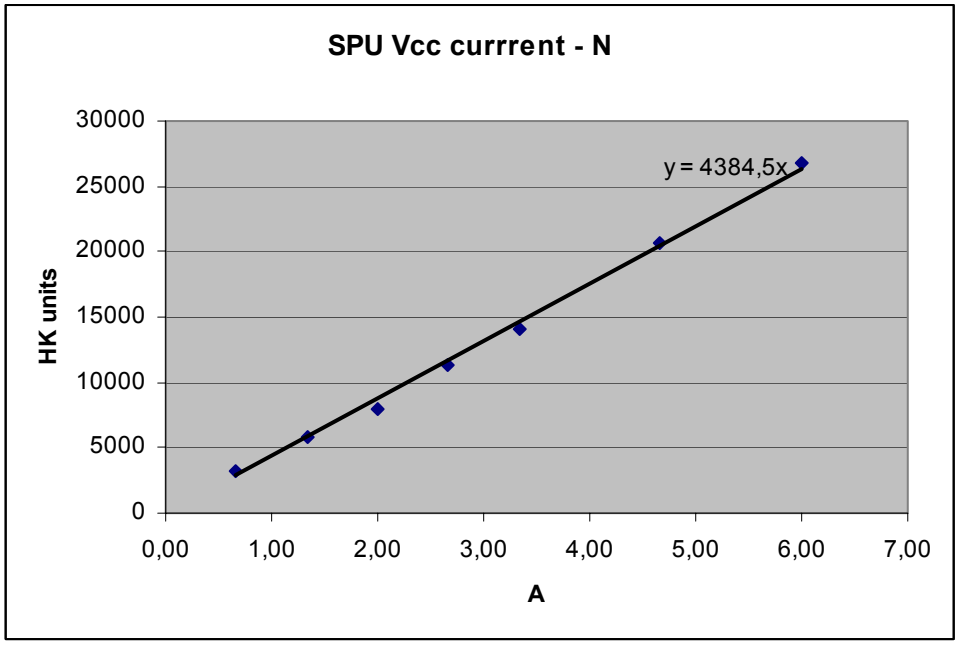
Temperature charts are based on nominal 15K sensor data, for illustration purposes. See User Manual for HK units to T° conversion procedure and use the "resistance – HK units" data from the table above.

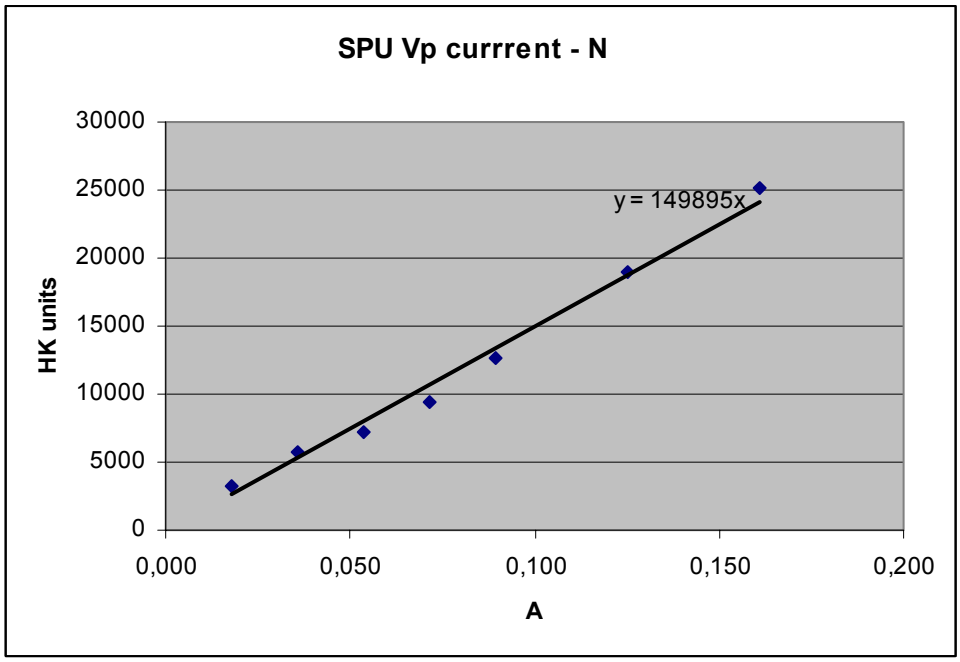
3.3.3.3 Voltage/current channels measurements

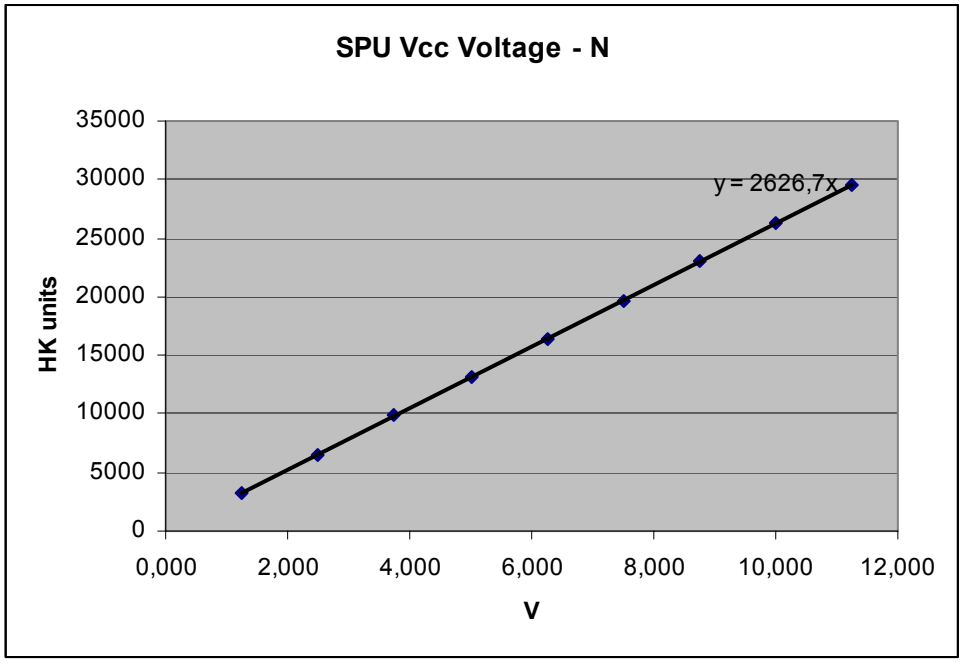
Connect voltage divider output to pins 4-12 then 5-13 then 6-14 then 5-15
Applied voltage should be accurate to +/- 0.1% (use calibrated voltmeter)
Record diagnostic HK on channels 423-424-425-419-428 at 64 Hz (16 ms)
Perform the following measurements :

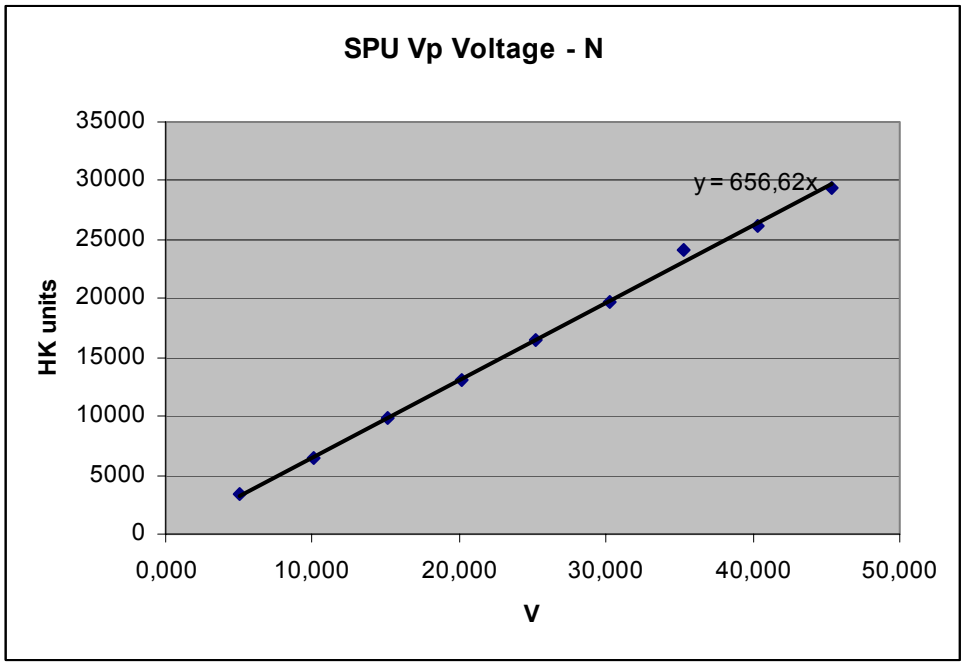
Applied voltage	Expected HK value	Pins 4-12 Vcc_cur_HK HK_ID 423	Pins 5-13 Vcc_vol_HK HK_ID 424	Pins 6-14 Vp_cur_HK HK_ID 425	Pins 7-15 Vp_vol_HK HK_ID 419	Offset 0V reference HK ID 428
10mV	3268	3262		3247		
20mV	6536	5790		5670		
30mV	9804	8031		7148		
40mV	13072	11285		9401		
50mV	16340	14024		12584		
70mV	22876	20724		18989		
90mV	29412	26832		25079		
1V	3268		3286		3314,5	
2V	6536		6572		6534	
3V	9804		9847		9803,5	
4V	13072		13133		13071,5	
5V	16340		16429		16492	
6V	19608		19700		19624,5	
7V	22876		22979		24194	
8V	26144		26282		26208	
9V	29412		29533		29405,5	
OV ref (averaged)		-4	-5,5	-6	-4	

Note : do not perform combinations where cells are colored
Note : record averages from individual measurements
Files diagSpuICC, diagSpuIP, diagSpuVCC, diagSpuVP


SPU Vcc currrent - N
HK units
A
y = 4384,5x
30000
25000
20000
15000
10000
5000
0
0,00
1,00
2,00
3,00
4,00
5,00
6,00
7,00


SPU Vp currrent - N
HK units
A
y = 149895x
30000
25000
20000
15000
10000
5000
0
0,000
0,050
0,100
0,150
0,200


SPU Vcc Voltage - N
y = 2626,7x
HK units
35000
30000
25000
20000
15000
10000
5000
0
0,000
2,000
4,000
6,000
8,000
10,000
12,000
V


SPU Vp Voltage - N
y = 656,62x
HK units
35000
30000
25000
20000
15000
10000
5000
0
0,000
10,000
20,000
30,000
40,000
50,000
V

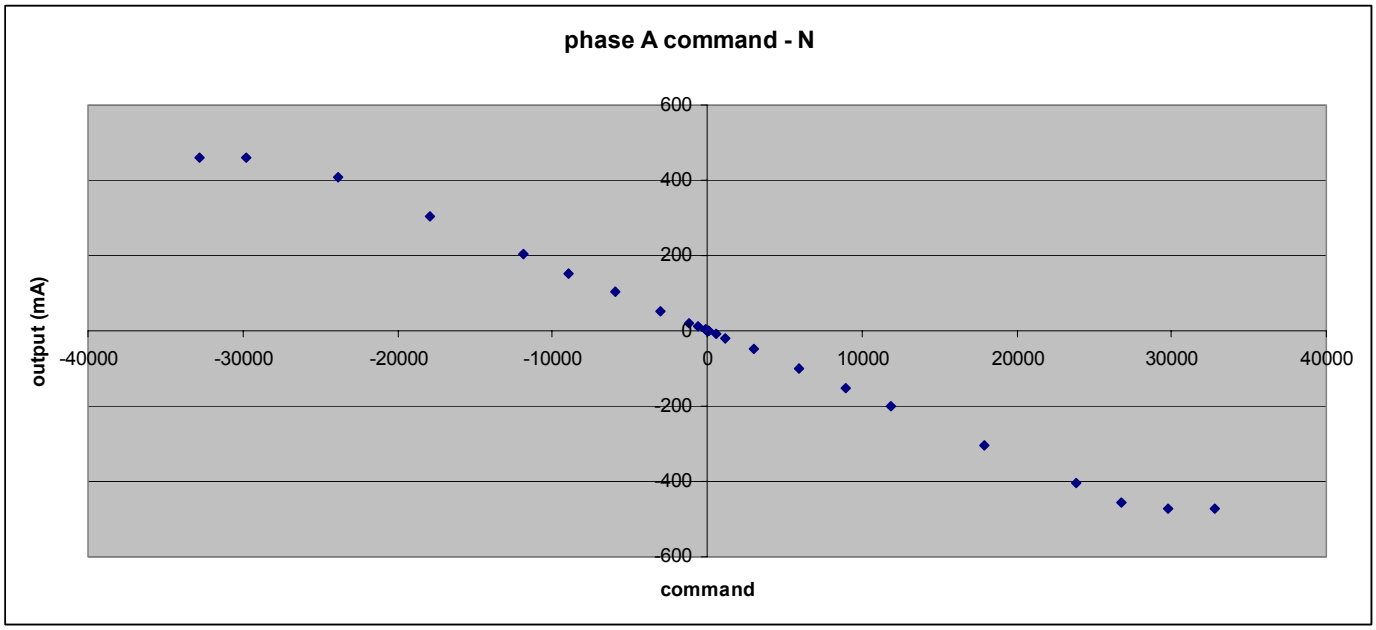
3.4 MIM3

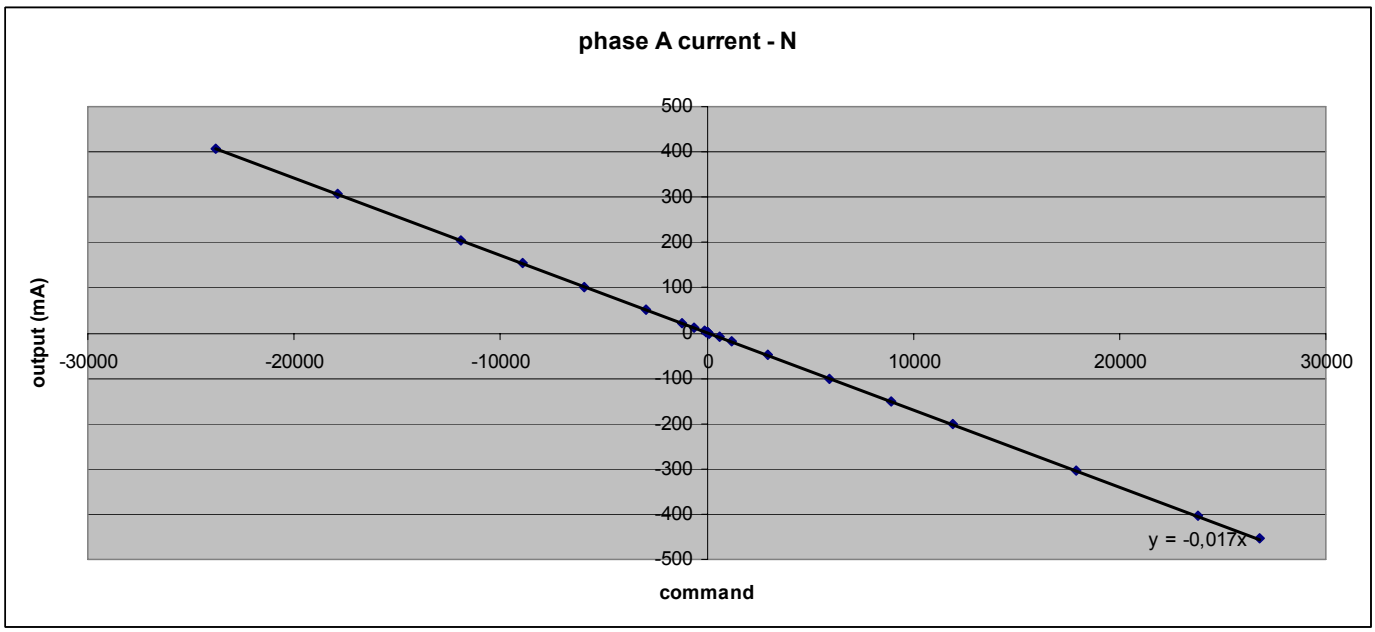
3.4.1 Amplifiers current output, Amplifiers current and voltage HK

Set the grating to "open loop" mode such that the OBSW directly commands the amplifier current, with the closed loop controller inactive
Using the OBSW commands, set a number of current levels, first on phase A, then on phase B

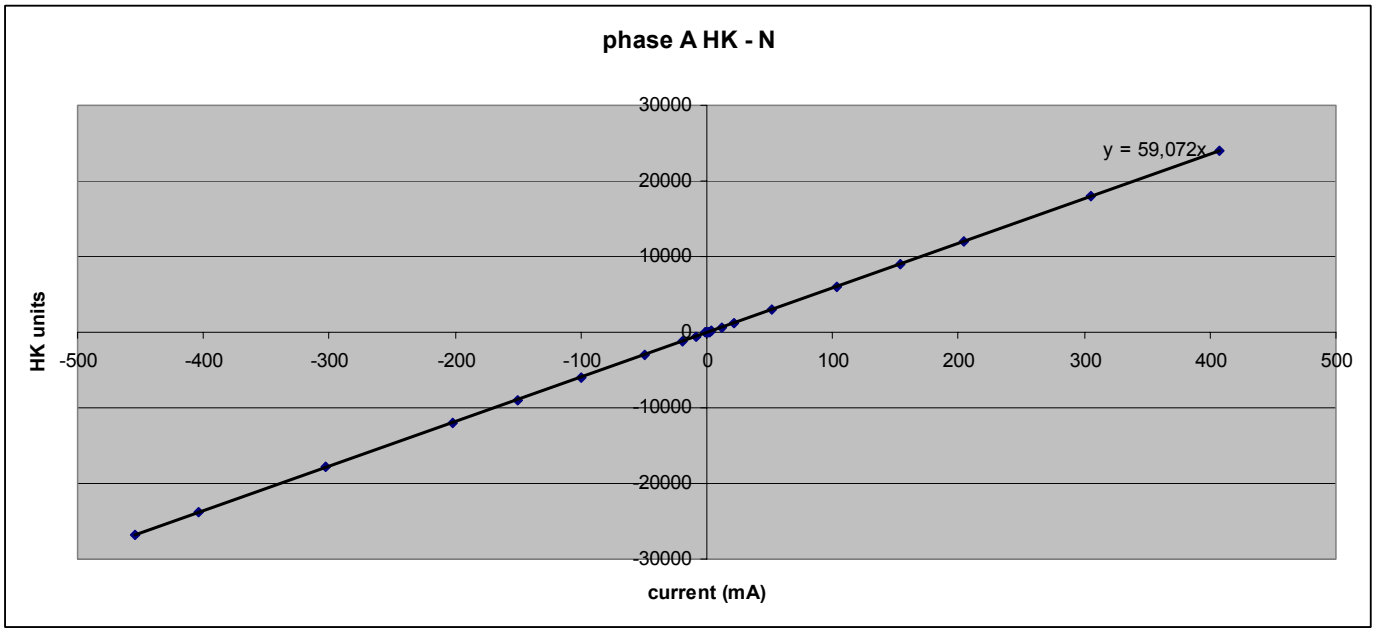
3.4.1.1 Calibration table – phase A

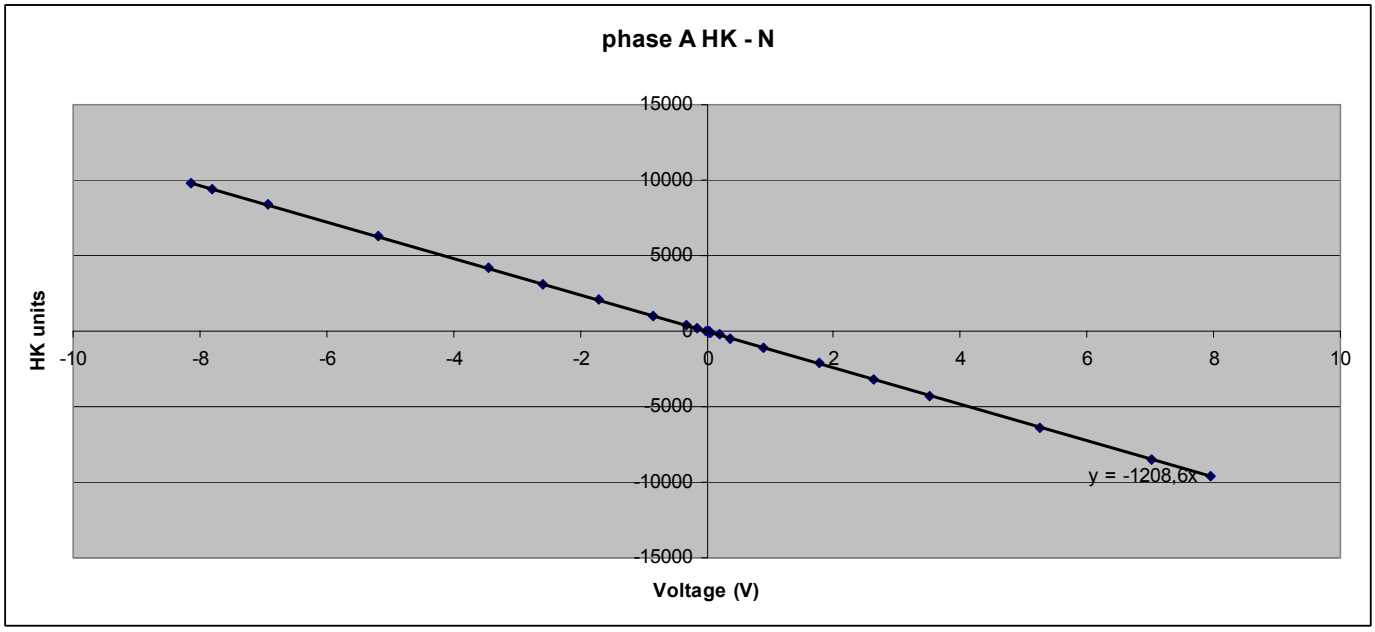
Command		Current Exp (mA)	Current meas (mA)	IMOTA Expected HK units	IMOTA recorded HK ID 560	Vload Exp (V)	Vload meas	VMOTA Expected HK units	VMOTA recorded HK ID 556	0V ref ID 428
dec	hex									
32767	7FFF0000	550	-473.1	32767	-27994	9,35	-8.13	7659	9820	
29788	745C0000	500	-473.72	29788	-27994	8,5	-8.13	6963	9820	
26809	68B90000	450	-454.76	26809	-26889	7,65	-7.80	6267	9422	
23831	5D170000	400	-404.11	23831	-23885	6,8	-6.93	5570	8363	
17873	45D10000	300	-302.74	17873	-17894	5,1	-5.185	4178	6262	
11915	2E8B0000	200	-201.35	11915	-11904	3,4	-3.448	2785	4162	
8936	22E80000	150	-150.67	8936	-8910	2,55	-2.580	2089	3114	
5958	17460000	100	-100.00	5958	-5915	1,7	-1.713	1393	2065	
2979	0BA30000	50	-49.307	2979	-2922	0,85	-0.845	696	1018	
1192	04A80000	20	-18.911	1192	-1124	0,34	-0.324	279	388,5	
596	02540000	10	-8.772	596	-525	0,17	-0.151	139	178,5	
119	00770000	2	-0.652	119	-45	0,034	-0.013	28	11,5	
60	003C0000	1	0.352	60	14,5	0,017	0.006	14	-10,5	
0	00000000	0	1.371	0	75	0	0.024	0	-33	
-60	FFC40000	-1	2.377	-60	136.5	-0,017	0.042	-14	-54,5	
-119	FF890000	-2	3.382	-119	194	-0,034	0.059	-28	-75	
-596	FDAC0000	-10	11.507	-596	674	-0,17	0.199	-139	-243,5	
-1192	FB580000	-20	21.663	-1192	1273	-0,34	0.373	-279	-456	
-2979	F45D0000	-50	52.098	-2979	3070	-0,85	0.897	-696	-1089	
-5958	E8BA0000	-100	102.840	-5958	6062	-1,7	1.771	-1393	-2148	
-8936	DD180000	-150	153.552	-8936	9058	-2,55	2.644	-2089	-3204	
-11915	D1750000	-200	204.284	-11915	12054	-3,4	3.518	-2785	-4264	
-17873	BA2F0000	-300	305.760	-17873	18040	-5,1	5.264	-4178	-6377	
-23831	A2E90000	-400	407.228	-23831	24028	-6,8	7.02	-5570	-8494	
-29788	8BA40000	-500	461.99	-29788	27219	-8,5	7.95	-6963	-9610	
-32767	80010000	-550	461.00	-32767	27219	-9,35	7.94	-7659	-9610	





The first chart shows the effect of the current limiter included with the amplifier design. The second chart models the linear part of the transfer function.

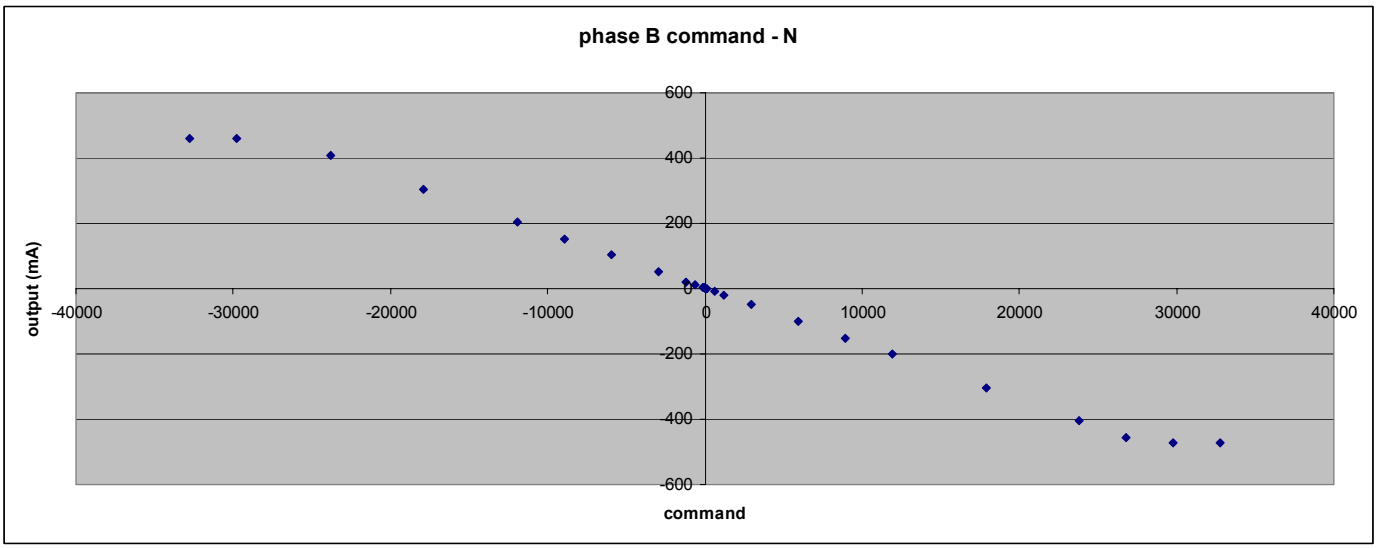

phase A HK - N
HK units
current (mA)
y = 59,072x
30000
20000
10000
0
-10000
-20000
-30000
-500
-400
-300
-200
-100
0
100
200
300
400
500

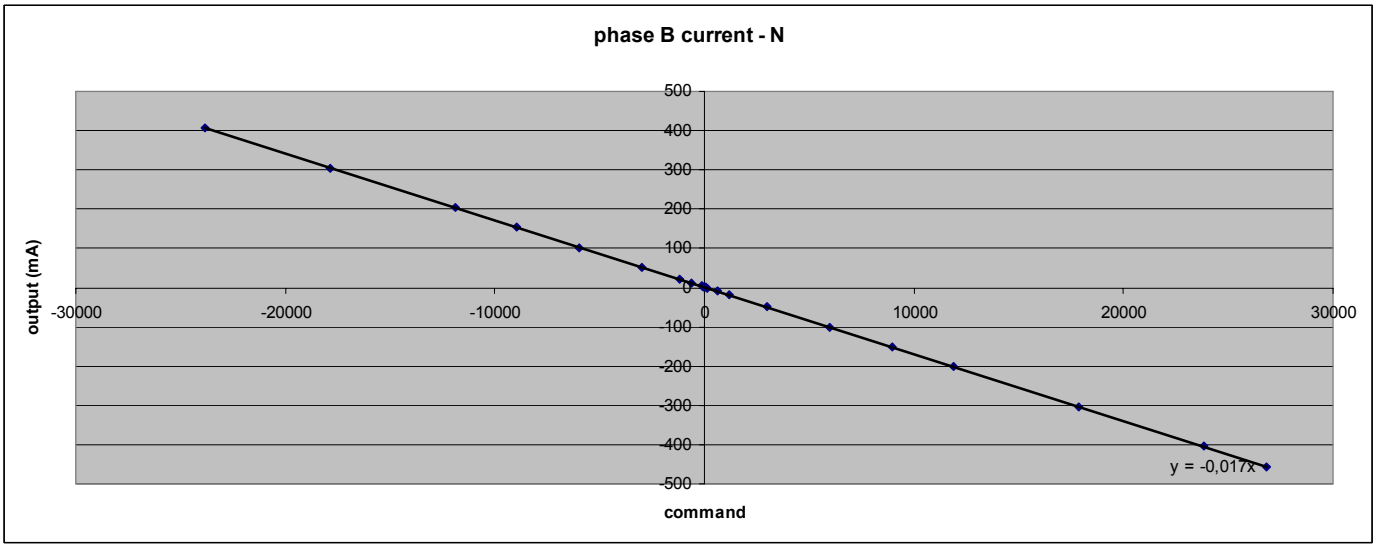

phase A HK - N
HK units
Voltage (V)
y = -1208,6x
15000
10000
5000
0
-5000
-10000
-15000
-10
-8
-6
-4
-2
0
2
4
6
8
10

Calibration table – phase B

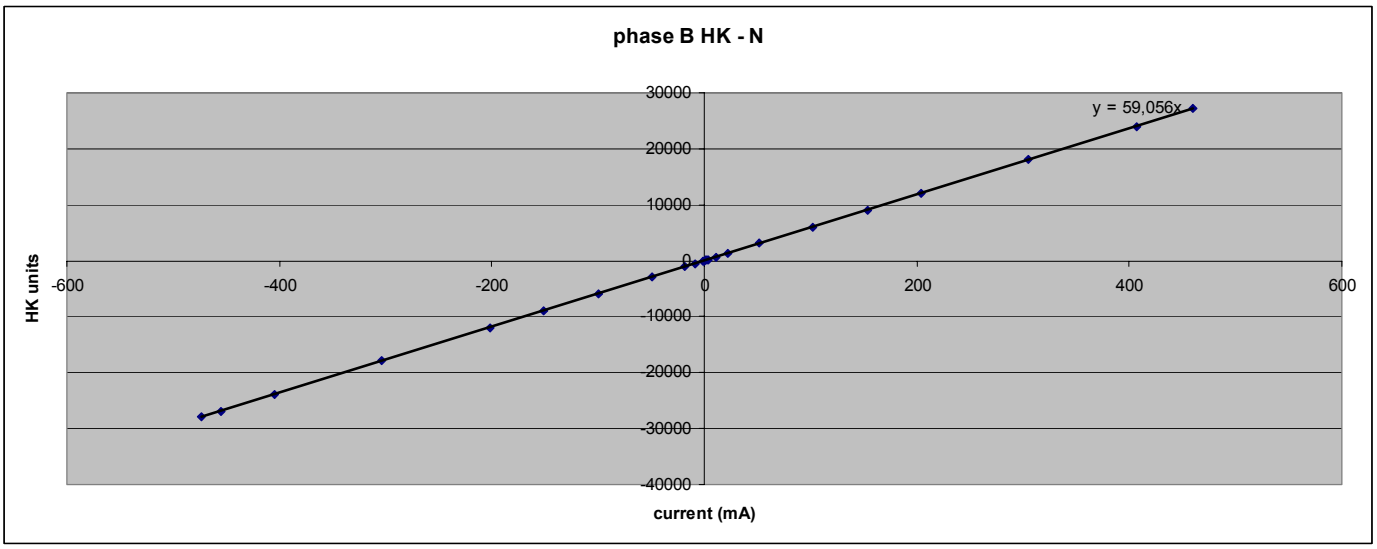
Command		Current Exp (mA)	Current meas (mA)	IMOTB Expected HK units	IMOTB recorded HK ID 567	Vload Exp (V)	Vload meas	VMOTB Expected HK units	VMOTB recorded HK ID 564	0V ref ID 428
dec	hex									
32767	7FFF	550	-473.779	32767	-27959	9,35	-8.01	7659	9774	
29788	745C	500	-473.830	29788	-27959	8,5	-8.00	6963	9774	
26809	68B9	450	-455.375	26809	-26869	7,65	-7.69	6267	9402	
23831	5D17	400	-404.659	23831	-23885	6,8	-6.84	5570	8342	
17873	45D1	300	-303.148	17873	-17895	5,1	-5.114	4178	6246	
11915	2E8B	200	-201.638	11915	-11903	3,4	-3.402	2785	4155	
8936	22E8	150	-150.877	8936	-8908	2,55	-2.545	2089	3106	
5958	1746	100	-100.156	5958	-5915	1,7	-1.690	1393	2062	
2979	0BA3	50	-49.402	2979	-2919	0,85	-0.834	696	1015	
1192	04A8	20	-18.949	1192	-1124	0,34	-0.321	279	386,5	
596	0254	10	-8.792	596	-525	0,17	-0.149	139	179	
119	0077	2	-0.674	119	-45	0,034	-0.013	28	10	
60	003C	1	0.336	60	15,5	0,017	0.005	14	-10,5	
0	0000	0	1.368	0	77	0	0.023	0	-32,5	
-60	FFC4	-1	2.346	-60	166	-0,017	0.040	-14	-64,5	
-119	FF89	-2	3.349	-119	195	-0,034	0.057	-28	-72	
-596	FDAC	-10	11.457	-596	676	-0,17	0.194	-139	-242,5	
-1192	FB58	-20	21.605	-1192	1274	-0,34	0.366	-279	-451	
-2979	F45D	-50	51.978	-2979	3070	-0,85	0.878	-696	-1077	
-5958	E8BA	-100	102.646	-5958	6067	-1,7	1.735	-1393	-2123	
-8936	DD18	-150	153.283	-8936	9060	-2,55	2.590	-2089	-3167	
-11915	D175	-200	203.916	-11915	12052	-3,4	3.445	-2785	-4212	
-17873	BA2F	-300	305.201	-17873	18042	-5,1	5.156	-4178	-6303	
-23831	A2E9	-400	406.517	-23831	24031	-6,8	6.87	-5570	-8396	
-29788	8BA4	-500	460.262	-29788	27207	-8,5	7.78	-6963	-9508	
-32767	8001	-550	460.172	-32767	27207	-9,35	7.78	-7659	-9508	

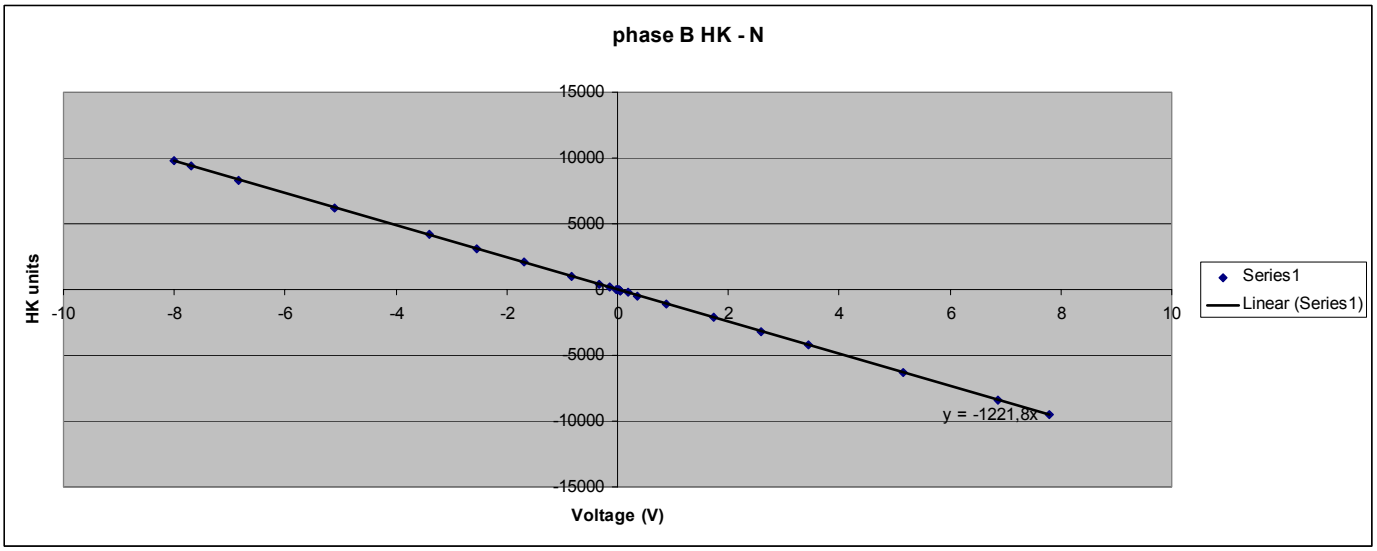
Script name diagGratFW





The first chart shows the effect of the current limiter included with the amplifier design. The second chart models the linear part of the transfer function.


phase B HK - N
y = 59,056x
30000
20000
10000
0
-10000
-20000
-30000
-40000
-600
-400
-200
0
200
400
600
HK units
current (mA)


phase B HK - N
15000
10000
5000
0
-5000
-10000
-15000
-10
-8
-6
-4
-2
0
2
4
6
8
10
y = -1221,8x
Series1
Linear (Series1)
HK units
Voltage (V)

3.4.1.2 Monitoring table – power supplies – script name diagGratW2

	HK 554 V1 voltage	HK 409 V1 current	HK 558 V2 voltage	HK 410 V2 current	HK 562 V3 voltage	HK 411 V3 current	HK 568 V4 voltage	HK 412 V4 current
A = 550 mA								
A = -550 mA								
B = 550 mA								
B = -550 mA								
A=B=0								

3.4.2 Inductosyn drive voltage

3.4.2.1 Inductosyn drive calibration table

Amplitude command	Expected output (pins 13-25 open)	Measured output (pins 13-25 open)	Expected output (pins 13-25 closed)	Measured output (pins 13-25 shorted)
Default value	1V p/p	1.6	10V p/p	16
4095	1V p/p	1.59	10V p/p	15.3
2048	0.5 Vp/p	0.8	5 Vp/p	7.9
1024	0.25 Vp/p	0.4	2.5 Vp/p	4.0
512	0.125 Vp/p	0.2	1.25 Vp/p	2.0
256	62 mVp/p		620 mVp/p	1.0
128	31 mVp/p		310 mVp/p	0.5
64	15 mVp/p		150 mVp/p	250 mV
32	7.5 mVp/p		75 mVp/p	125 mV
16	3.75 mVp/p		37.5 mVp/p	60 mV
8			18.5 mVp/p	33 mV
4			9 mVp/p	
2			4.5 mVp/p	
1			2.25 mVp/p	
0	0		0	
Grating OFF	0		0	

Script name diagInductAmpli.txt
Note allow at least 2 minutes between changes
Noise level = 14 mV p/p (estimated on scope display)

3.4.3 Filter Wheels motors Hall effect sensors

3.4.3.1 FW1 Drive current verification

Send the OBSW command to select the Filter Wheel 1 (Spec) (2-58-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.74	2.83

Send the OBSW command to select the grating (this will deselect the filter wheels) (2-38-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

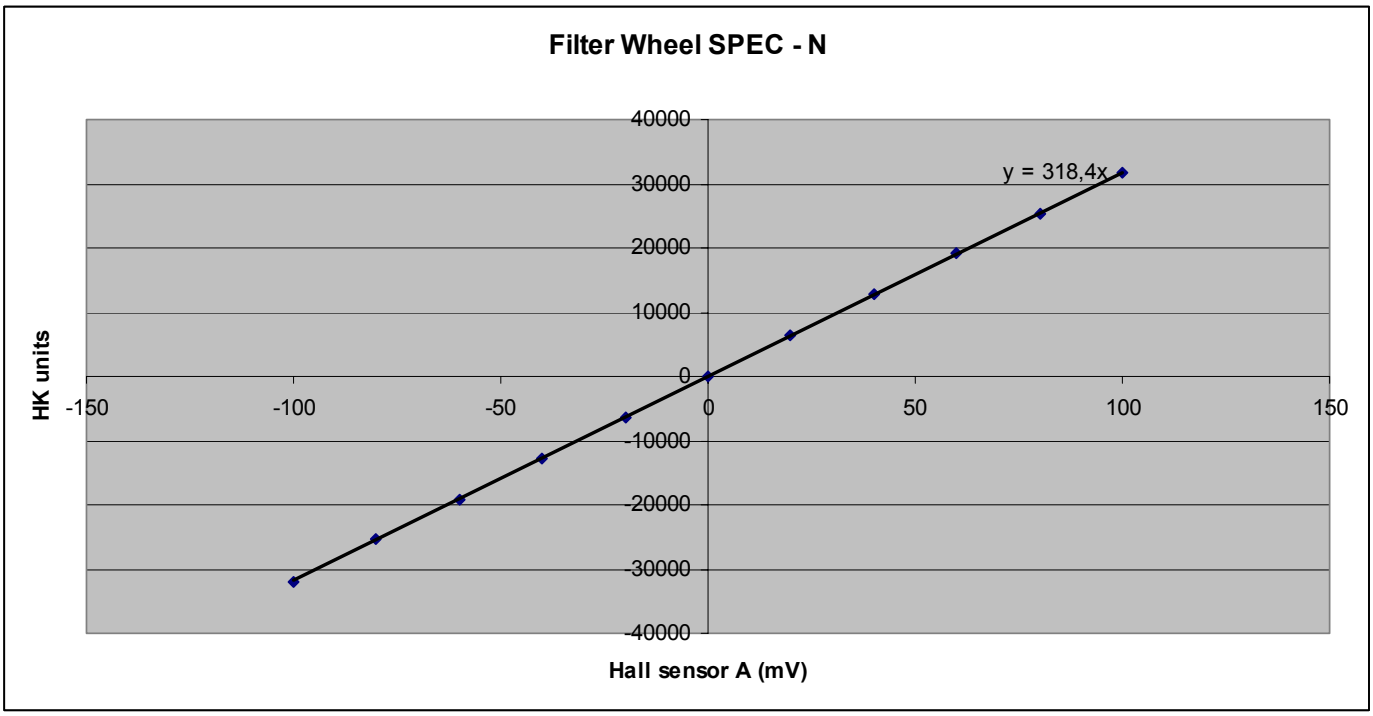
3.4.3.2 FW1 Readout amplifier calibration

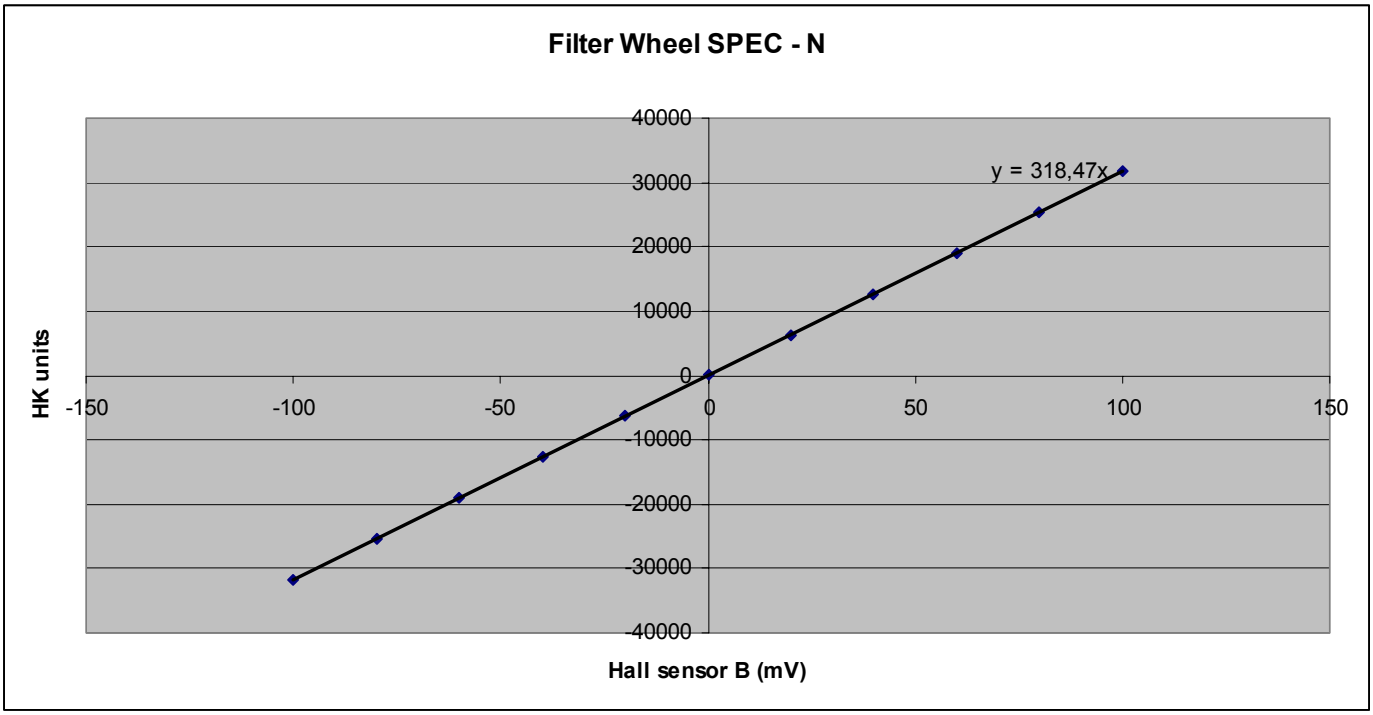
Send OBSW the command to power on the Filter Wheel 1 (2-58-0)
Record the HK measurements from HK ID 256 (A) and 257 (B) for several input levels

Input DC (mV)	Designed ADC input (V)	expected value	Recorded value A (HK 256)	Recorded value B (HK 257)	ADC offset (HK 428)
100	9,7	32013	31826	31825	-5
80	7,8	25610	25454	25482	-6
60	5,8	19208	19090	19117	-6
40	3,9	12805	12715	12750	-6
20	1,95	6402	6349	6374	-6
0	0	0	-10	2	-7
-20	-1,95	-6402	-6375	-6374	-6
-40	-3,9	-12805	-12754	-12745	-6
-60	-5,8	-19208	-19131	-19112	-6
-80	-7,8	-25610	-25447	-25484	-6
-100	-9,7	-32013	-31882	-31843	-8

Script name diagGratFWSpec

Send OBSW the command to power off the Grating (2-39-0)


Filter Wheel SPEC - N
y = 318,4x
HK units
Hall sensor A (mV)
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150


Filter Wheel SPEC - N
y = 318,47x
HK units
Hall sensor B (mV)
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150

Change connector to J14/J114

3.4.3.3 FW2 Drive current verification

Send the OBSW command to select the Filter Wheel 2 (Photo) (2-59-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.73	2.358

Send the OBSW command to select the grating (this will deselect the filter wheels) (2-38-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

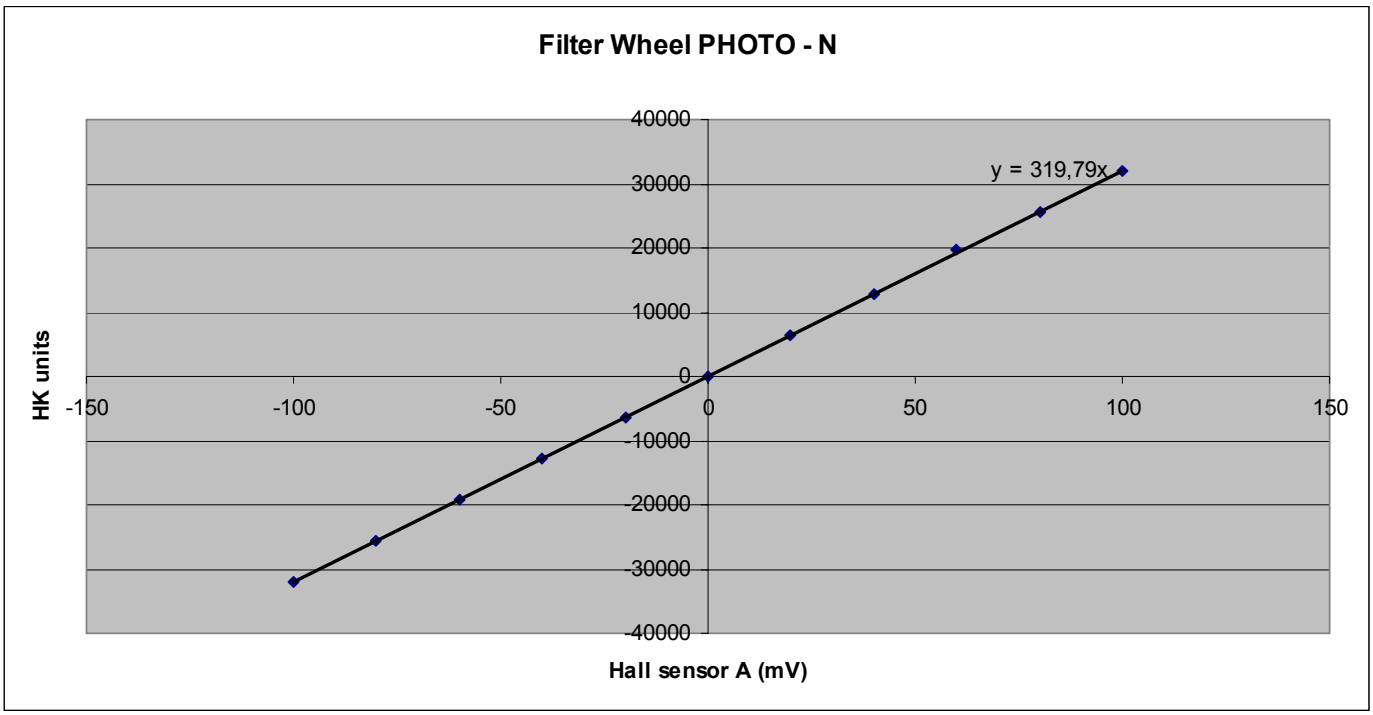
3.4.3.4 FW2 Readout amplifier calibration

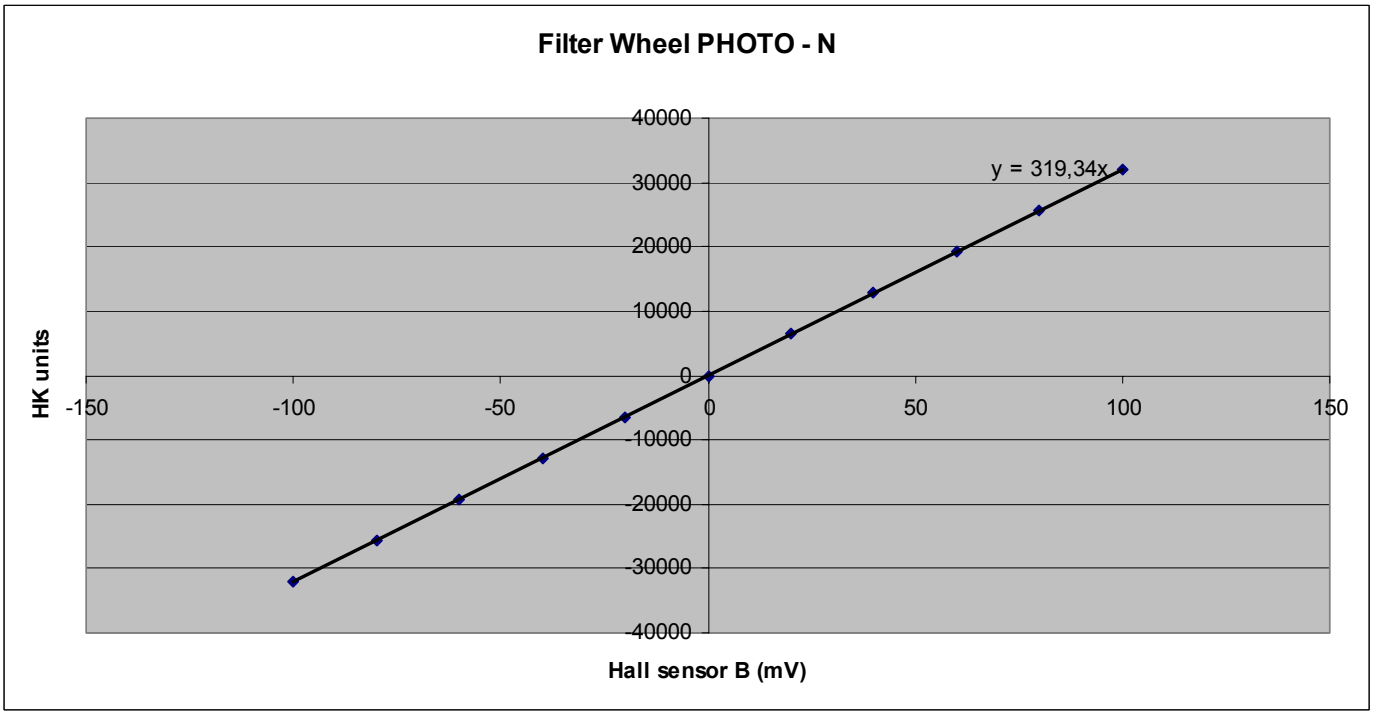
Send OBSW the command to power on the Filter Wheel 2 (2-59-0)
Record the HK measurements from HK ID 256 (A) and 257 (B) for several input levels

Input DC (mV)	Designed ADC input (V)	expected value	Recorded value A (HK 256)	Recorded value B (HK 257)	ADC offset (HK 428)
100	9,7	32013	31888	31947	-7
80	7,8	25610	25496	25534	-6
60	5,8	19208	19770	19151	-6
40	3,9	12805	12757	12762	-6
20	1,95	6402	6359	6394	-6
0	0	0	-11	-5	-6
-20	-1,95	-6402	-6385	-6391	-9
-40	-3,9	-12805	-12757	-12758	-9
-60	-5,8	-19208	-19150	-19161	-7
-80	-7,8	-25610	-25501	-25568	-10
-100	-9,7	-32013	-31916	-31930	-10

Script name diagGratFWPhoto

Send OBSW the command to power off the Grating (2-39-0)


Filter Wheel PHOTO - N
y = 319,79x
HK units
Hall sensor A (mV)
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150


Filter Wheel PHOTO - N
y = 319,34x
HK units
Hall sensor B (mV)
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150

3.4.4 Filter Wheels position sensors

3.4.4.1 FW1 Drive current verification

Move the test connector to J13/J113

Send the OBSW command to select the Filter Wheel 1 (Spec) (2-58-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.73	2.369

Send the OBSW command to select the grating (this will deselect the filter wheels) (2-38-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

Move the test connector to J14/J114

Send the OBSW command to select the Filter Wheel 2 (Photo) (2-59-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.73	2.369

Send the OBSW command to select the grating (this will deselect the filter wheels) (2-38-0)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

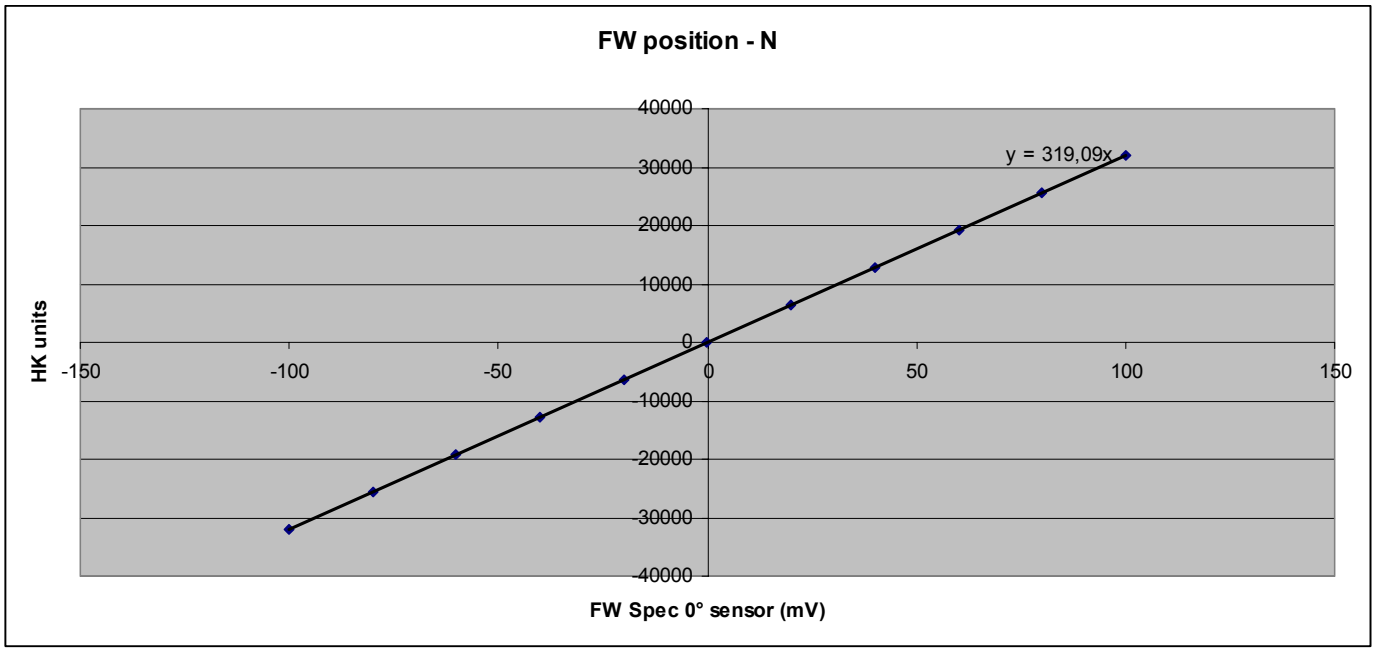
Send the OBSW command to deselect the grating (2-39-0)

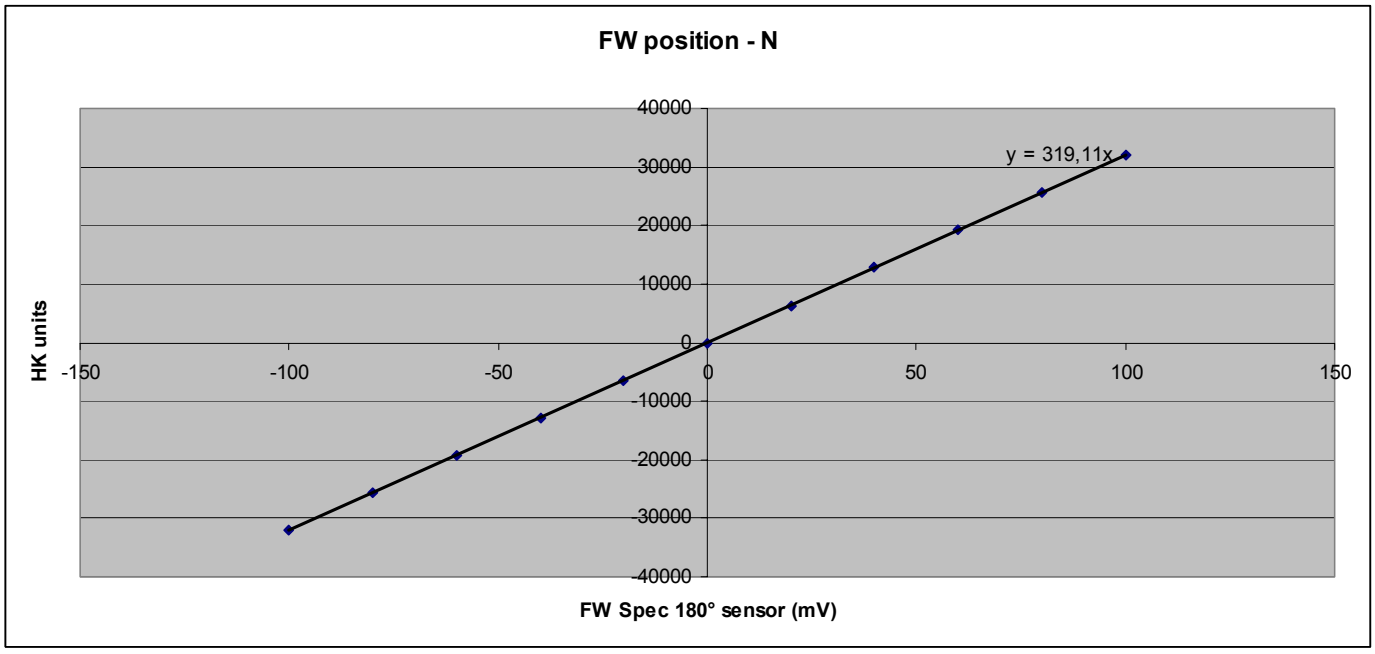
3.4.4.2 Readout amplifiers calibration

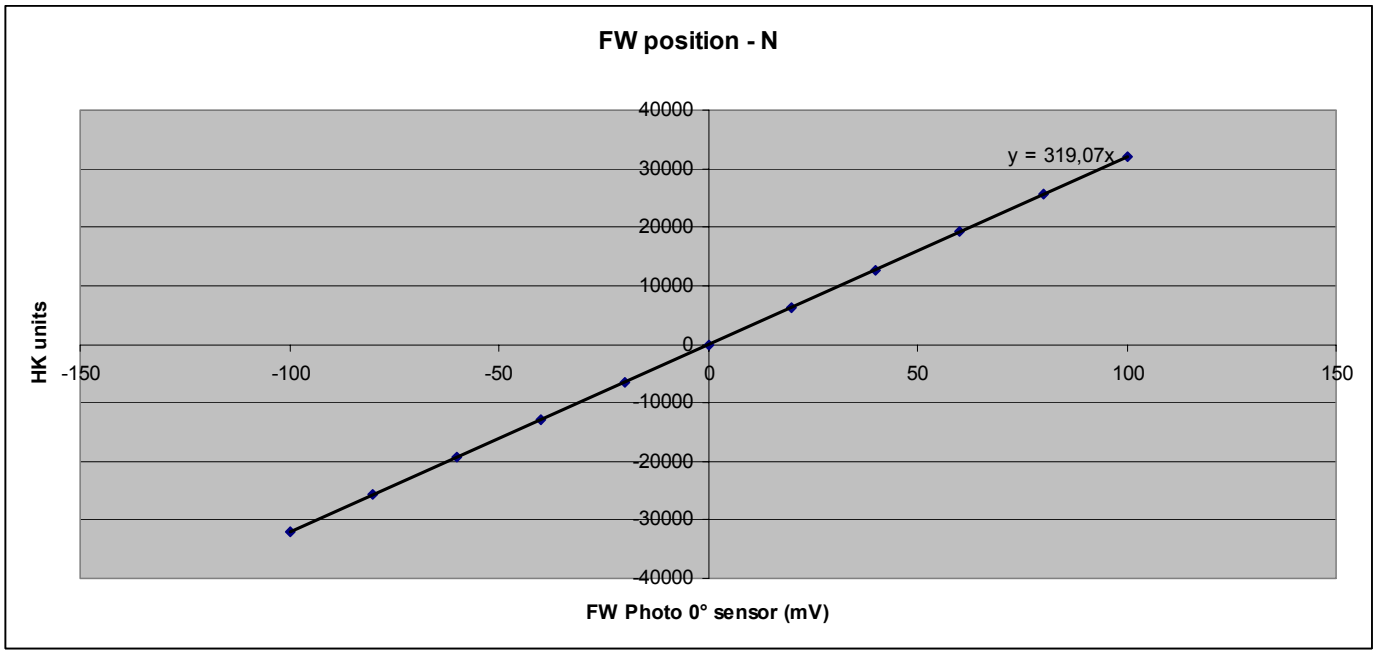
Apply a DC voltage differentially to the inputs as shown on the above diagram
The voltage should be in the range +/- 0 to 100 mV (amplifier gain spec = 97 X)
Send OBSW the command to power on Filter Wheel 1 , then Filter Wheel 2 after changing the test connector
Record the HK measurements from HK IDs 555, 559, 563, 569 for several input levels

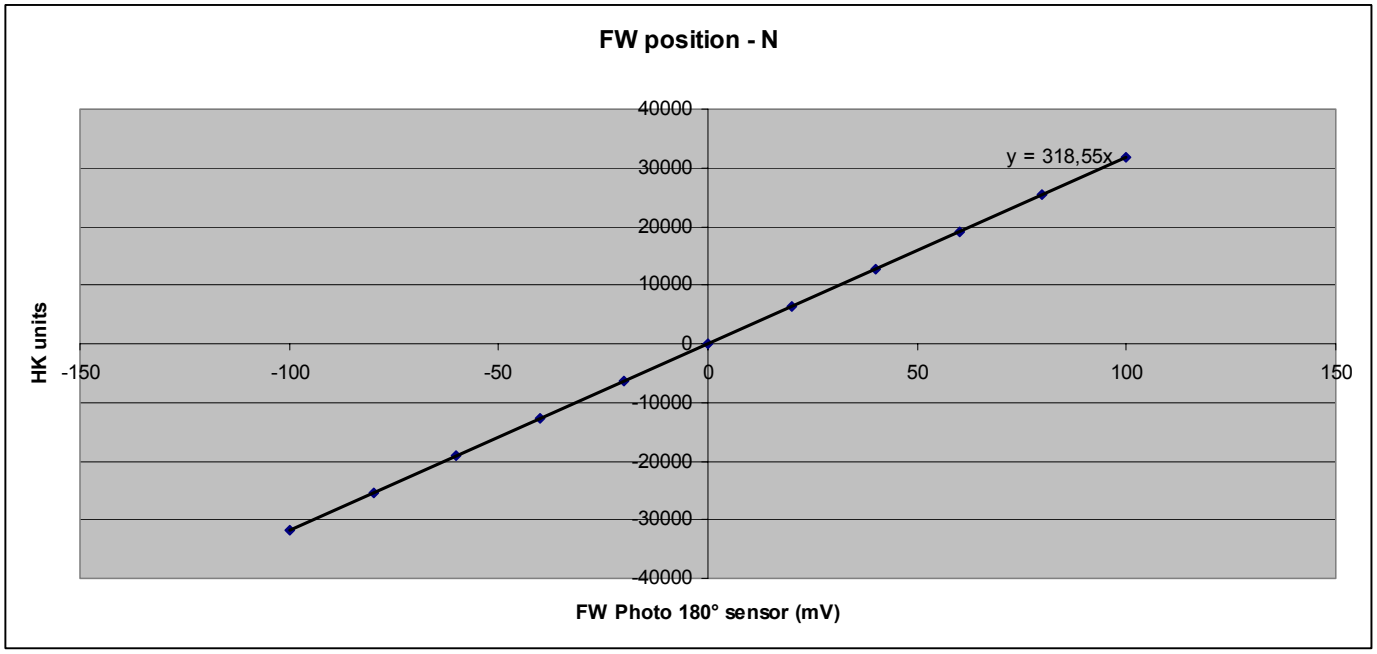
Input DC (mV)	Designed ADC input (V)	expected value	FW1(spec) 0° (HK 555)	FW1(spec) 180° (HK 559)	FW2(phot) 0° (HK 563)	FW2(phot) 180° (HK 569)	ADC offset (HK 428)
100	9,7	32013	31900	31900	31894	31842	
80	7,8	25610	25540	25530	25520	25470	
60	5,8	19208	19140	19150	19140	19100	
40	3,9	12805	12750	12760	12750	12730	
20	1,95	6402	6370	6360	6370	6370	
0	0	0	-10	-10	-14	-8	-8
-20	-1,95	-6402	-6380	-6390	-6390	-6380	
-40	-3,9	-12805	-12770	-12780	-12760	-12750	
-60	-5,8	-19208	-19140	-19150	-19150	-19120	
-80	-7,8	-25610	-25550	-25550	-25550	-25500	
-100	-9,7	-32013	-31900	-31900	-31911	-31870	

Script name : diagFwPos
FW1 : order +100,-100,-80,+80,etc…
FW2 : order 0,+20,-20,+40,-40 etc…


FW position - N
y = 319,09x
HK units
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150
FW Spec 0° sensor (mV)


FW position - N
y = 319,11x
HK units
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150
FW Spec 180° sensor (mV)


FW position - N
y = 319,07x
HK units
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150
FW Photo 0° sensor (mV)


FW position - N
y = 318,55x
HK units
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-150
-100
-50
0
50
100
150
FW Photo 180° sensor (mV)

3.4.5 Grating launch lock

Script name : diagGratLL.txt (repeat for each load value)

command	Load	V(M1)	I(M1)	V(M2)	I(M2)	546	570
Open L1	250	14	55	0	0	3709	-5
Close L1	250	-14	-55	0	0	-68	-6
Open L2	250	0	0	13.9	54.8	-5	3718
Close L2	250	0	0	-13.9	-55	-5	-54
Open 1+2	250	13.9	55	13.9	54.8	3698	3709
Close 1+2	250	-13.9	-55	-13.9	-54.8	-58	-47

command	Load	V(M1)	I(M1)	V(M2)	I(M2)	546	570
Open L1	125	13.8	108	0	0	7125	-3
Close L1	125	-13.8	-108	0	0	-1678	-7
Open L2	125	0	0	13.6	107	-5	7087
Close L2	125	0	0	-13.6	-107	-6	-1637
Open 1+2	125	13.6	107	13.6	106	7094	7053
Close 1+2	125	-13.6	-107	-13.6	-106	-1666	-1619

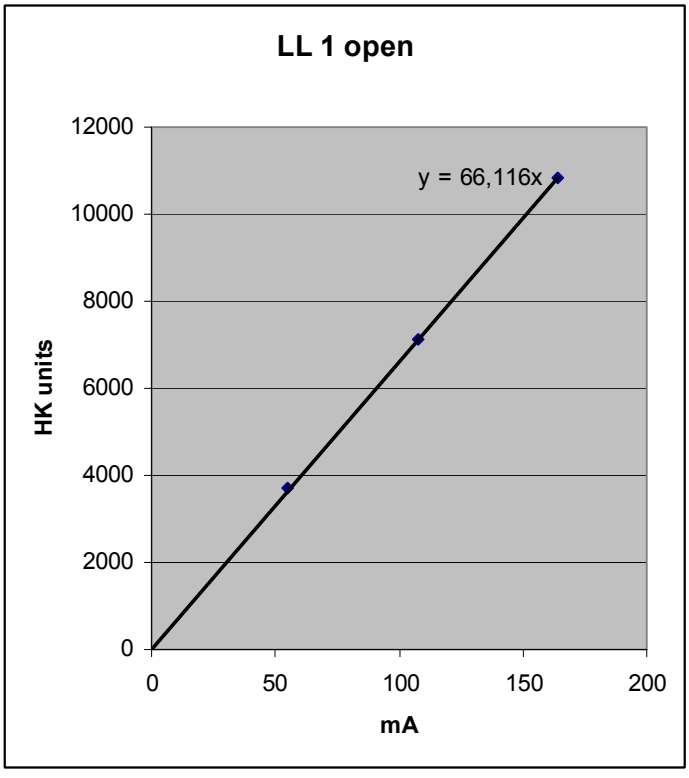
command	Load	V(M1)	I(M1)	V(M2)	I(M2)	546	570
Open L1	82	13.4	164	0	0	10829	-5
Close L1	82	-13.4	-164	0	0	-3119	-6
Open L2	82	0	0	13.3	163	-6	10745
Close L2	82	0	0	-13.3	-163	-3	-3054
Open 1+2	82	13.3	163	13.3	163	10799	10733
Close 1+2	82	-13.3	-163	-13.3	-163	-3108	-3038

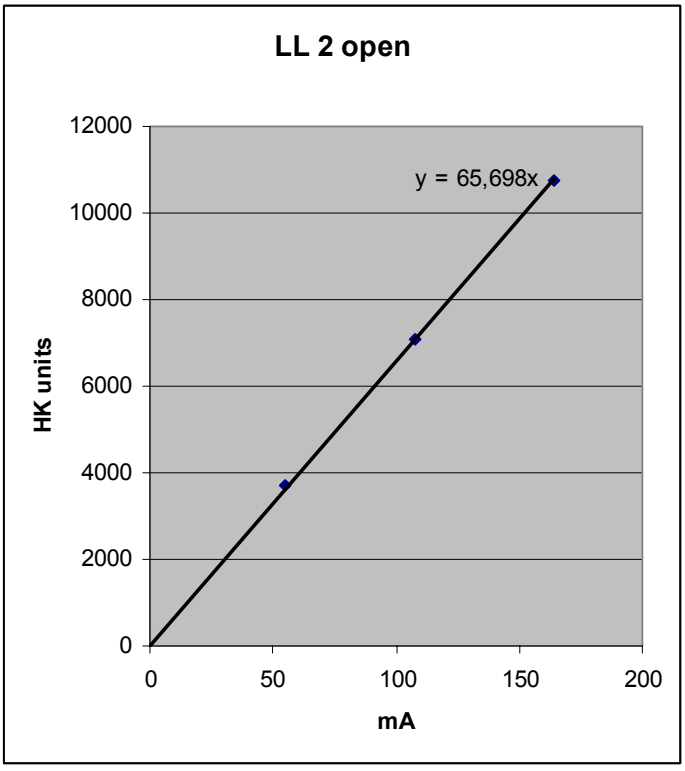
command	Load	V(M1)	I(M1)	V(M2)	I(M2)	546	570
Open L1	50	12.9	256	0	0	13930	-3
Close L1	50	-13	-257	0	0	-5089	-6
Open L2	50	0	0	12.8	252	-5	13746
Close L2	50	0	0	-12.9	-254	-6	-4950
Open 1+2	50	12.8	252	12.8	252	13842	13640
Close 1+2	50	-12.8	-252	-12.8	-252	-5020	-4901

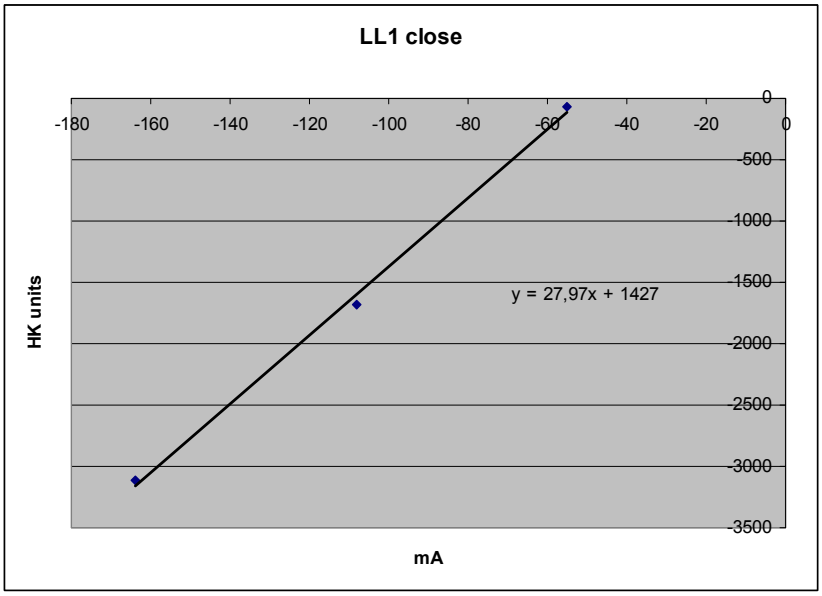
command	Load	V(M1)	I(M1)	V(M2)	I(M2)	546	570
Open L1	33	12.4	360	0	0	17834	-3
Close L1	33	-12.4	-360	0	0	-7225	-7
Open L2	33	0	0	12.4	360	-6	17610
Close L2	33	0	0	-12.4	-360	-5	-7092
Open 1+2	33	12.4	360	12.4	360	17676	17409
Close 1+2	33	-12.4	-360	-12.4	-360	-7118	-6974

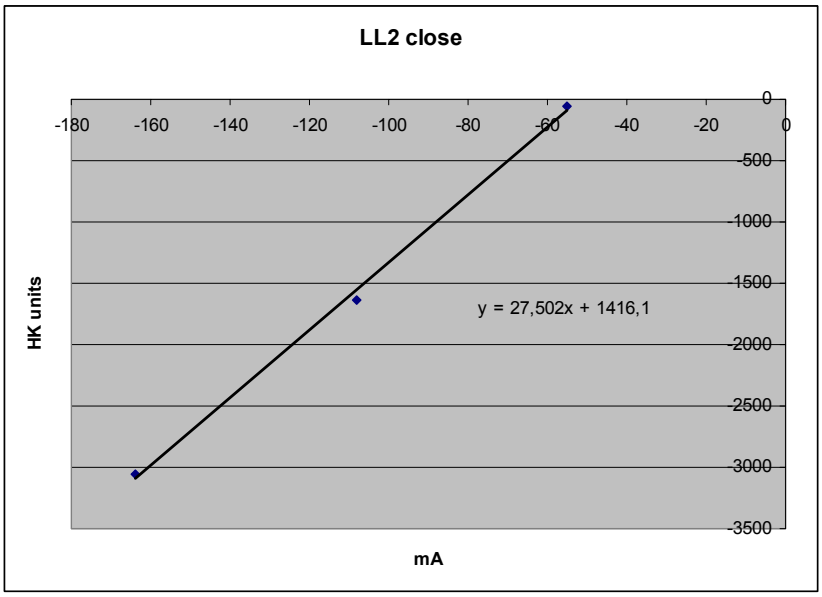
The non linearity of the HK measurement for negative currents (“close” operation) is clearly visible on the following summary table

current	LL1 HK	LL 2 HK
55	3709	3718
-55	-68	-54
108	7125	7087
-108	-1678	-1637
164	10829	10745
-164	-3119	-3054
255	13930	13746
-255	-5089	-4950
360	17834	17610
-360	-7225	-7092





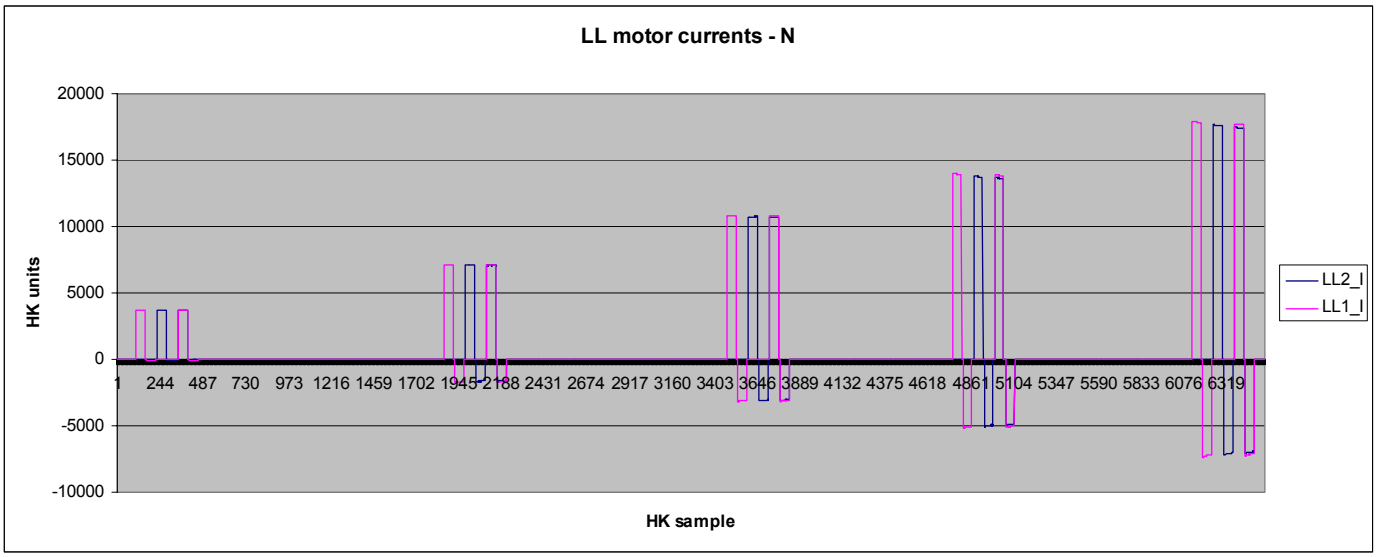


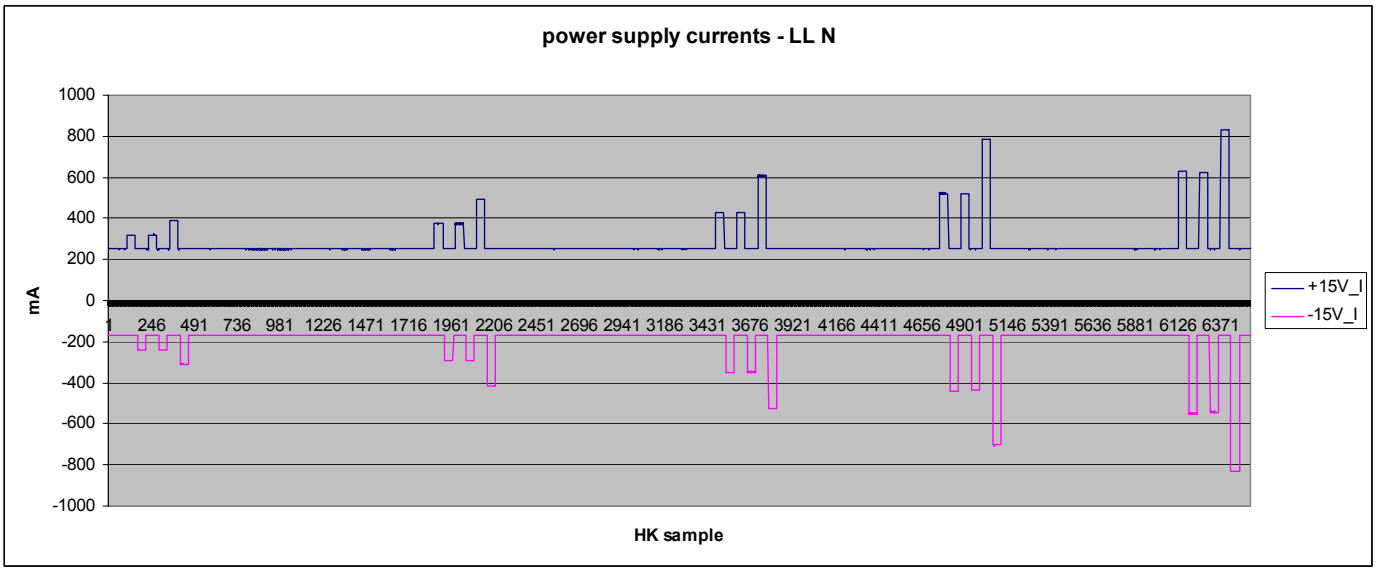


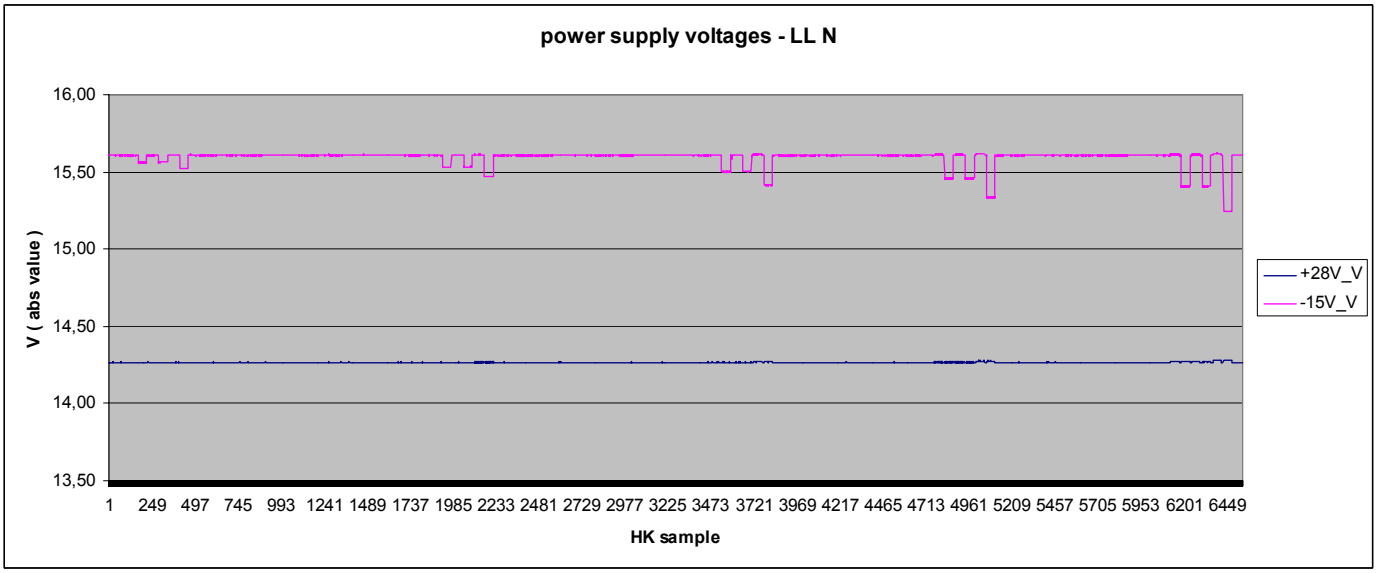
Power supplies monitoring :

Selected power supply currents and voltages were monitored during the test, to check for unwanted voltage drops during motor operation.

HK ID	410	411	568	562
name	Current +15V	Current -15V	Voltage +14V	Voltage -15V
scale	833 mA	833 mA	20 V	20 V
Nominal (value)			14V	-15V
Nominal (units)			22937	-24575
Deviation (%)				


LL motor currents - N
HK units
20000
15000
10000
5000
0
-5000
-10000
1 244 487 730 973 1216 1459 1702 1945 2188 2431 2674 2917 3160 3403 3646 3889 4132 4375 4618 4861 5104 5347 5590 5833 6076 6319
HK sample
LL2_I
LL1_I


power supply currents - LL N
mA
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
1 246 491 736 981 1226 1471 1716 1961 2206 2451 2696 2941 3186 3431 3676 3921 4166 4411 4656 4901 5146 5391 5636 5881 6126 6371
HK sample
+15V_I
-15V_I


power supply voltages - LL N
V (abs value)
16,00
15,50
15,00
14,50
14,00
13,50
1 249 497 745 993 1241 1489 1737 1985 2233 2481 2729 2977 3225 3473 3721 3969 4217 4465 4713 4961 5209 5457 5705 5953 6201 6449
HK sample
+28V_V
-15V_V

3.4.5.1 Limit switches drive current verification

Send the OBSW command to activate the Launch Lock
Monitor the voltage over the drive chain (about 0.7V, pin 8 = positive, pin 22 = negative)

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0.7 mA)	0.72	0.714

Send the OBSW command to deselect the launch lock

Measure the current in the drive chain	Recorded value	voltage over the drive chain
(should be 0 mA)	0	0

3.4.5.2 Limit switches threshold verification

Input Voltage mV	**Nominal close**		**Nominal open**		**Redundant close**		**Redundant open**		**Parameter Raw value**
	exp	**act**	**exp**	**act**	**exp**	**act**	**exp**	**act**	
-5	0	0	0	0	0		0		9961472
0	0	0	0	0	0		0		9961472
5	1	1	0	0	1		1		1083703296
10	1	1	0	0	1		1		1083703296
15	1	1	0	0	1		1		1083703296
20	1	1	0	0	1		1		1083703296
25	1	1	1	1	1		1		-1063780352
30	1	1	1	1	1		1		-1063780352

Script name : diagGratLLSwitch

Actual = expected

3.5 FPU temperature sensors

3.5.1 Quick functional check

All sensors connections are brought from the related front panel connectors to a break-out box
The following HK channels should be read-out and compared with the connected test resistors

name	ID	Test resistor value (nominal)			
		100	500	2000	5000
DMC_FPU_T_SENS_ST	404				
DMC_FW_SPEC_TEMP	405				
DMC_FW_PHOT_TEMP	406				
DMC_CHOPPER_TEMP	407				
DMC_GRATING_TEMP	408				
DMC_FPU_T1_T	426				
DMC_FPU_T2_T	427				
DMC_CAL_SRC_TEMP	429				

3.5.2 Calibration

Measurement of test resistors values :

name	ID	Test resistor value (nominal)			
		100	500	2000	5000
DMC_FPU_T_SENS_ST	404				
DMC_FW_SPEC_TEMP	405				
DMC_FW_PHOT_TEMP	406				
DMC_CHOPPER_TEMP	407				
DMC_GRATING_TEMP	408				
DMC_FPU_T1_T	426				
DMC_FPU_T2_T	427				
DMC_CAL_SRC_TEMP	429				

Overall (resistance to resistance) calibration points :

name	FW_SPEC	FW_PHOT	CHOPPER	GRATING	FPU_T1	FPU_T2	CAL_SRC
ID	405	406	407	408	426	427	429
Test Res.	Measured (one channel at a time, with all other channels > 80 ohms, while checking that the other channels measurements remain stable)						
80	80	80	80	80	80	80	80
100	100	100	100	99	100	99	99
200	200	199	199	198	199	199	199
300	299	298	299	298	299	299	299
400	399	398	398	397	398	398	397
500	499	497	498	495	497	497	497
1000	991	987	986	985	986	984	984
1500	1486	1481	1478	1476	1478	1478	1476
2000	1981	1974	1971	1969	1972	1970	1970
2500	2475	2470	2466	2464	2466	2464	2461
3000	2972	2961	2958	2952	2944	2953	2953
3500	3463	3455	3451	3443	3454	3447	3441
4000	3963	3946	3942	3940	3942	3938	3937
4500	4455	4448	4439	4434	4448	4434	4430
5000	4950	4929	4933	4924	4933	4928	4927
10 K	9896	9879	9867	9863	9908	9852	9878
20 K	19767	19738	19722	19671	19721	19624	19683
50 K	49317	49703	49216/49538	49288/49003	48170/49778	49115/48892	48125
100 K	98780/99492	96620/97984	97790/97301	98603/98127	97633/98146	98414/98987	97557/96459
200 K	196645/202968	193188/200816	199996/195947	198731/196024	194810/200384	196160/191405	193361/195947
500 K	499150/505591	473335/484497	453281/486631	496596/479335	488133/499920	499231/481482	474724/486473
1 M	997836	1044408	912443	1041562	1067728	1023716	1051602

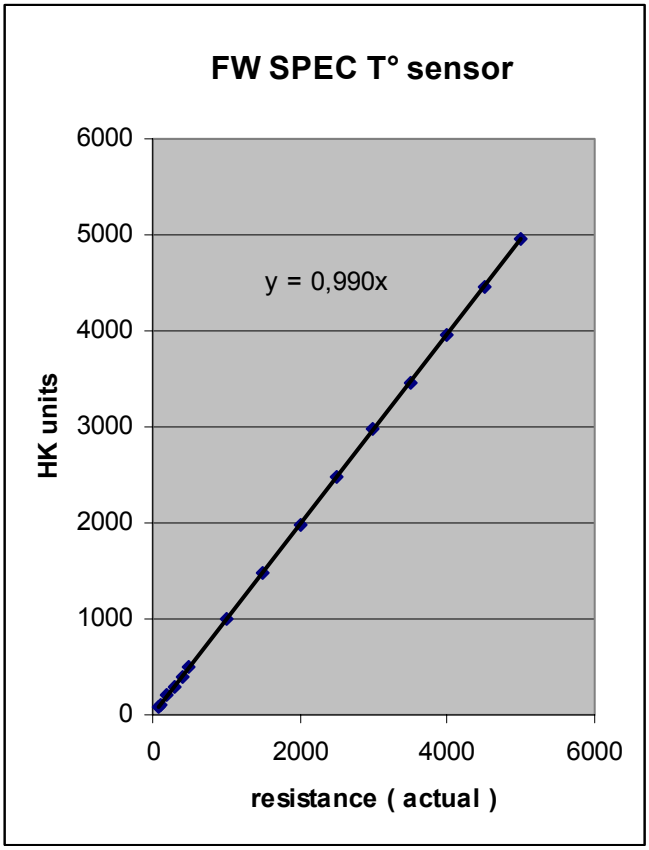
Script name diagTS2

Note cabling resistance = 80 milliohms
Wait 2 measurement cycles (+/- 2 minutes) for values > 50Kohms
Monitor sensor voltage to detect measurement time
Use LL loads to simulate non-calibrated channels (250, 250, 125, 82, 82, 100)

T° data on charts is from standard Lake Shore curves, for information only. Calibration curve from actual flight sensor should be used instead.

FW SPEC T° sensor readout

test R	simulated T° (K)	Datron reading	FW_SPEC (405)	error ohms	error %
80	193	80,02	80	-0,02	-0,02%
100	153	100	100	0	0,00%
200	75,1	199,97	200	0,03	0,02%
300	49,4	299,99	299	-0,99	-0,33%
400	36,7	399,97	399	-0,97	-0,24%
500	29,2	499,95	499	-0,95	-0,19%
1000	14,3	999,96	991	-8,96	-0,90%
1500	9,40	1499,87	1486	-13,87	-0,92%
2000	6,99	1999,8	1981	-18,8	-0,94%
2500	5,55	2499,7	2475	-24,7	-0,99%
3000	4,60	2999,6	2972	-27,6	-0,92%
3500	3,92	3499,5	3463	-36,5	-1,04%
4000	3,42	3999,4	3963	-36,4	-0,91%
4500	3,03	4499,4	4455	-44,4	-0,99%
5000	2,72	4999,3	4950	-49,3	-0,99%
10 K	1,33	9999,5	9896	-103,5	-1,04%
20 K		19999	19767	-232	-1,16%
50 K		49999	49317	-682	-1,36%
100 K		100004	99492	-512	-0,51%
200 K		200005	202968	2963	1,48%
500 K		500010	505591	5581	1,12%
1 M		999984	997836	-2148	-0,21%

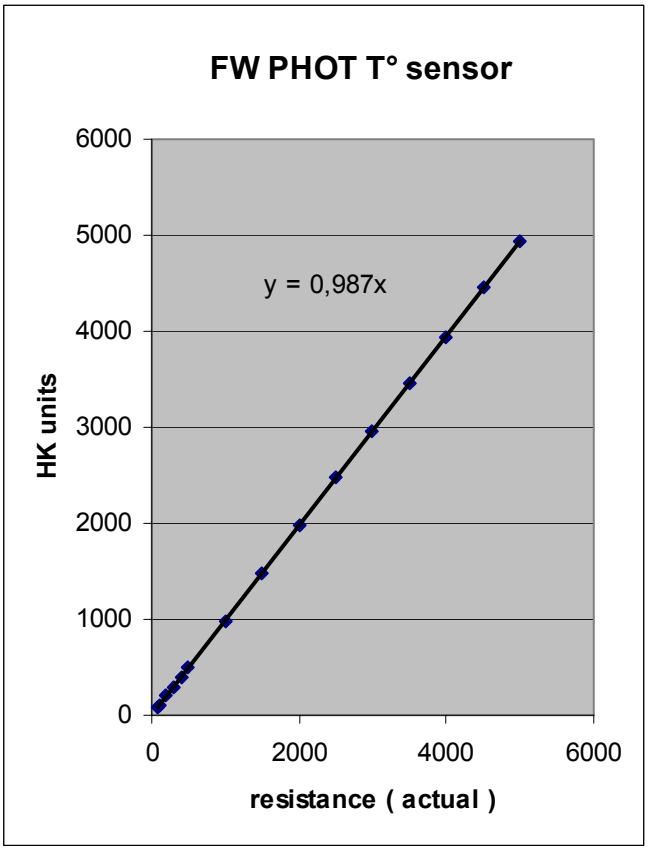


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	0,01
5000	2,72	1800	-0,03

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

FW PHOT T° sensor readout

test R	simulated T° (K)	Datron reading	FW_PHOT	error ohms	error %
			406		
80	193	80,02	80	-0,02	-0,02%
100	153	100	100	0	0,00%
200	75,1	199,97	199	-0,97	-0,49%
300	49,4	299,99	298	-1,99	-0,66%
400	36,7	399,97	398	-1,97	-0,49%
500	29,2	499,95	497	-2,95	-0,59%
1000	14,3	999,96	987	-12,96	-1,30%
1500	9,40	1499,87	1481	-18,87	-1,26%
2000	6,99	1999,8	1974	-25,8	-1,29%
2500	5,55	2499,7	2470	-29,7	-1,19%
3000	4,60	2999,6	2961	-38,6	-1,29%
3500	3,92	3499,5	3455	-44,5	-1,27%
4000	3,42	3999,4	3946	-53,4	-1,34%
4500	3,03	4499,4	4448	-51,4	-1,14%
5000	2,72	4999,3	4929	-70,3	-1,41%
10 K	1,33	9999,5	9879	-120,5	-1,21%
20 K		19999	19738	-261	-1,31%
50 K		49999	49703	-296	-0,59%
100 K		100004	97984	-2020	-2,02%
200 K		200005	200816	811	0,41%
500 K		500010	484497	-15513	-3,10%
1 M		999984	1044408	44424	4,44%

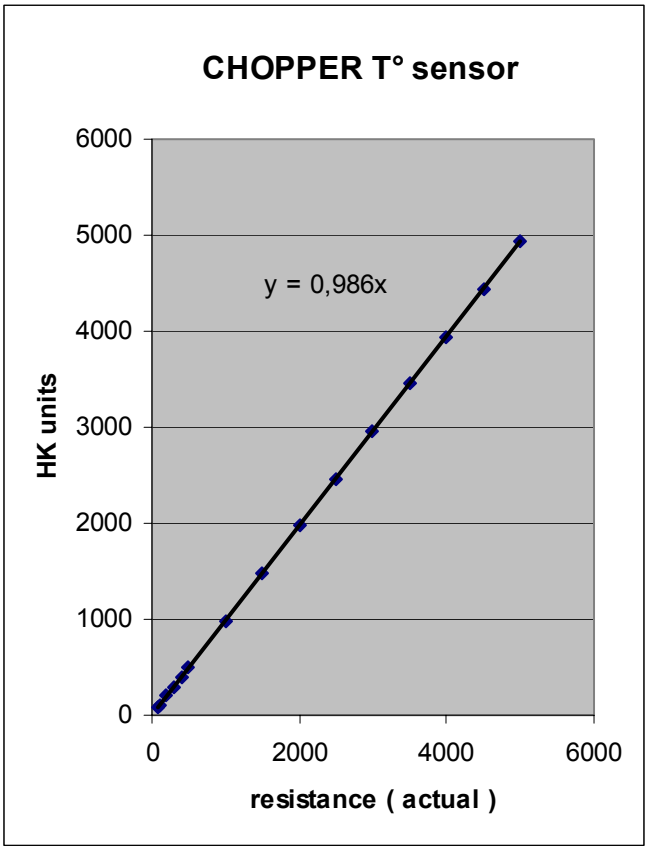


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,37308
5000	2,72	1800	-0,03906

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

Chopper T° sensor readout

test R	simulated T° (K)	Datron reading	CHOPPER	error ohms	error %
			407		
80	193	80,02	80	-0,02	-0,02%
100	153	100	100	0	0,00%
200	75,1	199,97	199	-0,97	-0,49%
300	49,4	299,99	299	-0,99	-0,33%
400	36,7	399,97	398	-1,97	-0,49%
500	29,2	499,95	498	-1,95	-0,39%
1000	14,3	999,96	986	-13,96	-1,40%
1500	9,40	1499,87	1478	-21,87	-1,46%
2000	6,99	1999,8	1971	-28,8	-1,44%
2500	5,55	2499,7	2466	-33,7	-1,35%
3000	4,60	2999,6	2958	-41,6	-1,39%
3500	3,92	3499,5	3451	-48,5	-1,39%
4000	3,42	3999,4	3942	-57,4	-1,44%
4500	3,03	4499,4	4439	-60,4	-1,34%
5000	2,72	4999,3	4933	-66,3	-1,33%
10 K	1,33	9999,5	9867	-132,5	-1,33%
20 K		19999	19722	-277	-1,39%
50 K		49999	49538	-461	-0,92%
100 K		100004	97301	-2703	-2,70%
200 K		200005	195947	-4058	-2,03%
500 K		500010	486631	-13379	-2,68%
1 M		999984	912443	-87541	-8,75%

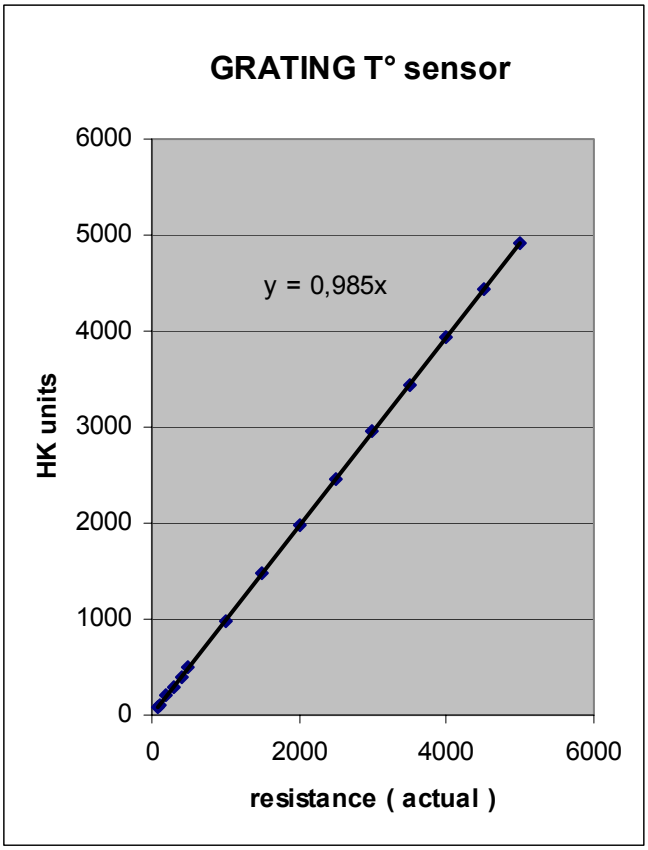


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,37308
5000	2,72	1800	-0,03683

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

Grating T° sensor readout

test R	simulated T° (K)	Datron reading	GRATING	error ohms	error %
			408		
80	193	80,02	80	-0,02	-0,02%
100	153	100	99	-1	-1,00%
200	75,1	199,97	198	-1,97	-0,99%
300	49,4	299,99	298	-1,99	-0,66%
400	36,7	399,97	397	-2,97	-0,74%
500	29,2	499,95	495	-4,95	-0,99%
1000	14,3	999,96	985	-14,96	-1,50%
1500	9,40	1499,87	1476	-23,87	-1,59%
2000	6,99	1999,8	1969	-30,8	-1,54%
2500	5,55	2499,7	2464	-35,7	-1,43%
3000	4,60	2999,6	2952	-47,6	-1,59%
3500	3,92	3499,5	3443	-56,5	-1,61%
4000	3,42	3999,4	3940	-59,4	-1,49%
4500	3,03	4499,4	4434	-65,4	-1,45%
5000	2,72	4999,3	4924	-75,3	-1,51%
10 K	1,33	9999,5	9863	-136,5	-1,37%
20 K		19999	19671	-328	-1,64%
50 K		49999	49003	-996	-1,99%
100 K		100004	98127	-1877	-1,88%
200 K		200005	196024	-3981	-1,99%
500 K		500010	479335	-20675	-4,13%
1 M		999984	1041562	41578	4,16%

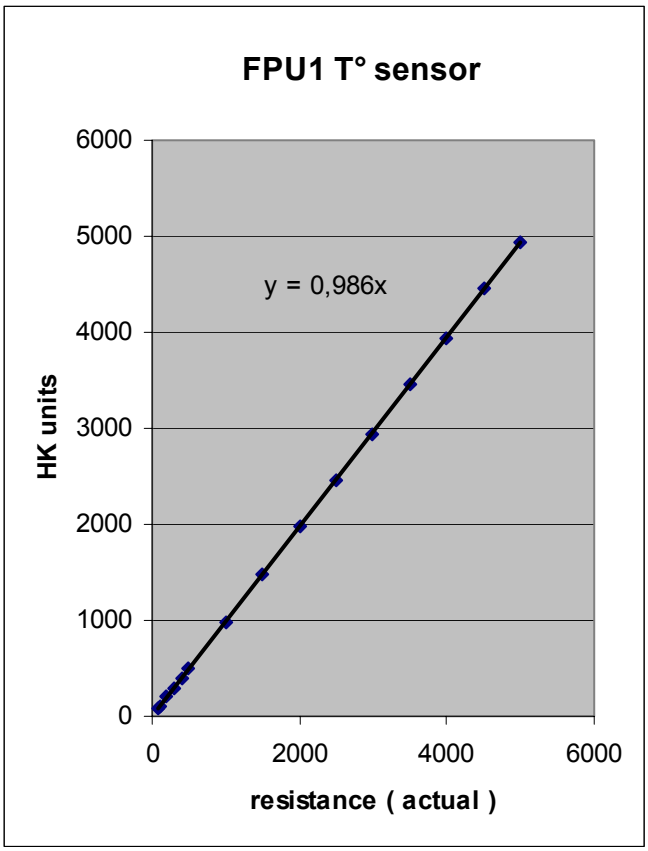


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,75769
5000	2,72	1800	-0,04183

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

FPU1 T° sensor readout

test R	simulated T° (K)	Datron reading	FPU_T1	error ohms	error %
			426		
80	193	80,02	80	-0,02	-0,02%
100	153	100	100	0	0,00%
200	75,1	199,97	199	-0,97	-0,49%
300	49,4	299,99	299	-0,99	-0,33%
400	36,7	399,97	398	-1,97	-0,49%
500	29,2	499,95	497	-2,95	-0,59%
1000	14,3	999,96	986	-13,96	-1,40%
1500	9,40	1499,87	1478	-21,87	-1,46%
2000	6,99	1999,8	1972	-27,8	-1,39%
2500	5,55	2499,7	2466	-33,7	-1,35%
3000	4,60	2999,6	2944	-55,6	-1,85%
3500	3,92	3499,5	3454	-45,5	-1,30%
4000	3,42	3999,4	3942	-57,4	-1,44%
4500	3,03	4499,4	4448	-51,4	-1,14%
5000	2,72	4999,3	4933	-66,3	-1,33%
10 K	1,33	9999,5	9908	-91,5	-0,92%
20 K		19999	19721	-278	-1,39%
50 K		49999	49778	-221	-0,44%
100 K		100004	98146	-1858	-1,86%
200 K		200005	200384	379	0,19%
500 K		500010	499920	-90	-0,02%
1 M		999984	1067728	67744	6,77%

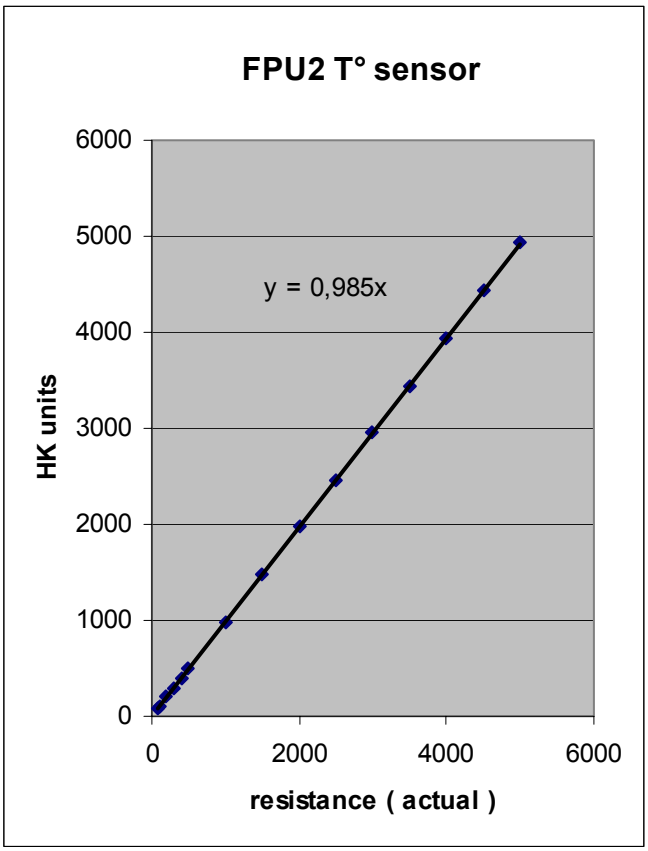


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,37308
5000	2,72	1800	-0,03683

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

FPU1 T° sensor readout

test R	simulated T° (K)	Datron reading	FPU_T2	error ohms	error %
			427		
80	193	80,02	80	-0,02	-0,02%
100	153	100	99	-1	-1,00%
200	75,1	199,97	199	-0,97	-0,49%
300	49,4	299,99	299	-0,99	-0,33%
400	36,7	399,97	398	-1,97	-0,49%
500	29,2	499,95	497	-2,95	-0,59%
1000	14,3	999,96	984	-15,96	-1,60%
1500	9,40	1499,87	1478	-21,87	-1,46%
2000	6,99	1999,8	1970	-29,8	-1,49%
2500	5,55	2499,7	2464	-35,7	-1,43%
3000	4,60	2999,6	2953	-46,6	-1,55%
3500	3,92	3499,5	3447	-52,5	-1,50%
4000	3,42	3999,4	3938	-61,4	-1,54%
4500	3,03	4499,4	4434	-65,4	-1,45%
5000	2,72	4999,3	4928	-71,3	-1,43%
10 K	1,33	9999,5	9852	-147,5	-1,48%
20 K		19999	19624	-375	-1,88%
50 K		49999	48892	-1107	-2,21%
100 K		100004	98987	-1017	-1,02%
200 K		200005	191405	-8600	-4,30%
500 K		500010	481482	-18528	-3,71%
1 M		999984	1023716	23732	2,37%

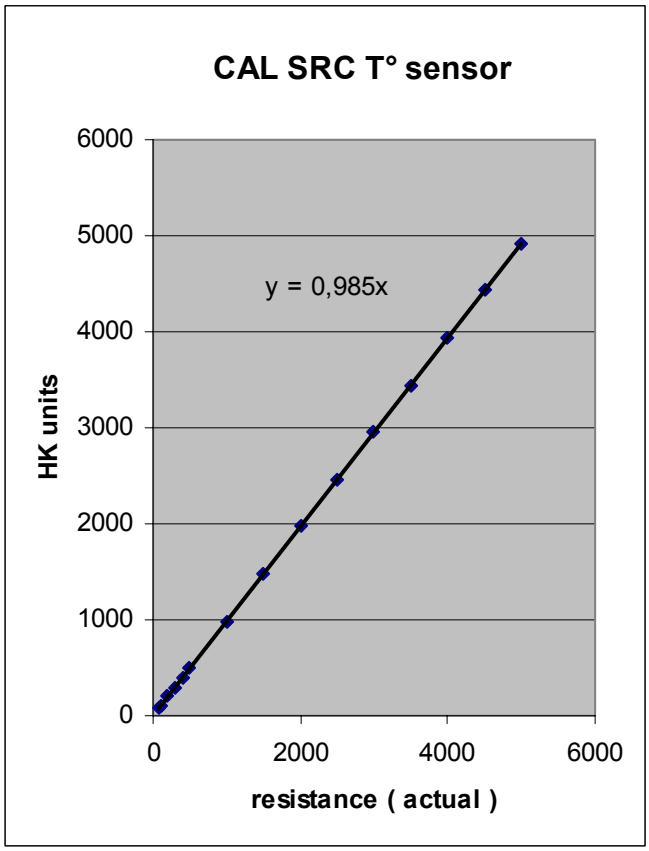


test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,37308
5000	2,72	1800	-0,03961

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

Calibration Source T° sensor readout

test R	simulated T° (K)	Datron reading	CAL SRC	error ohms	error %
			429		
80	193	80,02	80	-0,02	-0,02%
100	153	100	99	-1	-1,00%
200	75,1	199,97	199	-0,97	-0,49%
300	49,4	299,99	299	-0,99	-0,33%
400	36,7	399,97	397	-2,97	-0,74%
500	29,2	499,95	497	-2,95	-0,59%
1000	14,3	999,96	984	-15,96	-1,60%
1500	9,40	1499,87	1476	-23,87	-1,59%
2000	6,99	1999,8	1970	-29,8	-1,49%
2500	5,55	2499,7	2461	-38,7	-1,55%
3000	4,60	2999,6	2953	-46,6	-1,55%
3500	3,92	3499,5	3441	-58,5	-1,67%
4000	3,42	3999,4	3937	-62,4	-1,56%
4500	3,03	4499,4	4430	-69,4	-1,54%
5000	2,72	4999,3	4927	-72,3	-1,45%
10 K	1,33	9999,5	9878	-121,5	-1,22%
20 K		19999	19683	-316	-1,58%
50 K		49999	48125	-1874	-3,75%
100 K		100004	96459	-3545	-3,54%
200 K		200005	195947	-4058	-2,03%
500 K		500010	486473	-13537	-2,71%
1 M		999984	1051602	51618	5,16%



test R	simulated T° (K)	CX1050 sensitivity	Error (K)
200	75,5	2,6	-0,37308
5000	2,72	1800	-0,04017

Table shows raw values (no gain correction)
Chart shows best fit for gain correction below 5 Kohms

Test resistors verification (done after last measurement set on DMCn)

Test resistor	Datron reading
80	80.02
100	100.00
200	199.97
300	299.99
400	399.97
500	499.95
1000	999.96
1500	1499.87
2000	1999.8
2500	2499.7
3000	2999.6
3500	3499.5
4000	3999.4
4500	4499.4
5000	4999.3
10000	9999.5
20000	19999
50000	49999
100000	100004
200000	200005
500000	500010
1000000	999984