HERSCHEL/SPIRE

DETECTOR CONTROL UNIT
LIA_S
TEST PLAN

LIA_S BOARD Number:1

	Function	Name	Date	Visa
Prepared by		**PINSARD**	**20/7/2001**	
Verified by				
Approved by				

DOCUMENT STATUS and CHANGE RECORD

Date	Issue	Affected pages
9/3/2001	0.-	Creation

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PICTURES

1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to detail the tests that have been performed on the LIA_S boards. This document follows a specific order: first the success criteria are given, followed by the testing parameters and finally whether the test was successful or not.

1.2 SCOPE

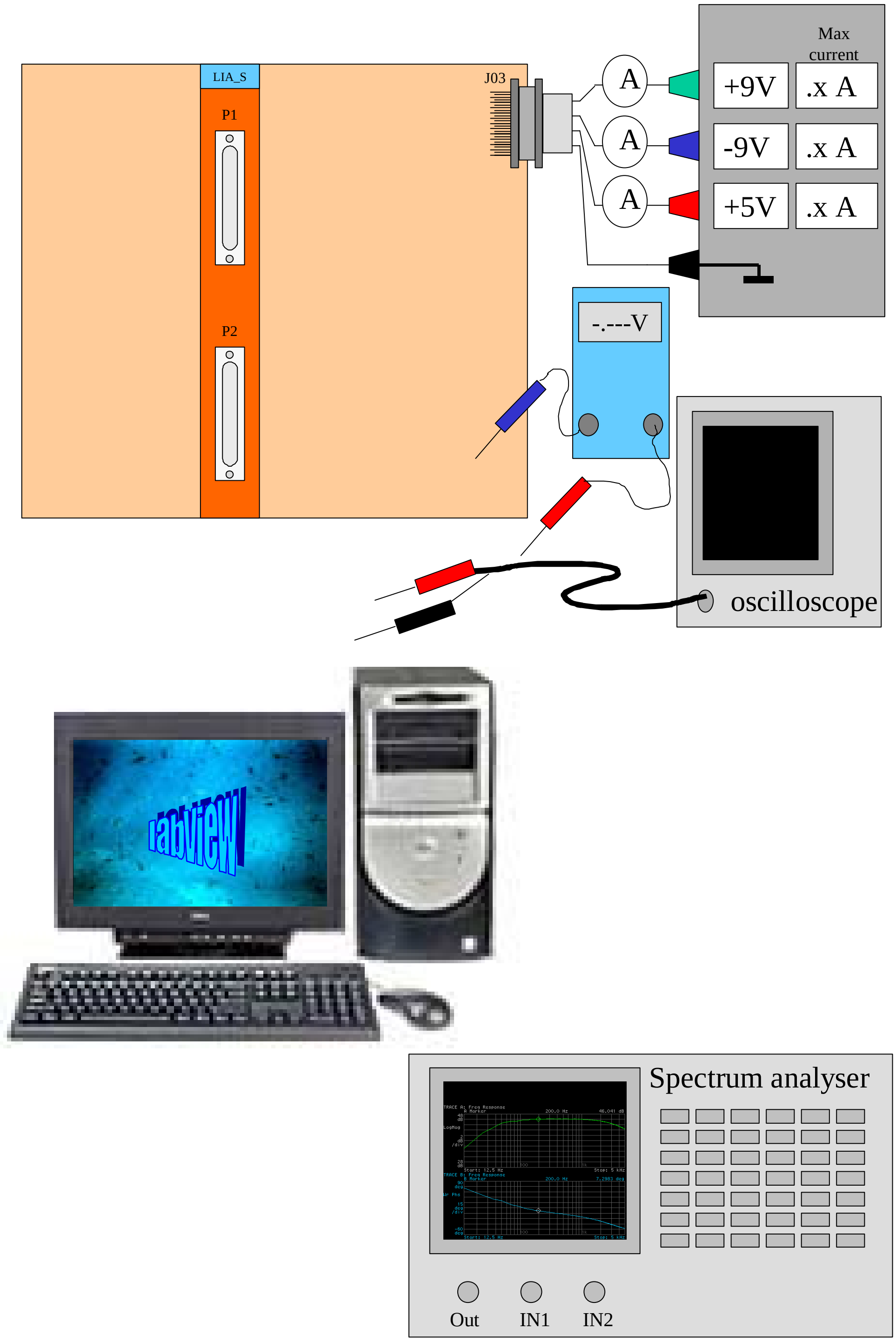
1.3 APPLICABLE DOCUMENTS

1.4 REFERENCE DOCUMENTS

- DETECTOR SUBSYSTEM SPECIFICATION DOCUMENT : FIST-SPI-PRJ-000103
- DRCU SUBSYSTEM SPECIFICATION DOCUMENT : SAp-SPIRE-CCa-25-00

2 GENERAL DESCRIPTION

2.1 OVERVIEW



Picture 2-1: overview

3 TEST EQUIPEMENTS

- DUAL OUTPUT DC POWER SUPPLY	HP E3620A 0-25V 0-1A
- DIGITAL OSCILLOSCOPE	TEKTRONIX 2230
- MULTIMETER	WAVETEK
-2 CHANNEL NETWORK SIGNAL ANALYZER	SRS SR780

4 DCU QM1 ELECTRICAL TESTS

4.1 LIA_S test

4.1.1 Visual test

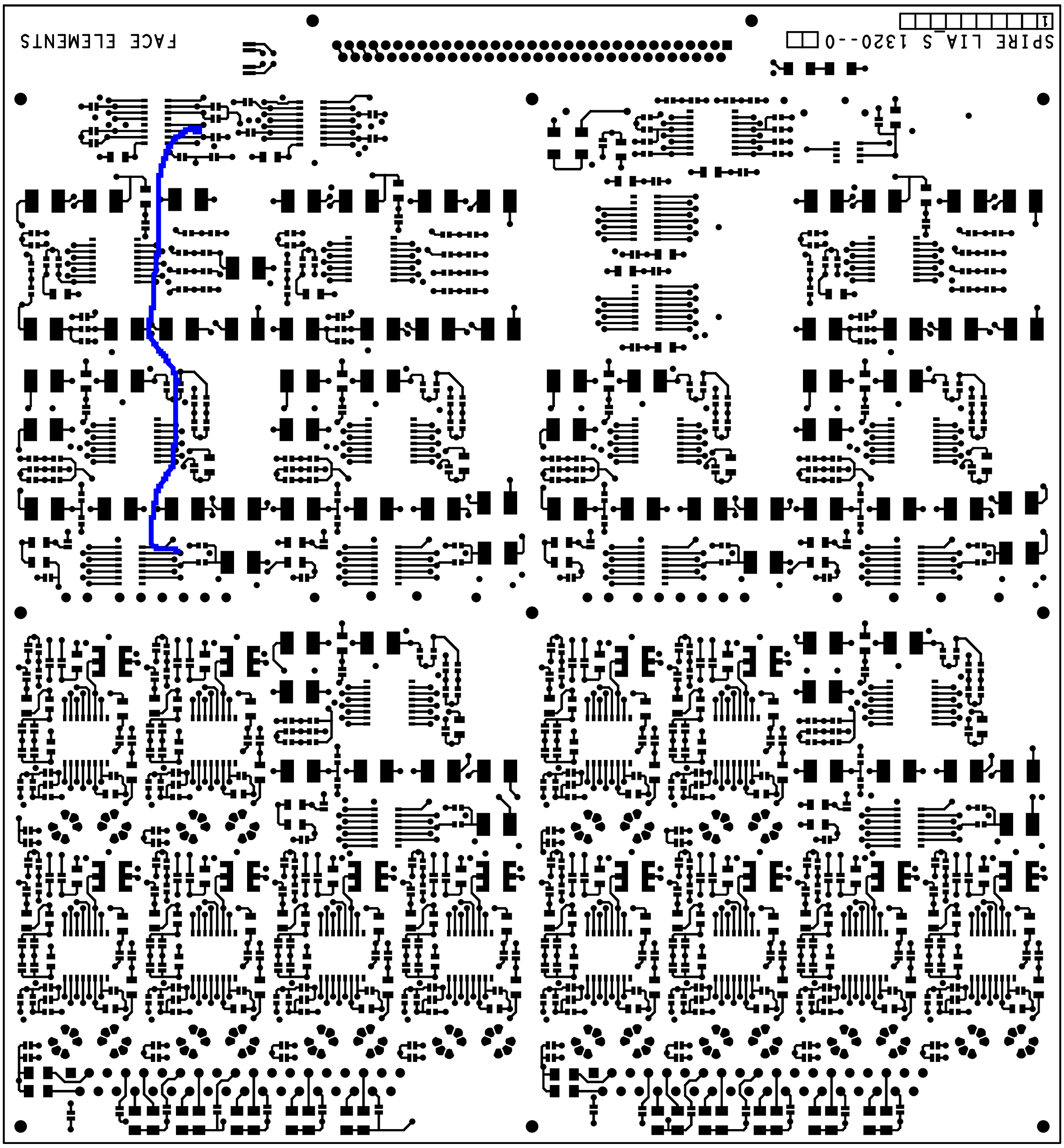
Test number	Test	Test check Date	Check Result	Corrections	Test Status OK/NOK
LIA_S1	Check that no components missing and all the component are in the good way.		R4,R7,R22 and R26	Add 51K resistors	OK
LIA_S2	Check that there isn't any visible short circuit		None		OK

NON CONFORMANCE:

Error with the demodulation signal named DEMOD1, instead of DEMOD_1.

Correction:

Make a connection between U9 pin 3 and U103 pin 6



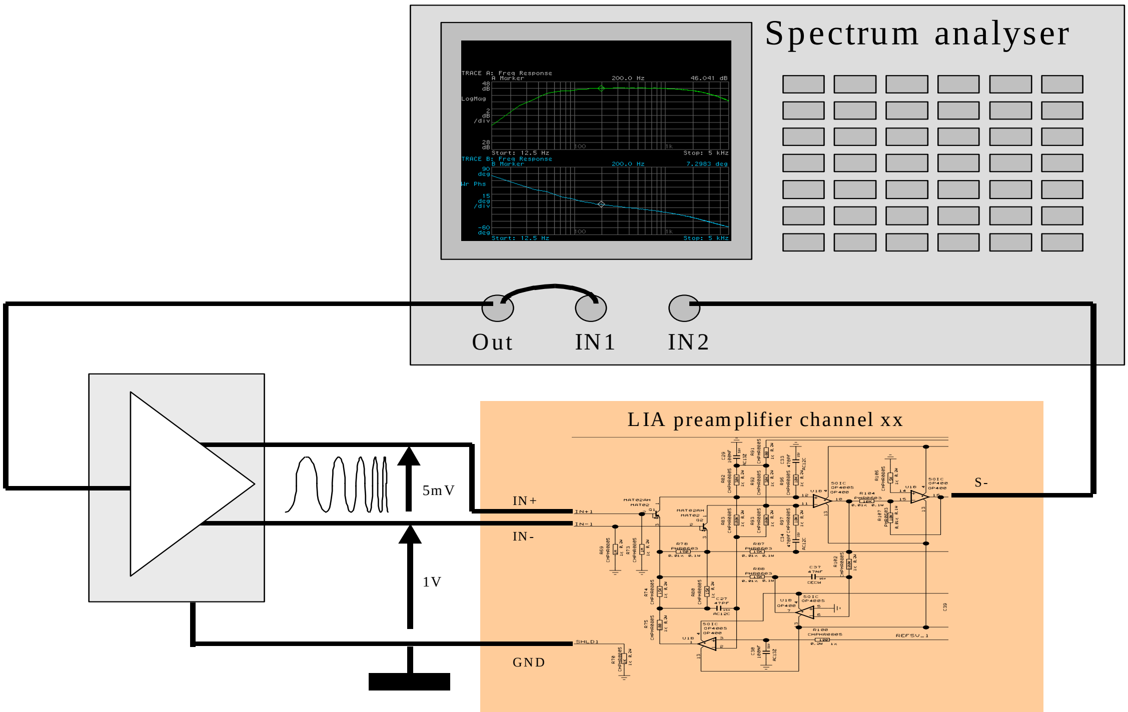
FACE ELEMENTS
SPIRE LIA S 1320--0

4.1.2 Test with power supplies

4.1.2.1 Test

Test number	Test	Test check Date	Check Result	Corrections	Test Status OK/NOK
LIA_S 3	Switch on the lab power Check there is any short circuit.		none		OK
LIA_S 4	Measure the current on +9V		100mA		OK
LIA_S 5	Measure the current on -9V		100mA		OK
LIA_S 6	Measure the current on +5V		17mA		OK

4.1.2.1.1 Preamplifier transfer function



This test is considered successful if on each channel there is:

A maximum gain between: 113,2 and 115,5
A low cut of frequency between: 35,145 and 35,855Hz
A high cut of frequency between: 2673 and 2727 Hz

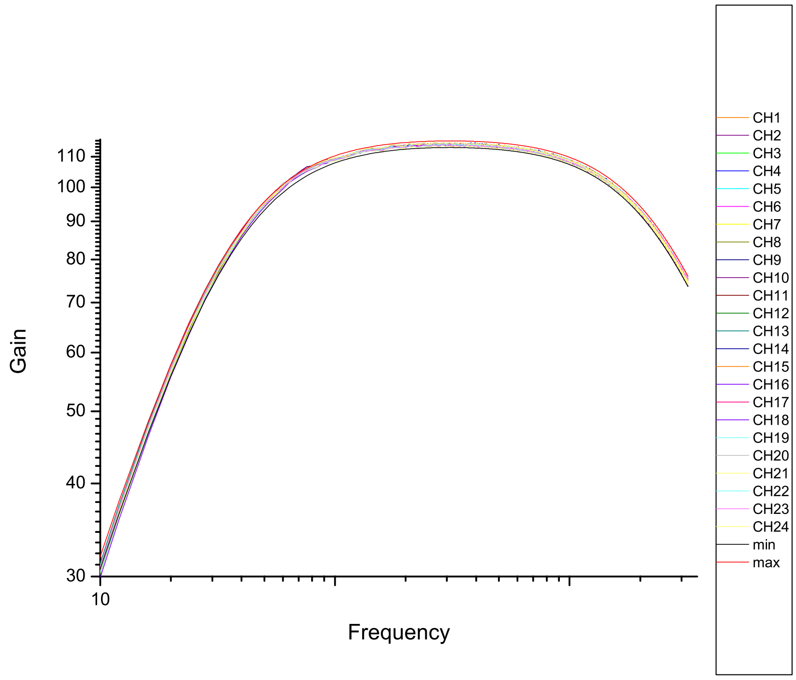
Measurement parameters:
BAND-PASS Filter Transfer Function
4 – 3200 Hz sine sweep, 10 mV amplitude at the input of the BPF
window: uniform, average: VecAvg*2

Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 7	Measure the transfer function of the channel 1 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 2 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 3 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 4 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 5 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 6 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 7 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 8 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 9 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 10 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 11 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 12 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 13 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 14 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 15 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 16 preamplifier		See pictures below		OK

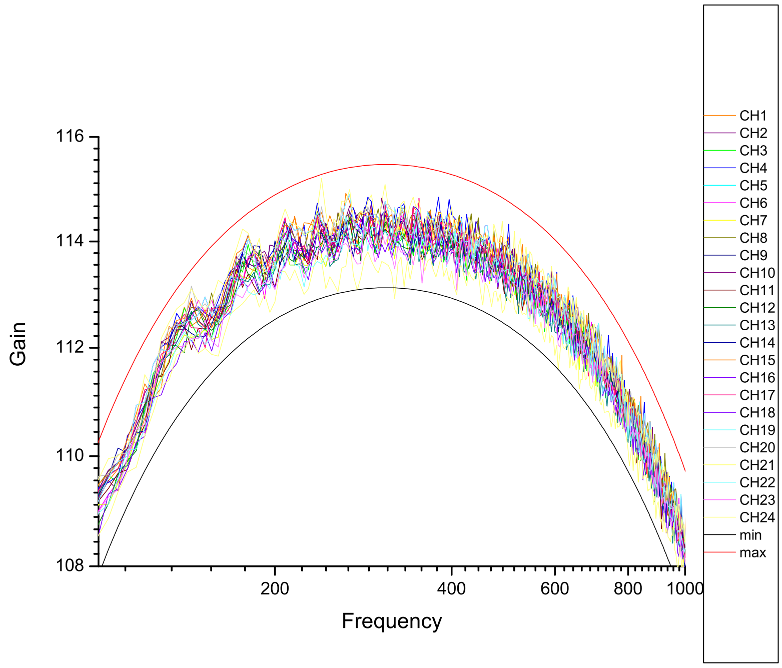
Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 7	Measure the transfer function of the channel 17 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 18 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 19 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 20 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 21 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 22 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 23 preamplifier		See pictures below		OK
LIA_S 7	Measure the transfer function of the channel 24 preamplifier		See pictures below		OK

BAND-PASS Filter Transfer Function – Modulus

The following graph shows all the BPF gains (V/V) according to the frequency as well as the theoretical templates:

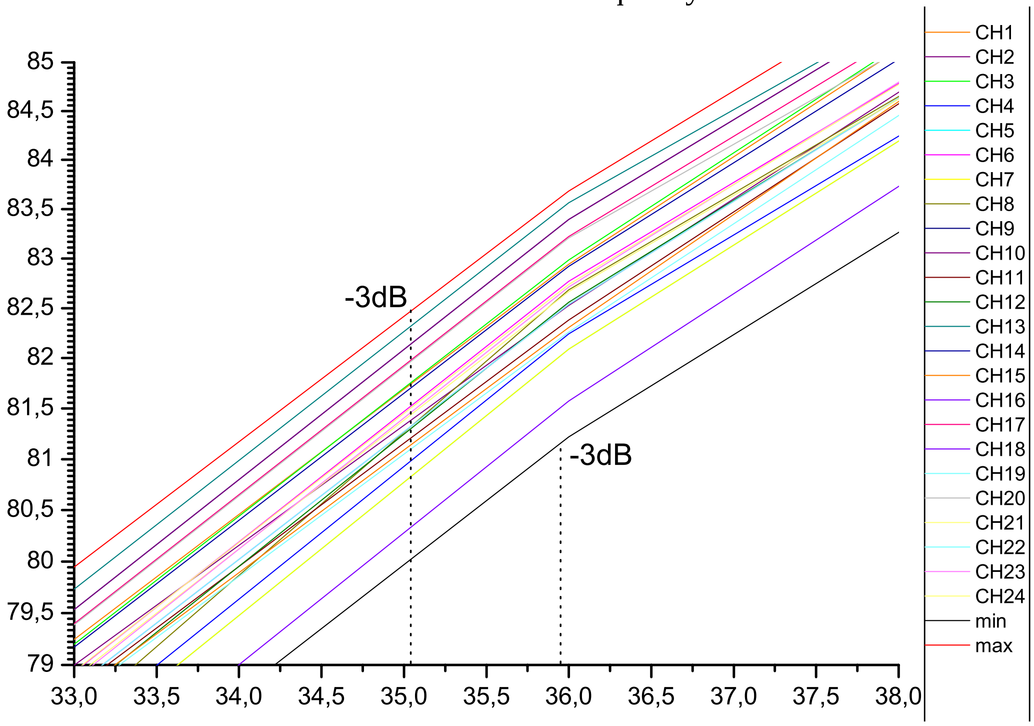


The following graph shows a close-up of the maximum gain zone:

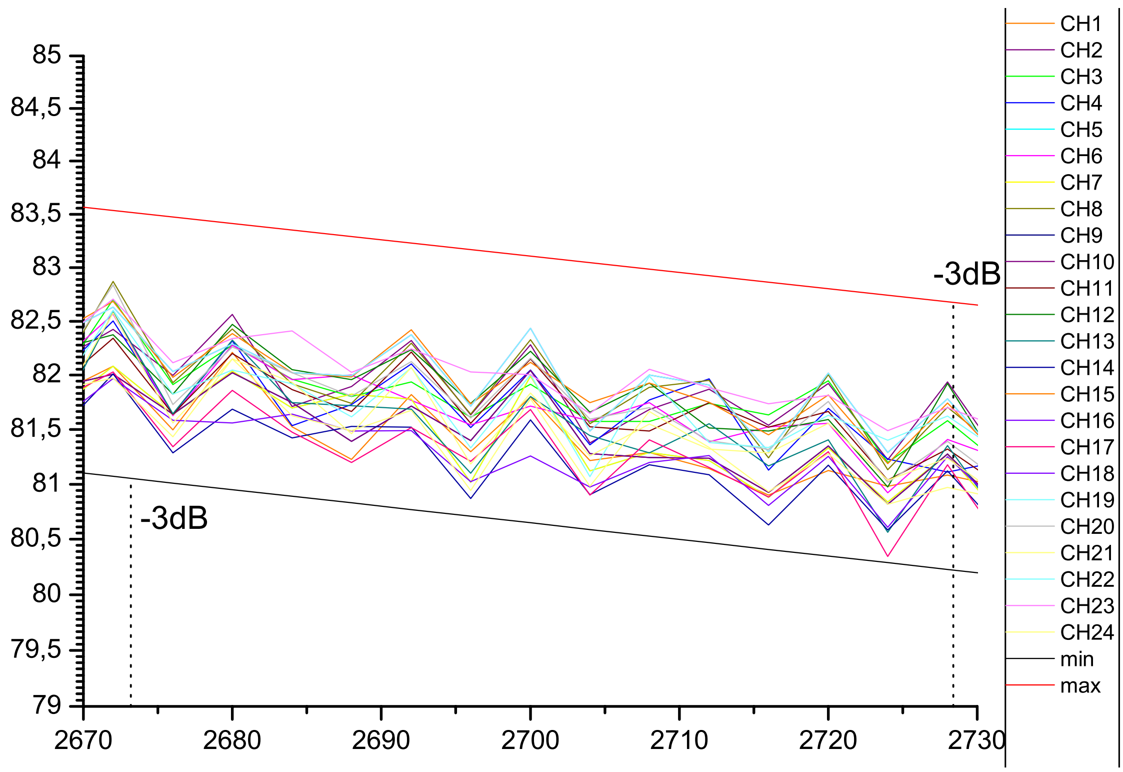


The following two graphs show close-ups of the cut-off frequencies:

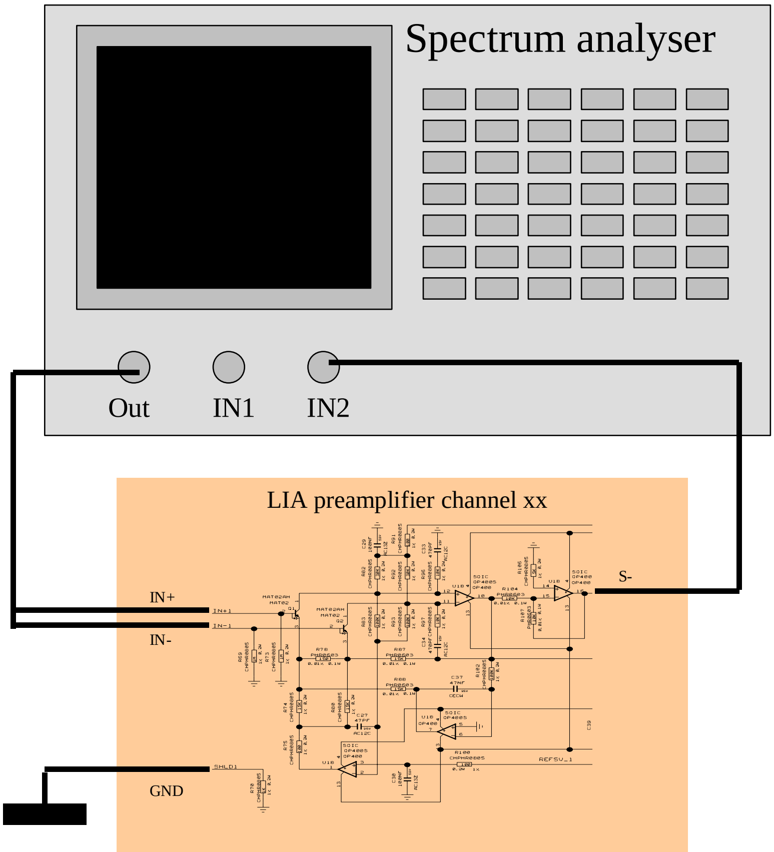
-3dB Low cut off frequency



-3dB High cut off frequency



4.1.2.1.2 Common-mode rejection



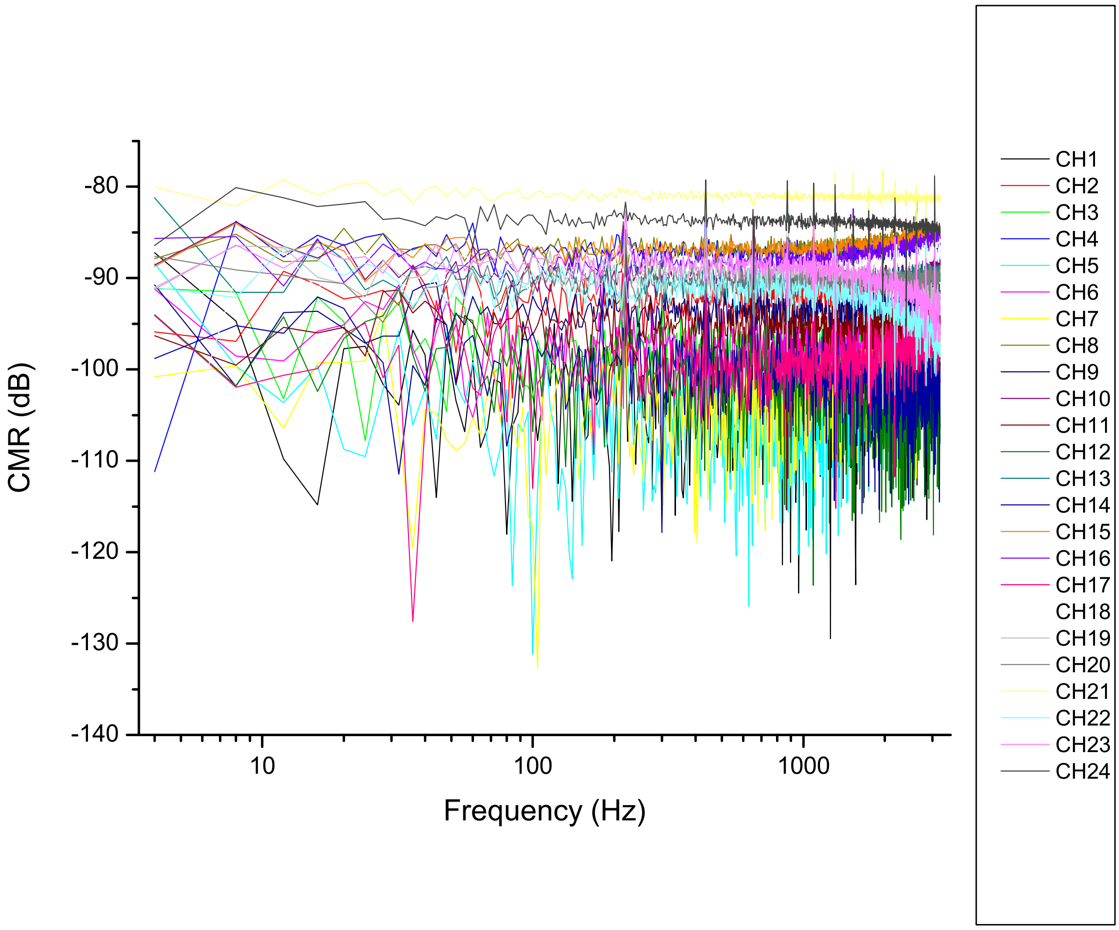
This test is considered successful if on each channel the CMR is less than **–60dB from 50 to 300 Hz**.

Measurement parameters:

4-3200 Hz sine sweep 100 mV between the inputs of the BPF and the gnd.
CH1 connected to source CH2 on output of the BPF
Measurement : <F2>/<F1> in dB, then minus BPF gain in dB.
Window = UNIFORM

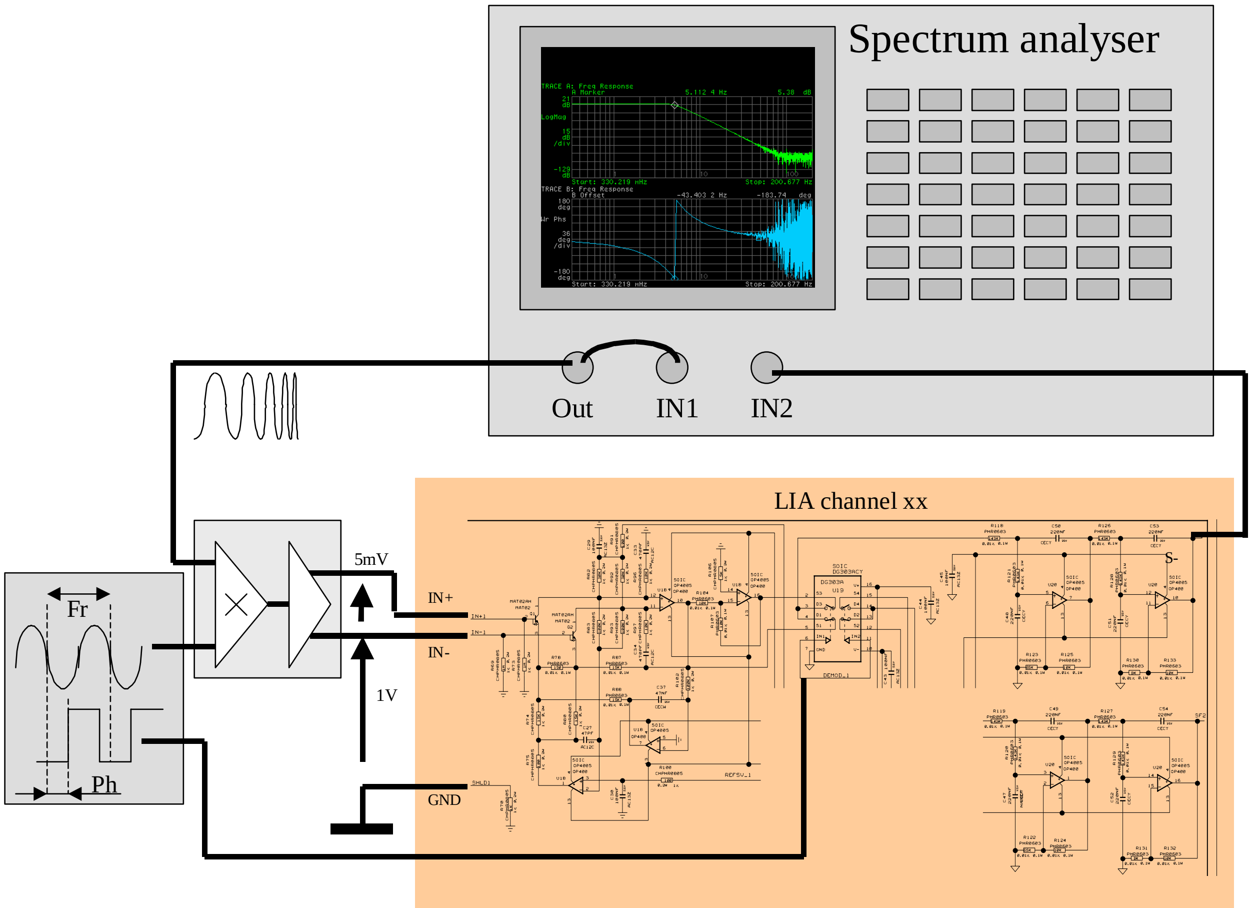
Test number	Test	Test check Date	Check Result	Corrections	Test Status OK/NOK
LIA_S 8	Measure the CMR of the channel 1 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 2 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 3 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 4 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 5 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 6 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 7 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 8 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 9 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 10 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 11 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 12 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 13 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 14 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 15 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 16 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 17 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 18 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 19 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 20 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 21 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 22 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 23 preamplifier		See picture below		OK
LIA_S 8	Measure the CMR of the channel 24 preamplifier		See picture below		OK

The following graph shows the wave of each channel's CMR:



The CMR dispersion between channels depends on the dispersion of the 15k resistors, which bias the MAT02.

4.1.2.1.3 LIA transfer function



1) The gain if a square modulation is used for the test:

$$Vin = Vrms\sum_{n=0}^{\infty}\frac{4}{(1+2n)\pi}\sin[(1+2n)\omega t]$$

After passing through the BPF there is the following signal:

$$V_{BPF} = Vrms\sum_{n=0}^{\infty}\frac{4}{(1+2n)\pi}\sin[(1+2n)\omega t]\bullet G_{BPF}[(1+2n)\omega]$$

After demodulation the DC value of the signal is:

$$V_{DEMODDC} = Vrms\frac{8}{(\pi)^2}\sum_{n=0}^{\infty}\frac{4}{(1+2n)}\bullet G_{BPF}[(1+2n)\omega]$$

So after the LPF, The gain max expression is :

$$G_{SQ}\max = \left(\frac{8}{(\pi)^2}\sum_{n=0}^{\infty}\frac{4}{(1+2n)}\bullet G_{BPF}[(1+2n)\omega]\right)\bullet 3.03$$

So This test is considered successful if on each channel:
-With a modulation frequency of 216Hz:

$$328 \le G_{SQ}\max \le 343$$

2) The gain if a sine modulation is used for the test:

$$Vin = Vrms\sqrt{2}\bullet\sin[\omega t]$$

After passing through the BPF there is the following signal:

$$V_{BPF} = Vrms\sqrt{2}\bullet\sin[\omega t]\bullet G_{BPF}[\omega]$$

After demodulation the DC value of the signal is

$$V_{DEMODDC} = Vrms\sqrt{2}\frac{2}{\pi}\bullet G_{BPF}[\omega]$$

So after the LPF, The gain max expression is :

$$G_{SINE}\max = \left(\sqrt{2}\frac{2}{\pi}\bullet G_{BPF}[\omega]\right)\bullet 3.03$$

So This test is considered successful if on each channel:
-With a modulation frequency of 216Hz:

$$308 \le G_{SQ}\max \le 315$$

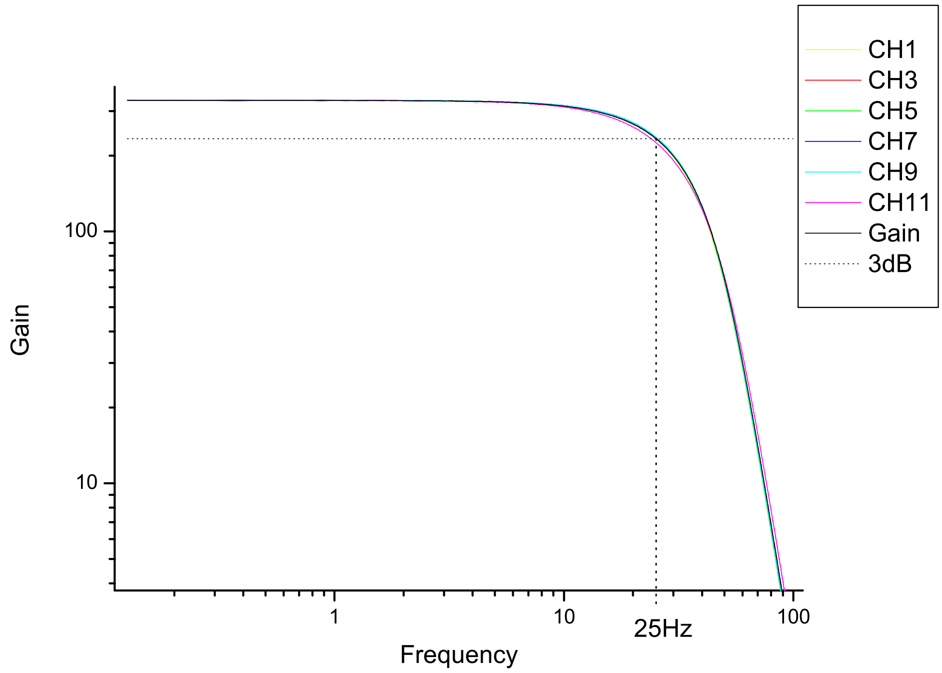
3) The cut off frequency should have a precision of ±**1%** at **25Hz**.

Measurement parameters:

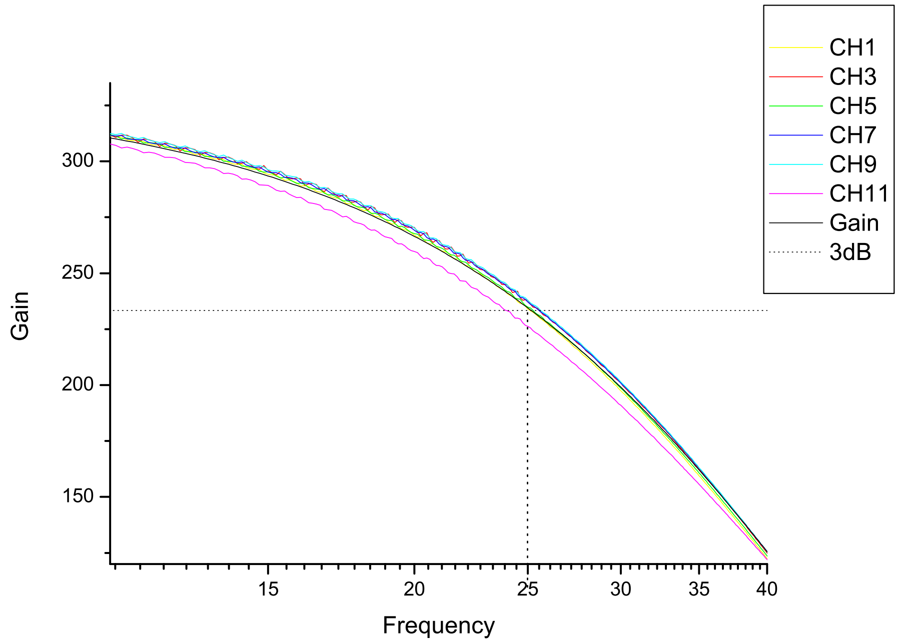
0.25-100 Hz sine chirp amplitude 1V.
Fbias = 216 Hz, rectangular modulation of a sine sweep
sine sweep ~10 mV at the input of the BPF.
window: uniform ; average: VecAvg*2

Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 9	Measure the transfer function of the channel 1		Fc=24,95 Gain = 331,7		OK
LIA_S 9	Measure the transfer function of the channel 2		Fc=25,7 Gain = 333		OK
LIA_S 9	Measure the transfer function of the channel 3		Fc=25,1 Gain = 331,9		OK
LIA_S 9	Measure the transfer function of the channel 4		Fc=25,1 Gain =333,4		OK
LIA_S 9	Measure the transfer function of the channel 5		Fc=25,4 Gain = 330,8		OK
LIA_S 9	Measure the transfer function of the channel 6		Fc=25,5 Gain =332,5		OK
LIA_S 9	Measure the transfer function of the channel 7		Fc=25,45 Gain = 331,4		OK
LIA_S 9	Measure the transfer function of the channel 8		Fc=25,7 Gain =332,6		OK
LIA_S 9	Measure the transfer function of the channel 9		Fc=25,45 Gain = 332,446787		OK
LIA_S 9	Measure the transfer function of the channel 10		Fc=25,9 Gain =332,7		OK
LIA_S 9	Measure the transfer function of the channel 11		The problem will be corrected before the QM1 integration		NOK
LIA_S 9	Measure the transfer function of the channel 12		Fc=25,1 Gain =332		OK
LIA_S 9	Measure the transfer function of the channel 13		Fc=24,65 Gain=328		OK
LIA_S 9	Measure the transfer function of the channel 14		Fc=24,9 Gain=332		OK
LIA_S 9	Measure the transfer function of the channel 15		The problem will be corrected before the QM1 integration		NOK
LIA_S 9	Measure the transfer function of the channel 16		Fc=24,65 Gain=332,5		OK
LIA_S 9	Measure the transfer function of the channel 17		Fc=25 Gain=333,4		OK
LIA_S 9	Measure the transfer function of the channel 18		Fc=25,6 Gain=332		OK
LIA_S 9	Measure the transfer function of the channel 19		Fc=24,9 Gain=328		OK
LIA_S 9	Measure the transfer function of the channel 20		Fc=25,4 Gain=333		OK
LIA_S 9	Measure the transfer function of the channel 21		Fc=25,4 Gain=331,5		OK
LIA_S 9	Measure the transfer function of the channel 22		The problem will be corrected before the QM1 integration		NOK
LIA_S 9	Measure the transfer function of the channel 23		Fc=25 Gain=328		OK
LIA_S 9	Measure the transfer function of the channel 24		Fc=25,3 Gain=334		OK

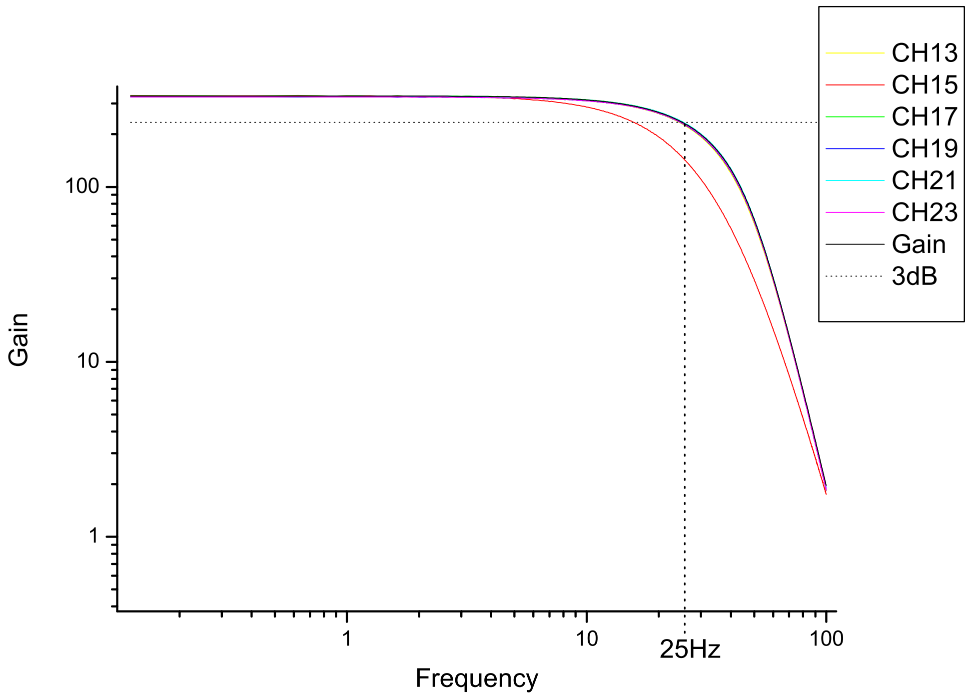
The following graph shows all the BPF gains (V/V) according to the frequency



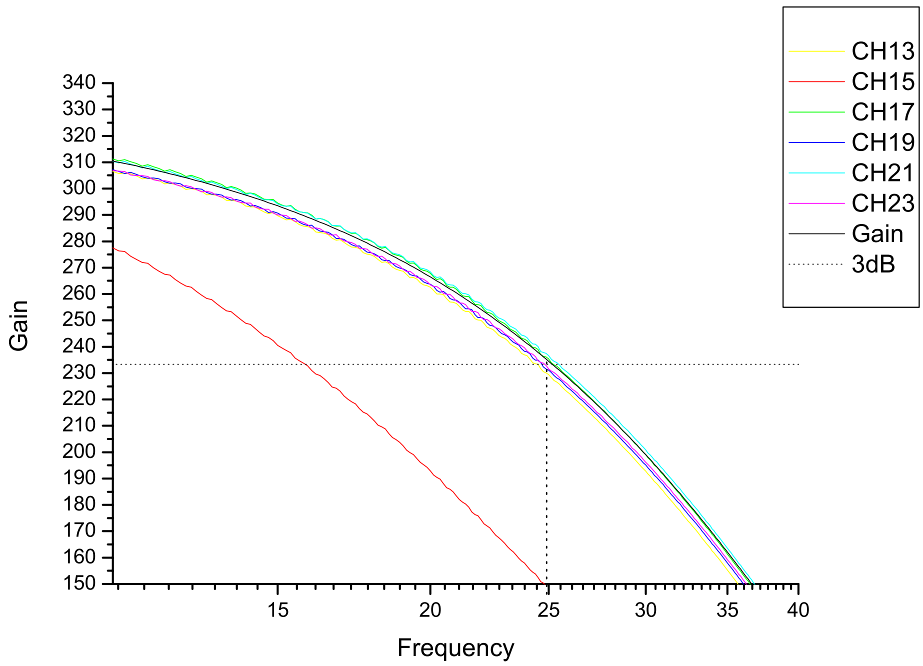
The following two graphs show close-ups of the cut-off frequencies at – 3dB:



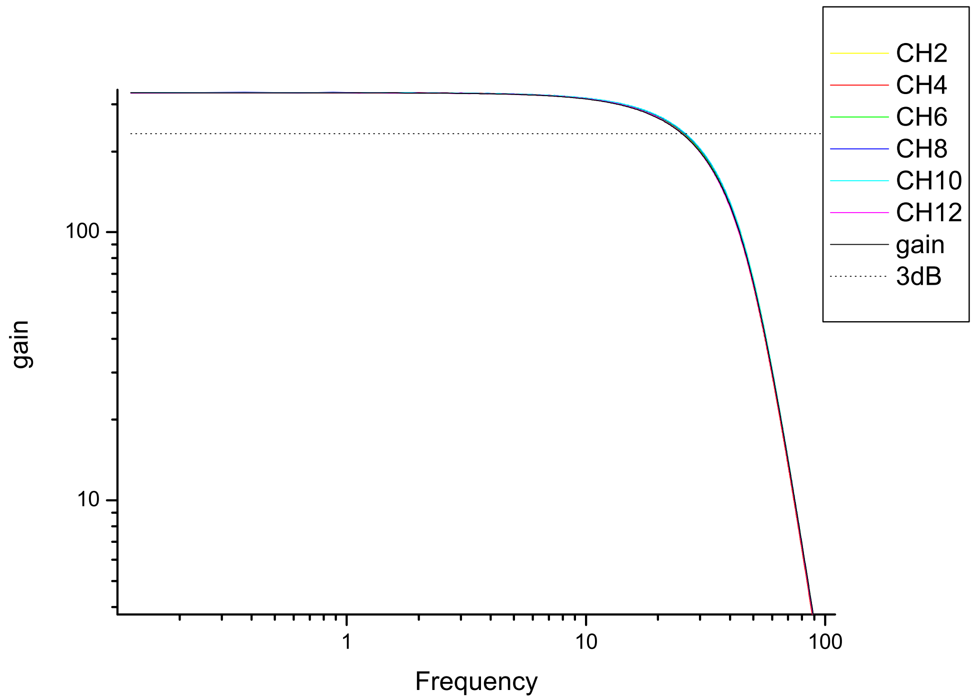
The following graph shows all the BPF gains (V/V) according to the frequency



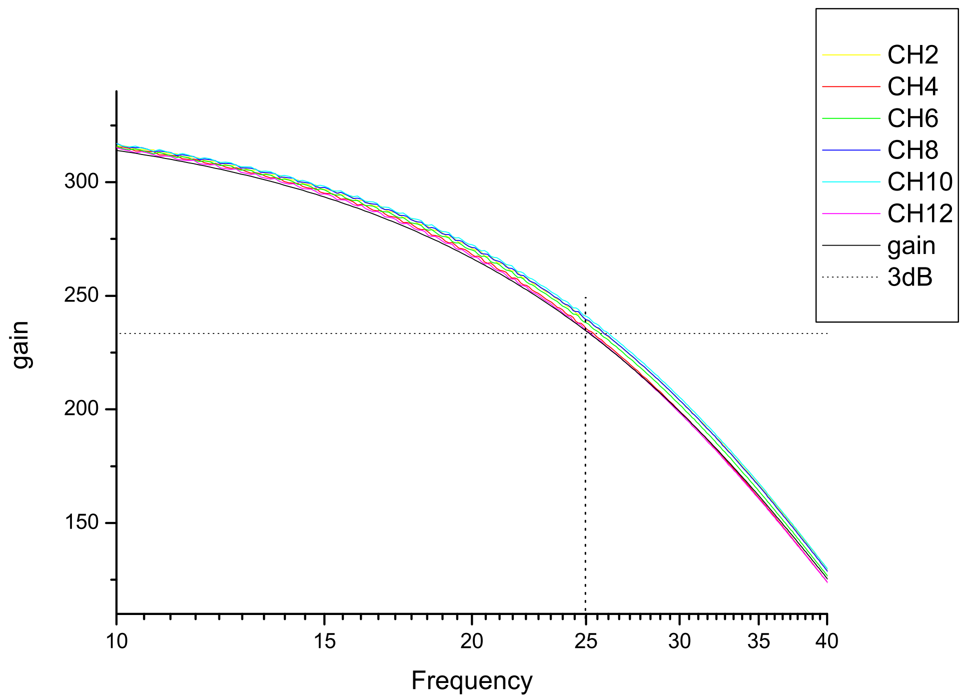
The following two graphs show close-ups of the cut-off frequencies at – 3dB:



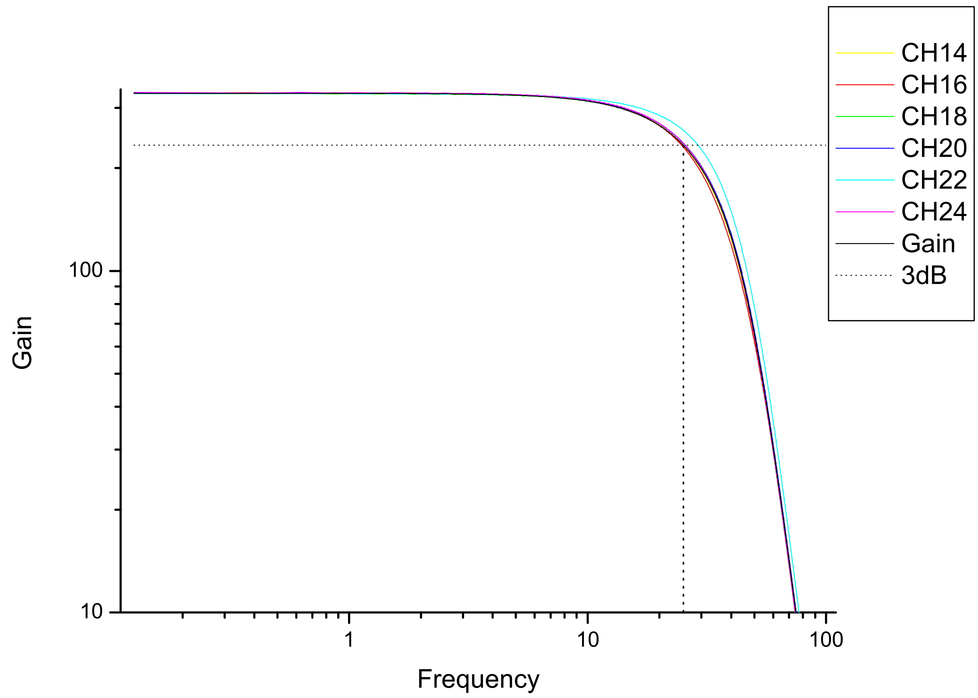
The following graph shows all the BPF gains (V/V) according to the frequency

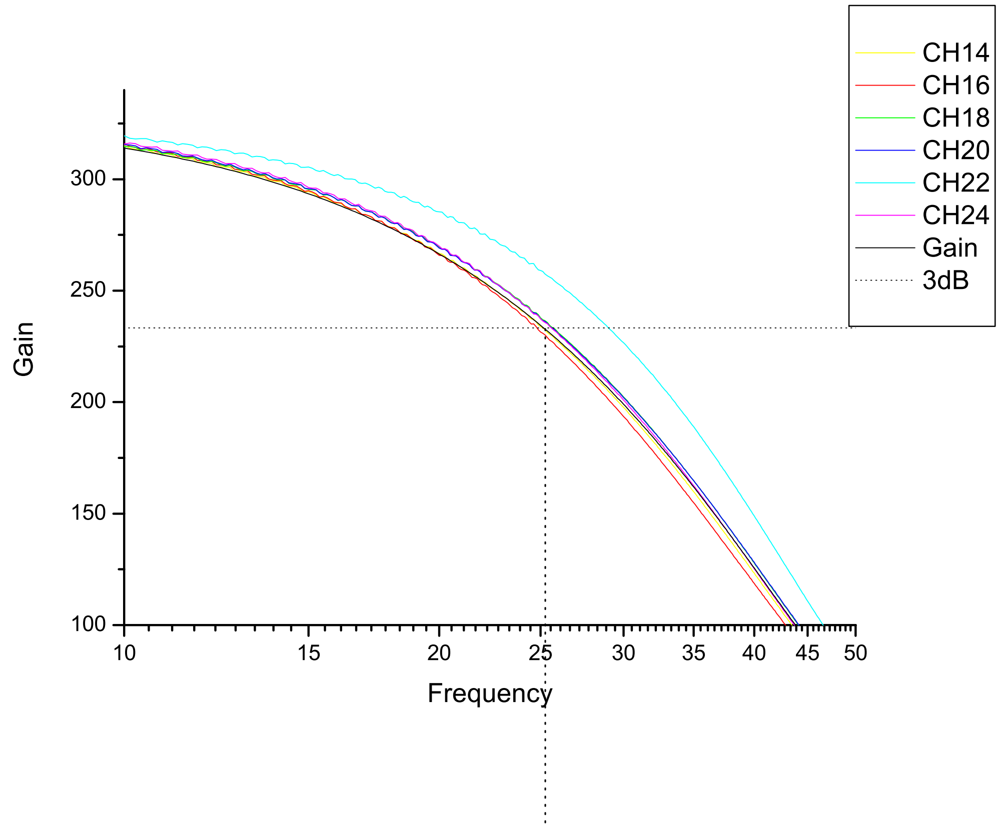


The following two graphs show close-ups of the cut-off frequencies at – 3dB:



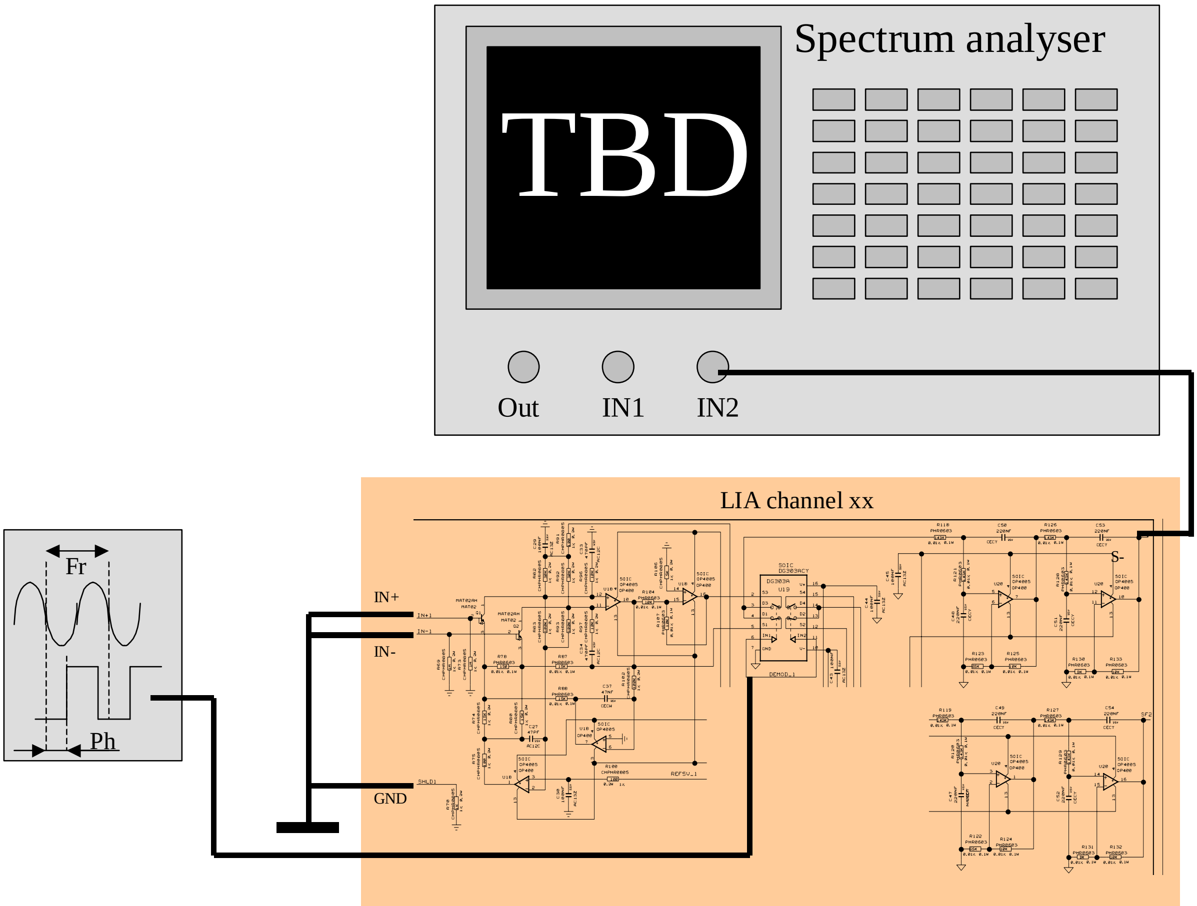
The following graph shows all the BPF gains (V/V) according to the frequency




CH14
CH16
CH18
CH20
CH22
CH24
Gain
3dB
Gain
300
250
200
150
100
10
15
20
25
30
35
40
45
50
Frequency

4.1.2.1.4 LIA input noise

Frequency range 15mHz to 10Hz

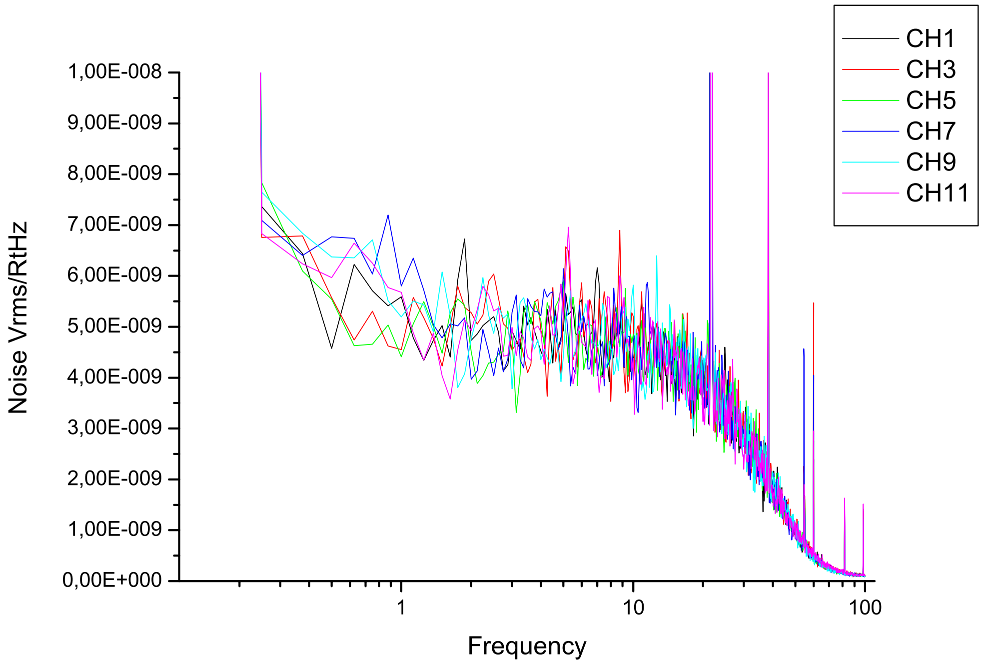


This Test will be **OK** if the input noise is lower than **7nVrms/rt(Hz)** over a frequency range of 0.05 to 25Hz on each channel

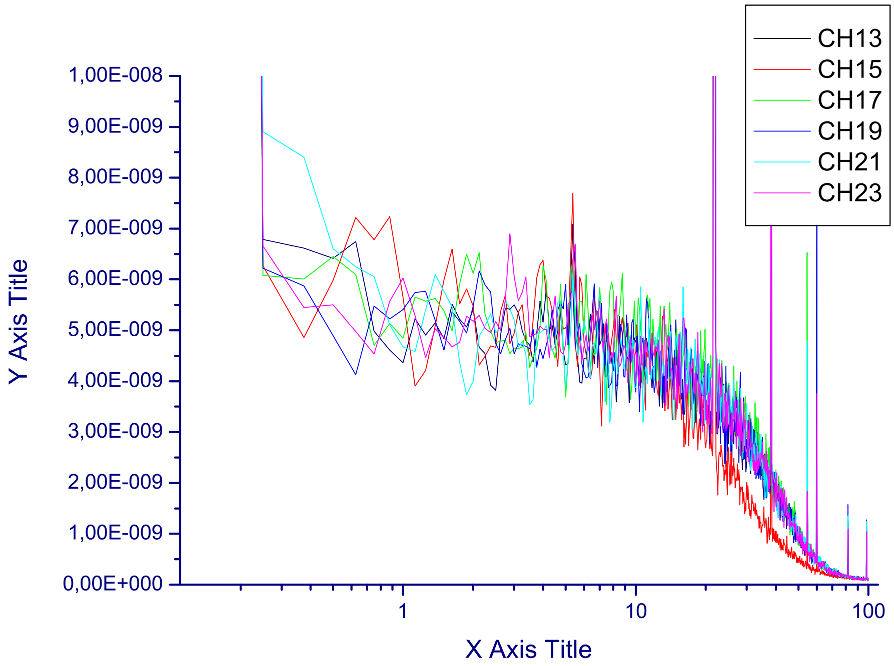
Measurement parameters:

Fbias = 216 Hz
Channel biased to Vout = 1.864 V, noises. BW = 0-100 Hz,
Window = Hanning, Channel AC Coupled via 10uF/1 MOhm,
Channel input range ~ -34dB, 20 RMS AVG * 8 sec.

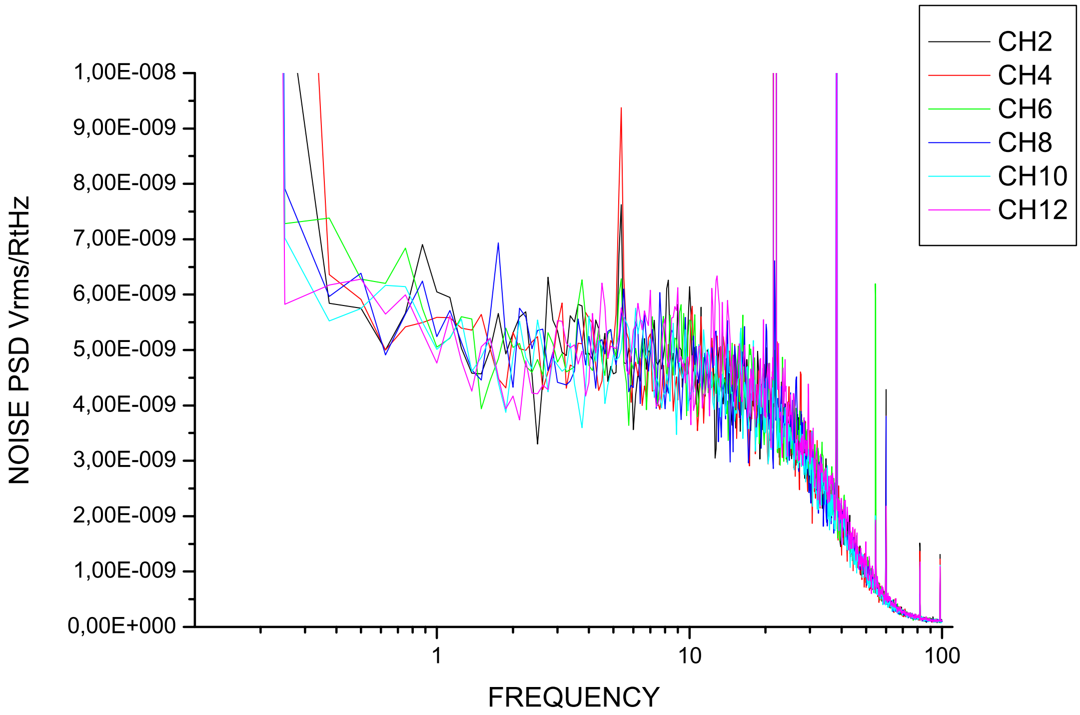
Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 10	Measure the noise of the channel 1		See picture below		OK
LIA_S 10	Measure the noise of the channel 2		See picture below		OK
LIA_S 10	Measure the noise of the channel 3		See picture below		OK
LIA_S 10	Measure the noise of the channel 4		See picture below		OK
LIA_S 10	Measure the noise of the channel 5		See picture below		OK
LIA_S 10	Measure the noise of the channel 6		See picture below		OK
LIA_S 10	Measure the noise of the channel 7		See picture below		OK
LIA_S 10	Measure the noise of the channel 8		See picture below		OK
LIA_S 10	Measure the noise of the channel 9		See picture below		OK
LIA_S 10	Measure the noise of the channel 10		See picture below		OK
LIA_S 10	Measure the noise of the channel 11		See picture below		OK
LIA_S 10	Measure the noise of the channel 12		See picture below		OK
LIA_S 10	Measure the noise of the channel 13		See picture below		OK
LIA_S 10	Measure the noise of the channel 14		See picture below		OK
LIA_S 10	Measure the noise of the channel 15		See picture below		OK
LIA_S 10	Measure the noise of the channel 16		See picture below		OK
LIA_S 10	Measure the noise of the channel 17		See picture below		OK
LIA_S 10	Measure the noise of the channel 18		See picture below		OK
LIA_S 10	Measure the noise of the channel 19		See picture below		OK
LIA_S 10	Measure the noise of the channel 20		See picture below		OK
LIA_S 10	Measure the noise of the channel 21		See picture below		OK
LIA_S 10	Measure the noise of the channel 22		See picture below		OK
LIA_S 10	Measure the noise of the channel 23		See picture below		OK
LIA_S 10	Measure the noise of the channel 24		See picture below		OK

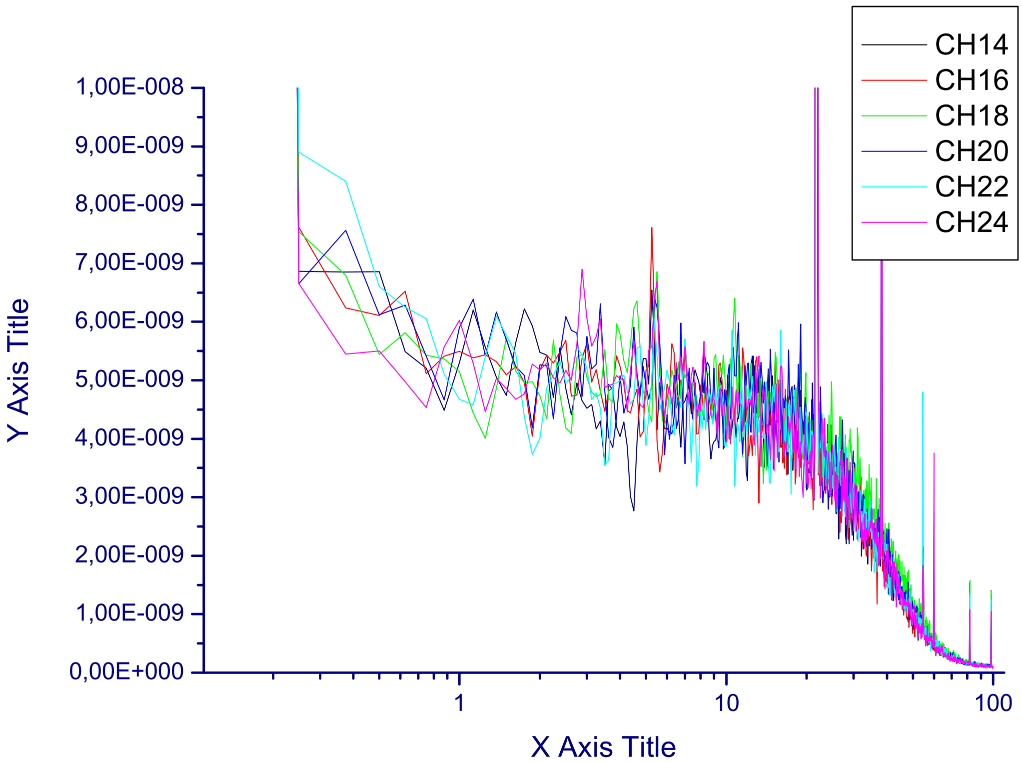


CH1
CH3
CH5
CH7
CH9
CH11
1,00E-008
9,00E-009
8,00E-009
7,00E-009
6,00E-009
5,00E-009
4,00E-009
3,00E-009
2,00E-009
1,00E-009
0,00E+000
Noise Vrms/RtHz
1
10
100
Frequency



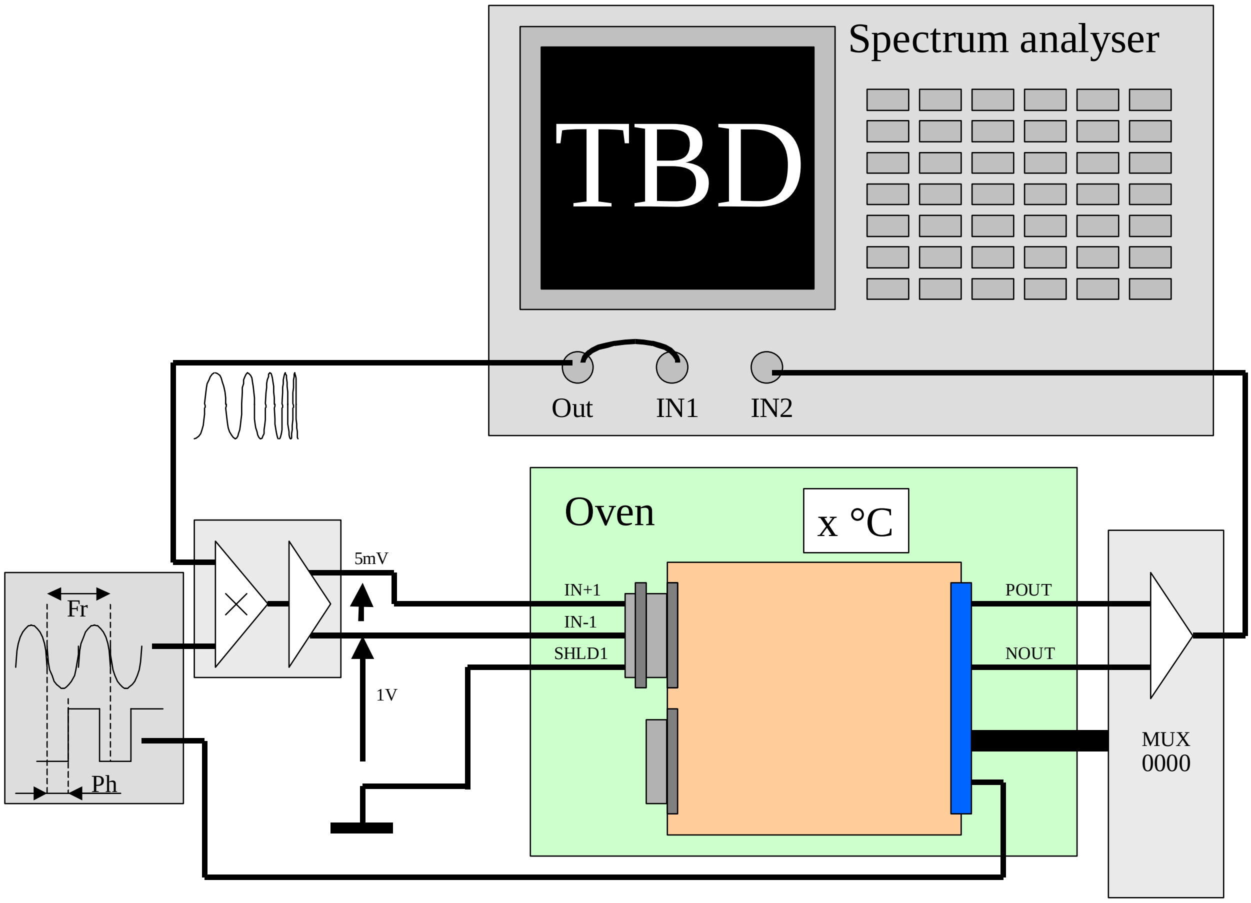
CH13
CH15
CH17
CH19
CH21
CH23
1,00E-008
9,00E-009
8,00E-009
7,00E-009
6,00E-009
5,00E-009
4,00E-009
3,00E-009
2,00E-009
1,00E-009
0,00E+000
Y Axis Title
1
10
100
X Axis Title


CH2
CH4
CH6
CH8
CH10
CH12
1,00E-008
9,00E-009
8,00E-009
7,00E-009
6,00E-009
5,00E-009
4,00E-009
3,00E-009
2,00E-009
1,00E-009
0,00E+000
NOISE PSD Vrms/RtHz
1
10
100
FREQUENCY


CH14
CH16
CH18
CH20
CH22
CH24
1,00E-008
9,00E-009
8,00E-009
7,00E-009
6,00E-009
5,00E-009
4,00E-009
3,00E-009
2,00E-009
1,00E-009
0,00E+000
Y Axis Title
1
10
100
X Axis Title

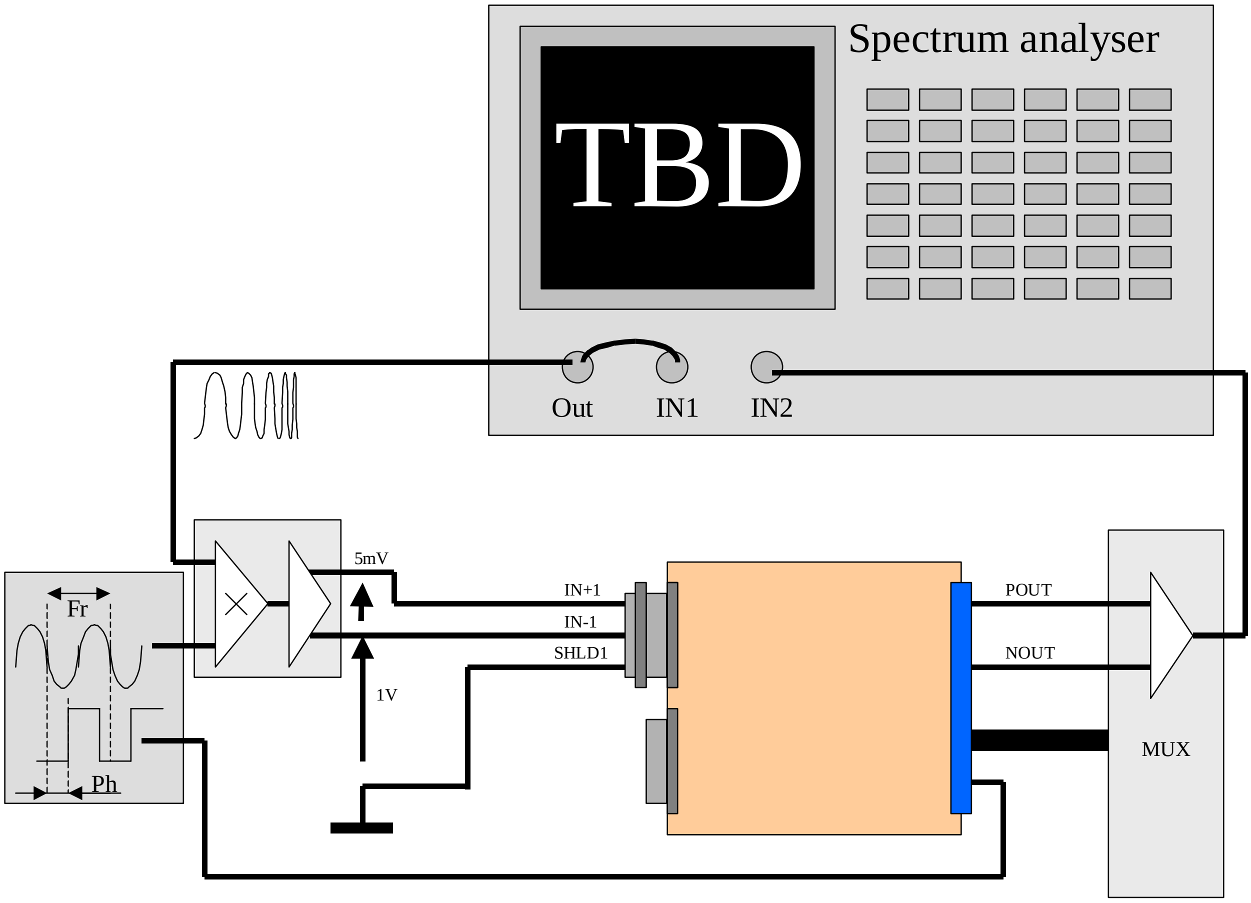
4.1.2.1.5 LIA TEMPERATURE STABILITIE

Frequency range 15mHz to 10Hz



Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 11	Measure the transfer function of the channel 1 at 0°C		This test are going to be done when the QM1 is integrated		
LIA_S 12	Measure the transfer function of the channel 1 at 20°C		This test are going to be done when the QM1 is integrated		
LIA_S 13	Measure the transfer function of the channel 1 at 40°C		This test are going to be done when the QM1 is integrated		

4.1.2.1.6 LIA channel cross-talk

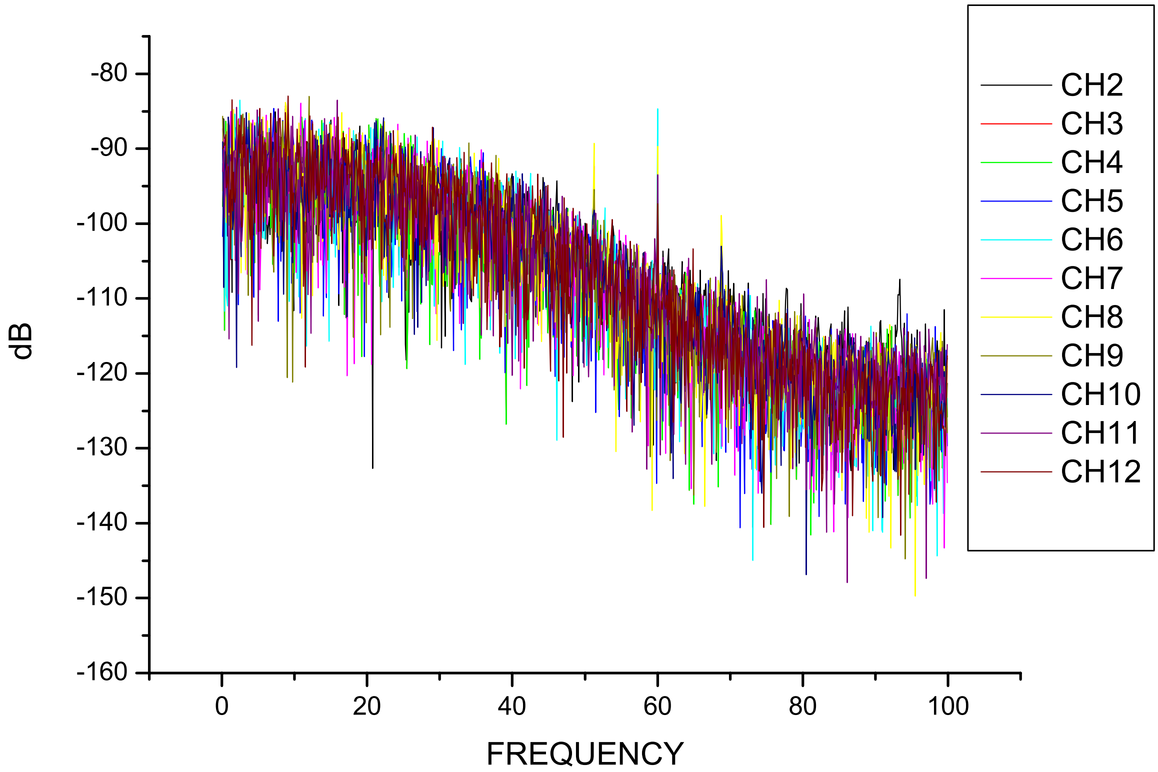


This test is considered successful if the electrical cross-talk between channel 1 and others channels is less than **0.05%** or also –66 dB

Measurement parameters:

0.25-100 Hz sine chirp amplitude 1V.
Fbias = 216 Hz, rectangular modulation of a sine sweep
sine sweep ~10 mV at the input of the BPF.
window: uniform ; average: VecAvg*2

Test number	Test	Test Date	Result	Corrections	Test Status OK/NOK
LIA_S 14	Measure the cross-talk between channel 1 and channel 2		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 3		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 4		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 5		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 6		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 7		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 8		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 9		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 10		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 11		See picture below		OK
LIA_S 14	Measure the cross-talk between channel 1 and channel 12		See picture below		OK


dB
-80
-90
-100
-110
-120
-130
-140
-150
-160
0
20
40
60
80
100
FREQUENCY
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH10
CH11
CH12

TRACEABILITY MATRIX

Requirement ID	Description	test
BDA-DRCU-01	The DRCU signal processing electronics shall have less than 7 nV/rtHz as seen post demodulation, after digitzation. Noise is referred to the input over the frequency range 0.05 to 25 Hz. This performance must be accomplished with a bias input signal to the DRCU of 10 mVrms AC, 5 mV DC, 1 V DC common-mode offset, with an input load of 7 kOhms.	LIA_S10
BDA-DRCU-03	Input capacitance to be less than 100 pF, measured from the DRCU DxMA connector pins without the harness.	TBD
BDA-DRCU-04	Input impedance to be larger than 1 MΩ from 50 – 300 Hz.	TBD
BDA-DRCU-11	The common-mode rejection is –60 dB (50 – 300 Hz).	LIA_S8
BDA-DRCU-14	The signal bandwidth of the spectrometer channels shall be 0.03 Hz to 25 Hz. The 25 Hz cutoff should have a precision of 1 %.	LIA_S9
BDA-DRCU-19	DRCU noise performance (BDA-DRCU-01) to be maintained under a warm electronics thermal drift of 1 K / hour (TBC).	LIA_S11, LIA_S12 & LIA_S13
BDA-DRCU-22	The DRCU shall not saturate at an input voltage as large as 11 (TBC) mV_{rms} at input (photometer), 17 (TBC) mV_{rms} at input (spectrometer). DRCU channels shall remain functional if one input signal goes to Vbias.	LIA_S7 & LIA_S9
BDA-DRCU-25	The electrical cross-talk between channels in the DRCU shall be less than 0.05 % (TBC). The electrical cross-talk shall be verified by varying the input signal on one channel and measuring the response in other channels. The input signal level to each channel must be representative.	LIA_S14
BDA-DRCU-26	Each signal input to the LIA module must be connected to ground by a diode. This provides both protection and allows the JFETs to turn on without the JFET heater.	LIA_S1