AN11571

TFF1044 Evaluation Results

Rev. 1 — 02 June 2015 Application note

Document information

Info	Content
Keywords	TFF1044, Quad LNB, Satellite Down Converter, FIMOD IC, EVB, Ku Band, NF, PCB
Abstract	This application note describes the TFF1044 evaluation board (EVB) design and its performances. The TFF1044 is an integrated down-converter for use in universal quad and Quattro Low Noise Block (LNB) convertors in a 10.70 GHz to 12.75 GHz Ku band satellite receiver system.

Revision history

Rev	Date	Description
1	20150602	First publication

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1. Introduction

This document describes the measurements of the TFF1044 on the v1 evaluation board (EVB). In order to provide a supply voltage to the TFF1044, we used an additional QUAD LNB Control Board. This control board can set each path to the desired polarization mode. It also can switch each LNB from low-band to high band and vice-versa.

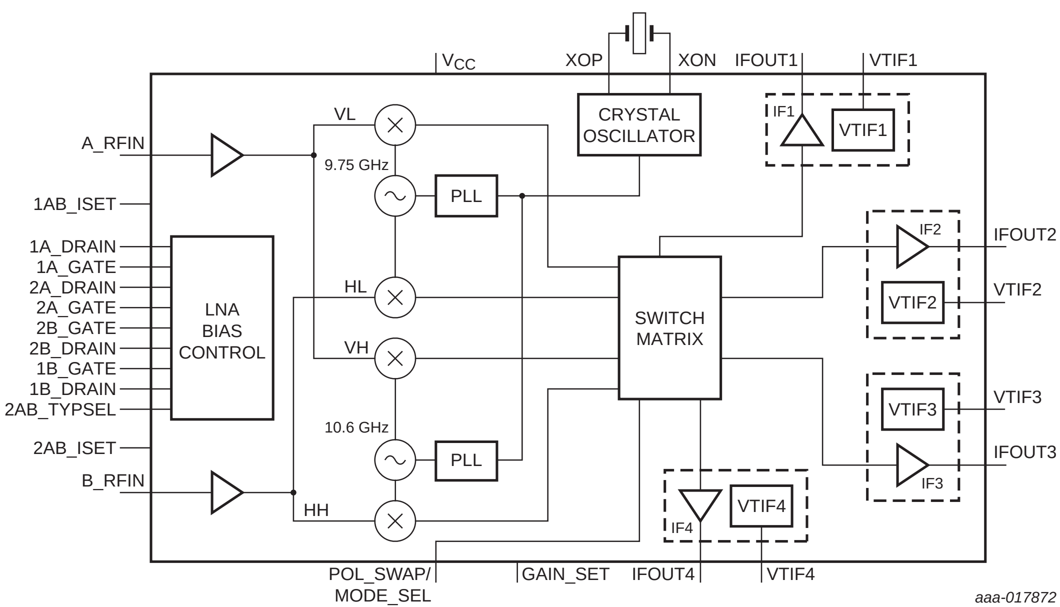
This document provides the TFF1044 and QUAD LNB Control Board circuit schematics, the bill of materials of the boards, the information relative to PCB technology and its artwork, and finally several typical test setups.

The main performances figures, such as Noise Figure, Gain, Image rejection, Cross polar, Cross talk, OIP3, Phase Noise, Spurs, consumption are summarized in chapter 4.

2. Product Description

The TFF1044HN is a 10.70 GHz to 12.75 GHz Ku band down converter for use in universal quad and Quattro Low Noise Block (LNB) in satellite receiver systems.
The device features two RF inputs (two polarizations) and four IF outputs (up to 4 active IF paths). It integrates bias generation and control for the external LNA stages, image rejection filtering, LO generation, down conversion mixers, IF amplifier stages, voltage and tone detection on each IF output (for polarization and band selection) and the 4 (IF channels) x 4 (2 polarizations, 2 bands) IF matrix switch.

For flexibility, the gain can be controlled in three discrete stages, the polarization of the RF inputs can be swapped and the second stage LNA biasing control can be switched from pHEMT to BJT configuration. EVB Circuit Description



The evaluation board is illustrated in Fig.1 associated with its schematic in Fig.2.

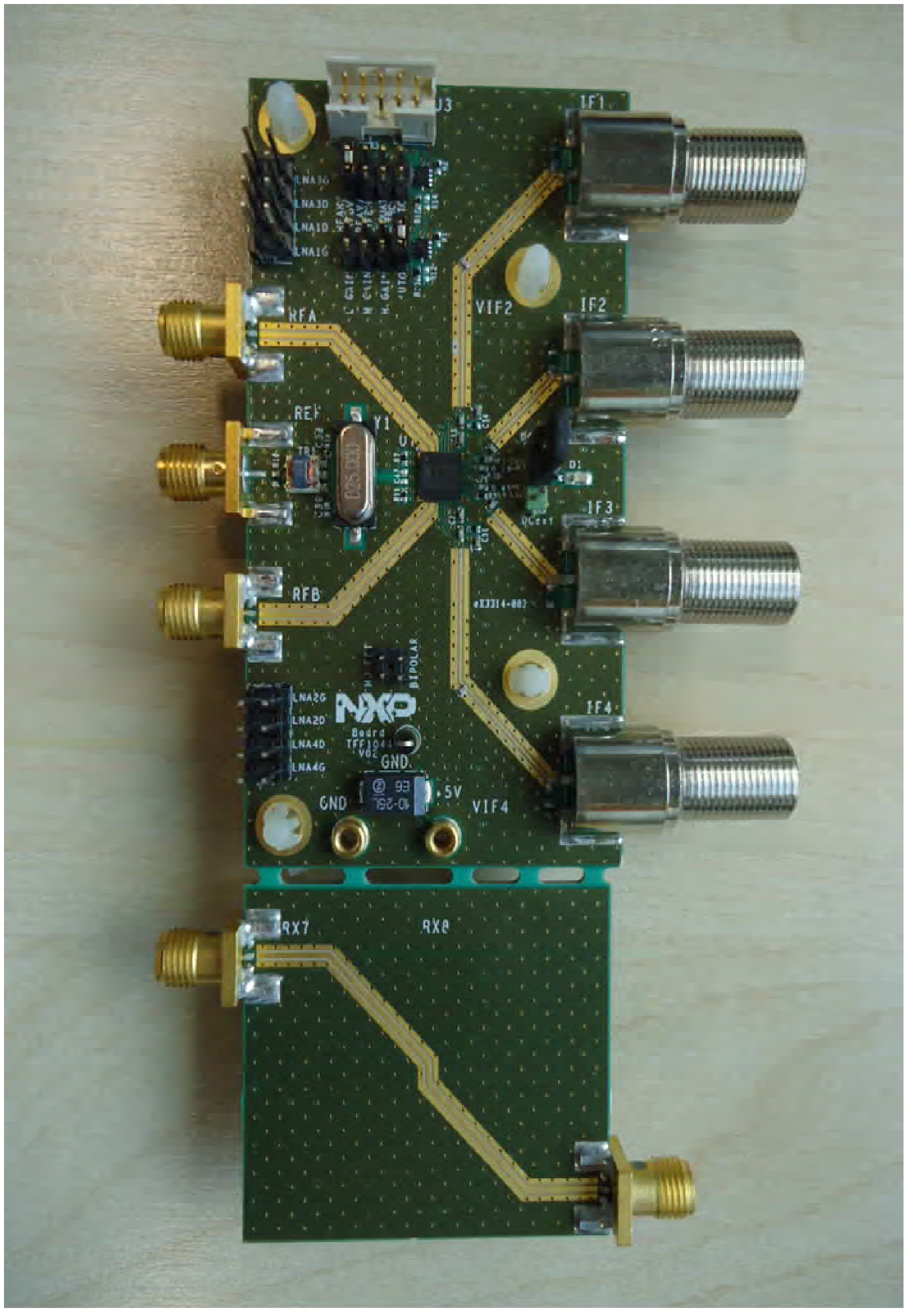


Figure 1 – TFF1044 Evaluation board

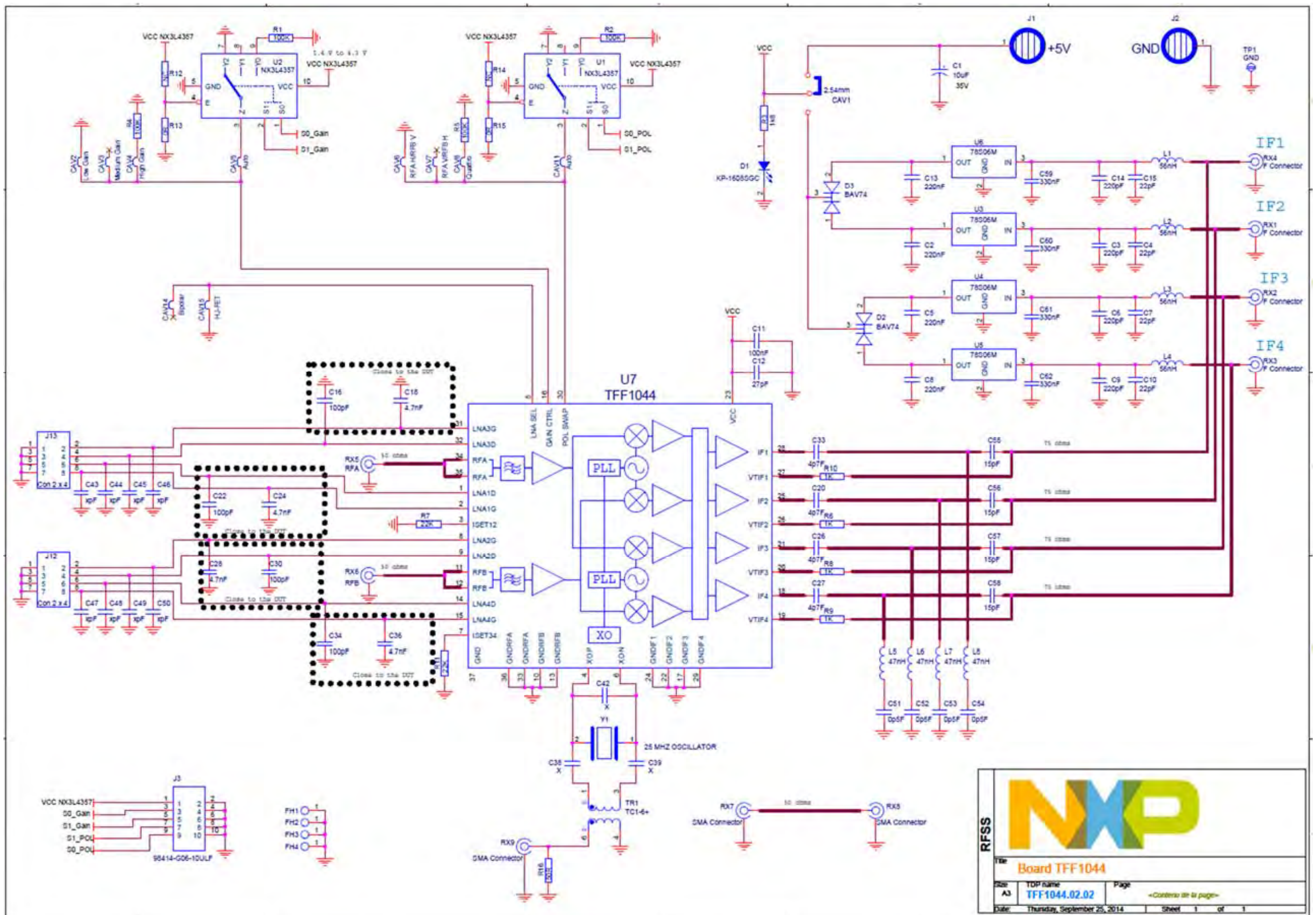


Figure 2 – TFF1044 Evaluation board schematic

REFDES	DESIGNATION	FOURNISSEUR	Code commande	COMP_VALUE	QUANTITY
C1	TANTAL_CMS_7343(293D106X9025D2TE3)	VISHAY/KEMET		10uF/25V	1
C38;C39;C42;C43;C44;C45;C46;C47;C48;C49;C50	C0402	MURATA		NC	11
C11	GRM155R71H104KE14	MURATA		100nF	1
C16;C22;C30;C34	GRM1555C1H101JA01D	MURATA		100pF	4
C18;C24;C28;C36	GRM155R71H472KA01	MURATA		4.7nF	4
C2;C5;C8;C13	GRM155R71C224KA88D	MURATA		220nF	4
C20;C26;C27;C33	GRM1555C1H4R7CA01D	MURATA		4.7pF	4
C55,C56,C57,C58	GRM1555C1H150CA01D	MURATA		15pF	4
C12	GRM1555C1H270JA01D	MURATA		27pF	1
C3;C6;C9;C14	GRM1555C1H221JA01D	MURATA		220pF	4
C4;C7;C10;C15	GRM1555C1H220JA01D	MURATA		22pF	4
C51,C52,C53,C54	GJM1555C1HR50WB01D	MURATA		0p5F	4
C59,C60,C61,C62	GRM219R71H334KA88	MURATA		330nF	4
CAV1	3 points Barrette droite pitch 2.54mm	FARNELL	5217805		1
CAV14;CAV15;CAV2;CAV3;CAV4;CAV5;CAV11;CAV6;CAV7;CAV8	Barrette droite pitch 2mm	FARNELL			10
	Jumper 2.54mm	FARNELL	2396301		3
	Jumper 2mm Black PQ25	FARNELL	510932		1
L1,L2,L3,L4	LQW18AN56NG00	MURATA		56nH	4
L5,L6,L7,L8	LQW15AN47NG00	MURATA		47nH	4
D1	LED KP-1608CGCK (VERT)	FARNELL	229-0328	KP-1608SGC	1
D2;D3	DIODE BAV74 SOT23	NXP		BAV74	2
FH1;FH2;FH3;FH4	SUPPORT CI	IMPULSION	100209100002	100209100002	4
J1;J2	DOUILLE NON ISOLEE 2MM	IMPULSION	LB2A	23.1000	2
J12;J13	CON_2X4_MD_SECABLE_H8MM6 pitch 2.54mm	FARNELL	1098460		2
J3	98414-G06-10ULF	FARNELL	2135963	98414-G06-10ULF	1
R1;R2;R4;R5	RES 0402 5% 1/16W_R0402_100K			100K	4
R12;R14	RES 0402 5% 1/16W_R0402_NC			NC	2
R13;R15	RES 0402 5% 1/16W_R0402_0R			0R	2
R16	RES 0402 5% 1/16W_R0402_50R			50R	1
R3	RES 0402 5% 1/16W_R0402_1K8			1k8	1
R6;R8;R9;R10	RES 0402 5% 1/16W_R0402_1K			1K	4
R7;R11	RES 0402 5% 1/16W_R0402_22K			22K	2
RX1;RX2;RX3;RX4	861V509ER6	FARNELL	142-6015	F Connector	4
RX5;RX6;RX7;RX8	PSF-S01-007(SASF55ZGT-P2)	GIGALANE(LTI)		SMA Connector	4
RX9	142-0701-851	FARNELL	101-9325	SMA Connector	1
TP1	BOUCLE TEST NOIR PQ100	FARNELL	873-1128	20-2137	1
TR1	TRANSFO_AT224	MINI-CIRCUIT		TC1-6+	1
U1;U2	SOT1049-3	NXP		NX3L4357	2
U3;U4;U5;U6	SOT89	SILICORE		78S06M	4
U7	TFF1044	NXP		TFF1044	1
Y1	HC-49/S-SMD	DYNAMIC		25 MHZ OSCILLATOR	1

Table 1 - Bill of material (BOM) of TFF1044 Evaluation board

3. Equipment, setup and settings

Table 2, below summarizes the list of equipment per measurement type, used to check the TFF1044 performances:

Table 2 - Equipment / measurement for Application board

Equipment, type & feature	Measurement at Vcc=5V , Tamb=25°C							
	NFG	GMI	Xpol	OIP3	PN	Sp1G7	SpNx25	Current
FSW26 or PXA: 26.5GHz SA with NF	1 x	1 x	1 x	1 x		1 x	1 x	
SSA E5052A: 7GHz					1 x			
SMA100A: 6GHz Signal Generator					1 x			
SMF100A: 40GHz Signal Generator		1 x	2x	2 x	1 x		1 x	
E3631A: Dual Power Supply	1 x	1 x	1 x	1 x	1 x	1 x	1 x	
E34401A: Multi-meter								1 x
HP346B: 15dB ENR Noise Source	1 x							

For each test, a table describes the signal applied on the RF input and the setting for each IF path.

All Measurement will be complemented by a figure.

In this report, the pin POL_SWAP/MODE_SEL is set to GND. **Therefore RF input path A is Horizontal and RF input path B is Vertical.** This is the convention used in this report. The other modes are functional but will not be discussed here.

Set the RF path with Cav6, 7, 8.

connection of POL_SWAP/MODE_SEL (pin 30)	Mode	Polarity	
		RF input path A	RF input path B
GND	quad	horizontal	vertical
float	quad	vertical	horizontal
GND via 100 kΩ pull-down resistor	quattro [1]	N/A	N/A

3.1 NF and Gain (NFG)

Noise Figure and Conversion Gain - measurement settings						
Measurement	RF input at		other channel on	LNB control board switches setting		
	Vertical	Horizontal		All Outputs ON CH1 / CH2 / CH3 / CH4	Polarity CH1 / CH2 / CH3 / CH4	Band CH1 / CH2 / CH3 /CH4
NFG LB V CH1	Noise Source	50 Ω load	V	SA / 50 Ω / 50 Ω / 50 Ω	V / V / V / V	LB / LB / LB / LB
			H	SA / 50 Ω / 50 Ω / 50 Ω	V / H /H / H	LB / LB / LB / LB
NFG LB V CH2	Noise Source	50 Ω load	V	SA / 50 Ω / 50 Ω / 50 Ω	V / V / V / V	LB / LB / LB / LB
			H	50 Ω / SA / 50 Ω / 50 Ω	H / V / H / H	LB / LB / LB / LB
NFG LB V CH3	Noise Source	50 Ω load	V	50 Ω / SA / 50 Ω / 50 Ω	V / V / V / V	LB / LB / LB / LB
			H	50 Ω / SA / 50 Ω / 50 Ω	H / H / V / H	LB / LB / LB / LB
NFG LB V CH4	Noise Source	50 Ω load	V	50 Ω / 50 Ω / SA / 50 Ω	V / V / V / V	LB / LB / LB / LB
			H	50 Ω / 50 Ω / SA / 50 Ω	H / H / H / V	LB / LB / LB / LB
NFG LB H CH1	50 Ω load	Noise Source	H	SA / 50 Ω / 50 Ω / 50 Ω	H / H / H / H	LB / LB / LB / LB
			V	SA / 50 Ω / 50 Ω / 50 Ω	H / V / V / V	LB / LB / LB / LB
NFG LB H CH2	50 Ω load	Noise Source	H	SA / 50 Ω / 50 Ω / 50 Ω	H / H / H / H	LB / LB / LB / LB
			V	50 Ω / SA / 50 Ω / 50 Ω	V /H / V / V	LB / LB / LB / LB
NFG LB H CH3	50 Ω load	Noise Source	H	50 Ω / SA / 50 Ω / 50 Ω	H / H / H / H	LB / LB / LB / LB
			V	50 Ω / SA / 50 Ω / 50 Ω	H / H / V / H	LB / LB / LB / LB
NFG LB H CH4	50 Ω load	Noise Source	H	50 Ω / 50 Ω / SA / 50 Ω	H / H / H / H	LB / LB / LB / LB
			V	50 Ω / 50 Ω / SA / 50 Ω	H / H / H / V	LB / LB / LB / LB
NFG HB V CH1	Noise Source	50 Ω load	V	50 Ω / SA / 50 Ω / 50 Ω	V / V / V / V	HB / HB / HB / HB
			H	50 Ω / SA / 50 Ω / 50 Ω	V / H /H / H	HB / HB / HB / HB
NFG HB V CH2	Noise Source	50 Ω load	V	50 Ω / 50 Ω / SA / 50 Ω	V / V / V / V	HB / HB / HB / HB
			H	50 Ω / 50 Ω / SA / 50 Ω	H / V / H / H	HB / HB / HB / HB
NFG HB V CH3	Noise Source	50 Ω load	V	50 Ω / 50 Ω / SA / 50 Ω	V / V / V / V	HB / HB / HB / HB
			H	50 Ω / 50 Ω / 50 Ω / SA	H / H / V / H	HB / HB / HB / HB
NFG HB V CH4	Noise Source	50 Ω load	V	50 Ω / 50 Ω / 50 Ω / SA	V / V / V / V	HB / HB / HB / HB
			H	50 Ω / 50 Ω / 50 Ω / SA	H / H / H / V	HB / HB / HB / HB
NFG HB H CH1	50 Ω load	Noise Source	H	50 Ω / SA / 50 Ω / 50 Ω	H / H / H / H	HB / HB / HB / HB
			V	50 Ω / SA / 50 Ω / 50 Ω	H / V / V / V	HB / HB / HB / HB
NFG HB H CH2	50 Ω load	Noise Source	H	50 Ω / 50 Ω / SA / 50 Ω	H / H / H / H	HB / HB / HB / HB
			V	50 Ω / 50 Ω / SA / 50 Ω	V / H / V / V	HB / HB / HB / HB
NFG HB H CH3	50 Ω load	Noise Source	H	50 Ω / 50 Ω / SA / 50 Ω	H / H / H / H	HB / HB / HB / HB
			V	50 Ω / 50 Ω / 50 Ω / SA	V / V / H / V	HB / HB / HB / HB
NFG HB H CH4	50 Ω load	Noise Source	H	50 Ω / 50 Ω / 50 Ω / SA	H / H / H / H	HB / HB / HB / HB
			V	50 Ω / 50 Ω / 50 Ω / SA	V / V / V / H	HB / HB / HB / HB
Duplicate the test list for three different gain settings						

Remark(s):

1) Outputs IF1to IF4 show similar NF and gain results when measured at chip level. Some differences are observed when measured on the Evaluation board, due to the presence of the IF biasing network and different length of transmission lines. Modifications to the IF biasing network might be required to correct this.

2) Gain measurement results are obtained using CW signals, Noise Figure results are obtained applying the Y-factor method (Noise Source / ESR table).

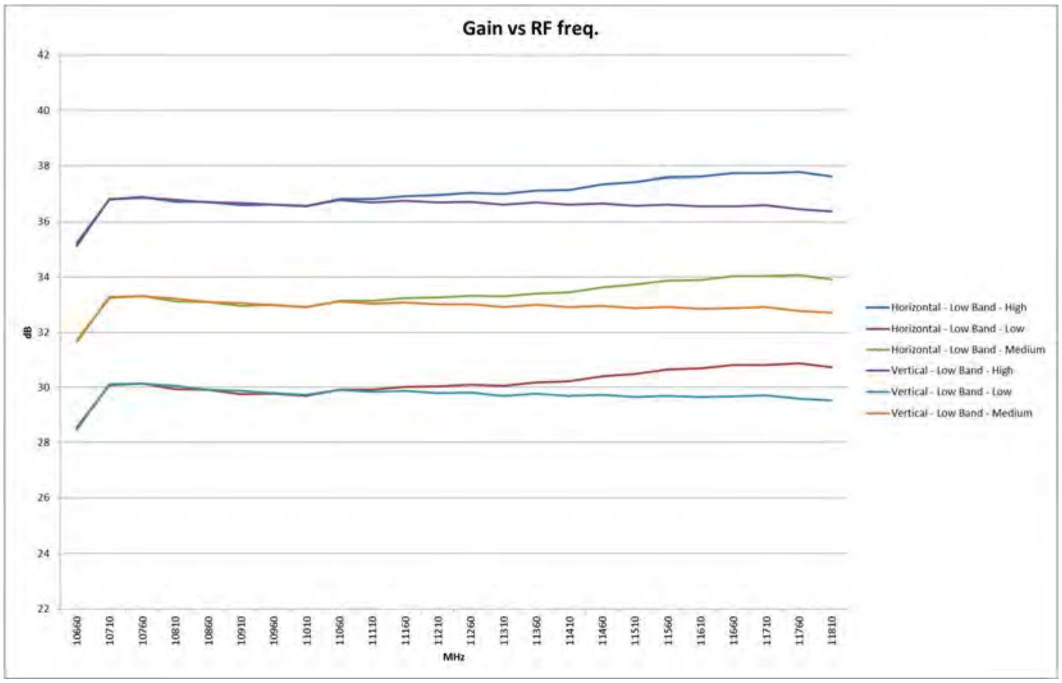


Figure 3 – Gain vs RF freq LB on IF1 (Only IF1 ON)

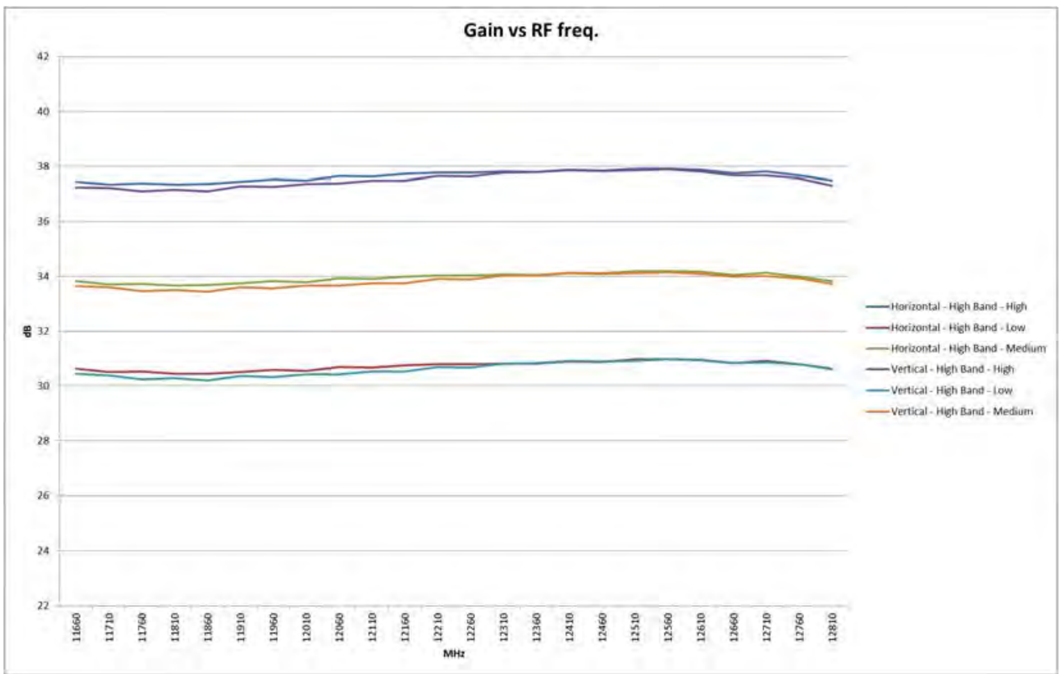


Figure 4 – Gain vs RF freq HB on IF1 (Only IF1 ON)

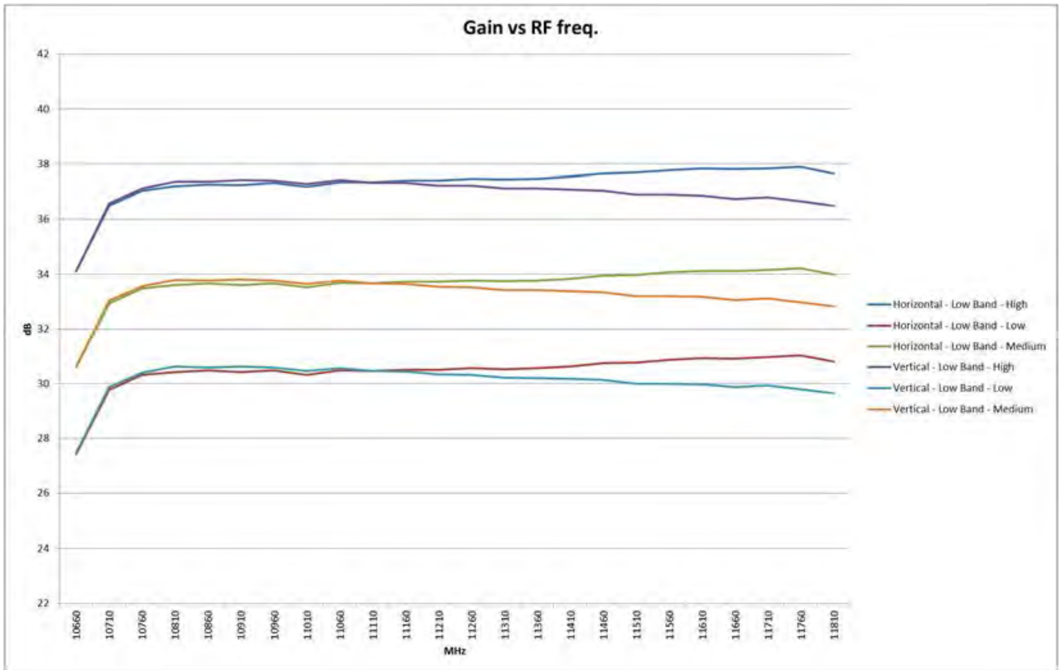


Figure 5 – Gain vs RF freq LB on IF2 (Only IF2 ON)

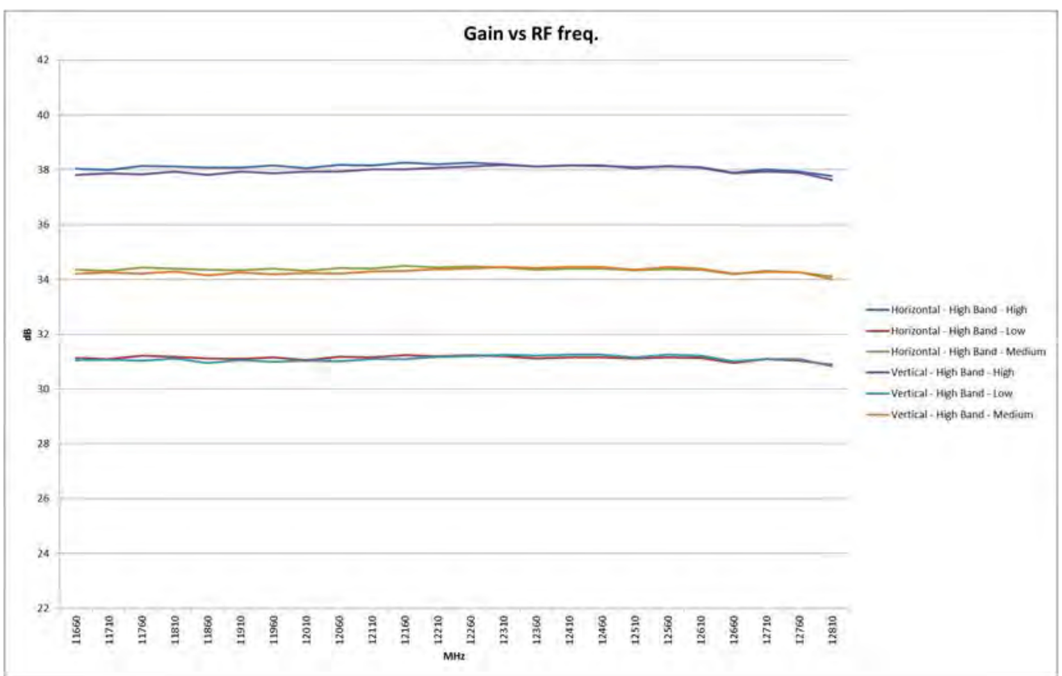


Figure 6 – Gain vs RF freq HB on IF2 (Only IF2 ON)

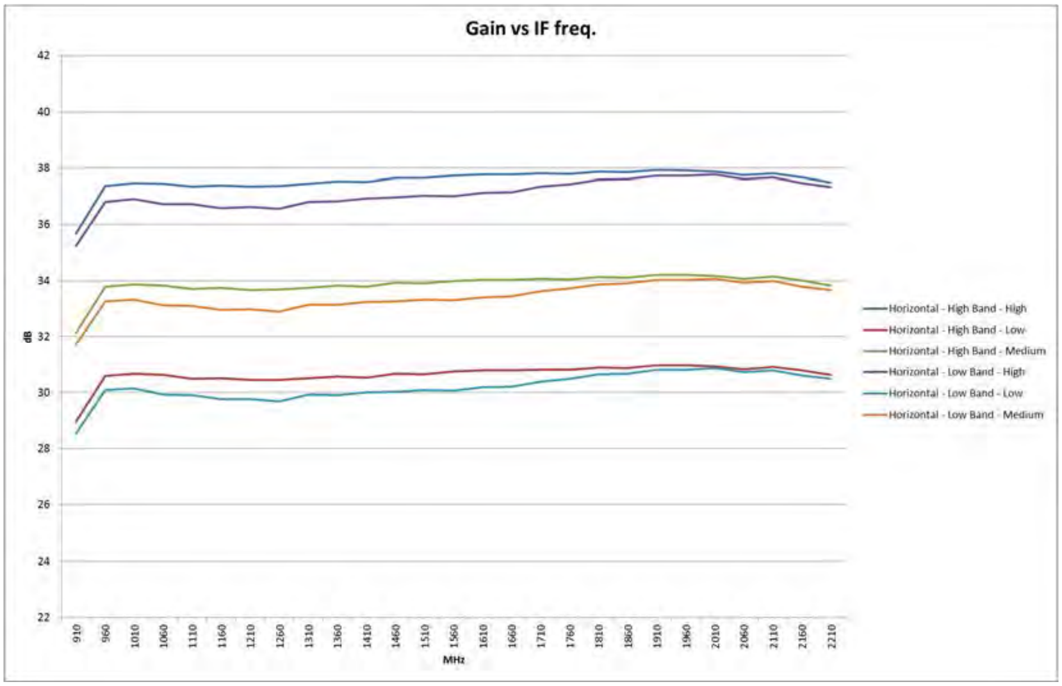


Figure 7 – Gain vs IF freq on IF1 Hor (Only IF1 ON)

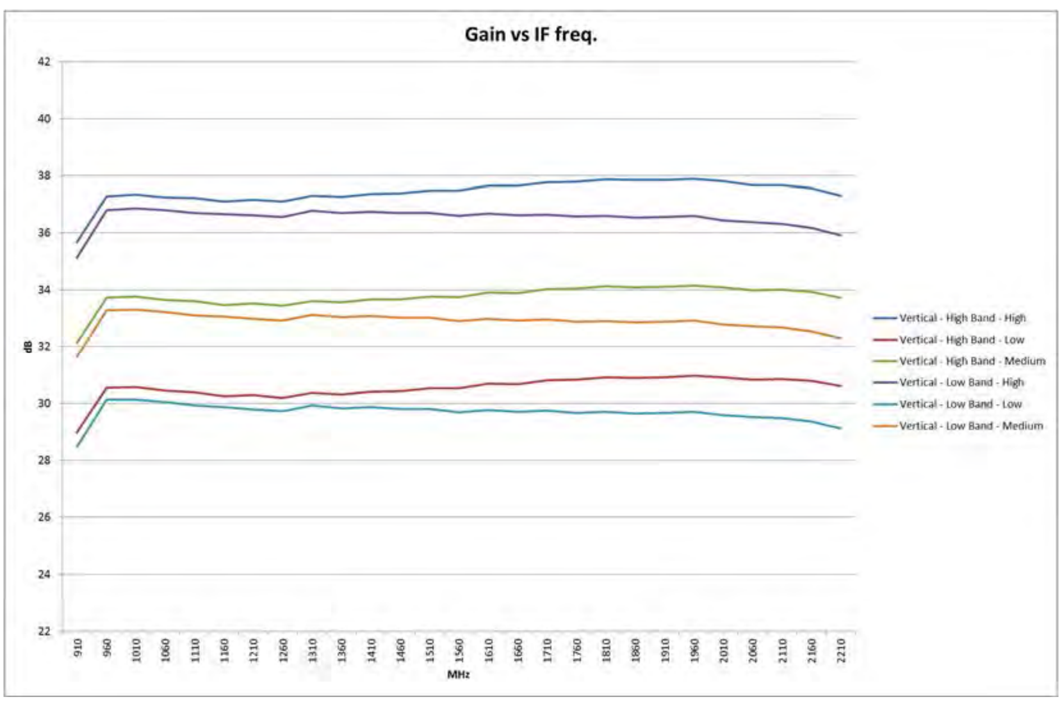


Figure 8 – Gain vs IF freq on IF1 Ver (Only IF1 ON)

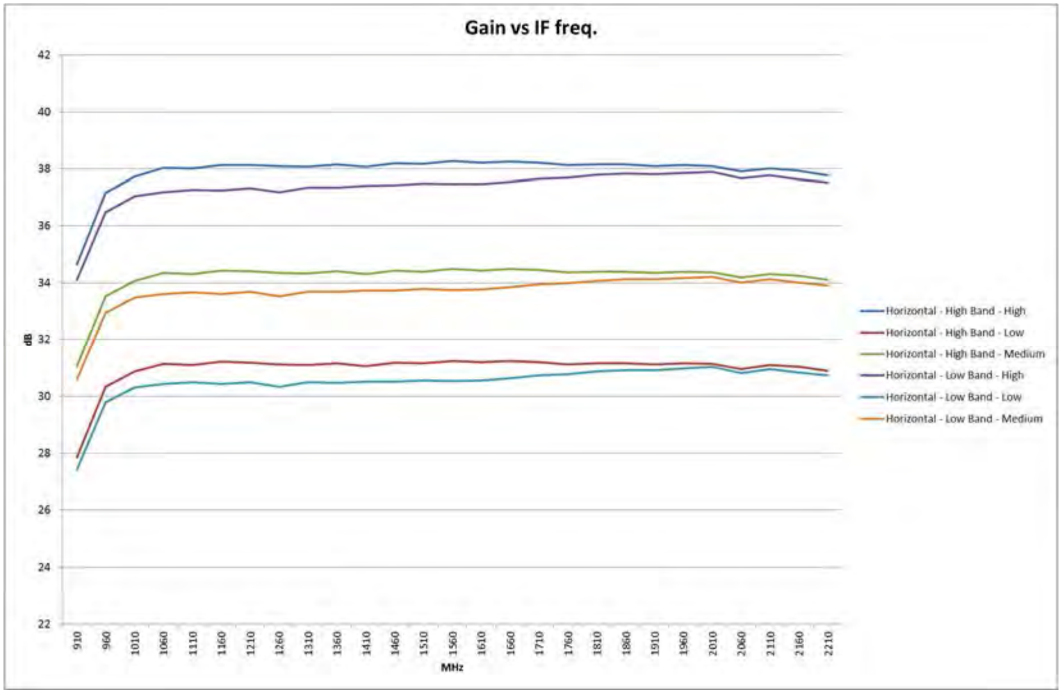


Figure 9 – Gain vs IF freq on IF2 Hor (Only IF2 ON)

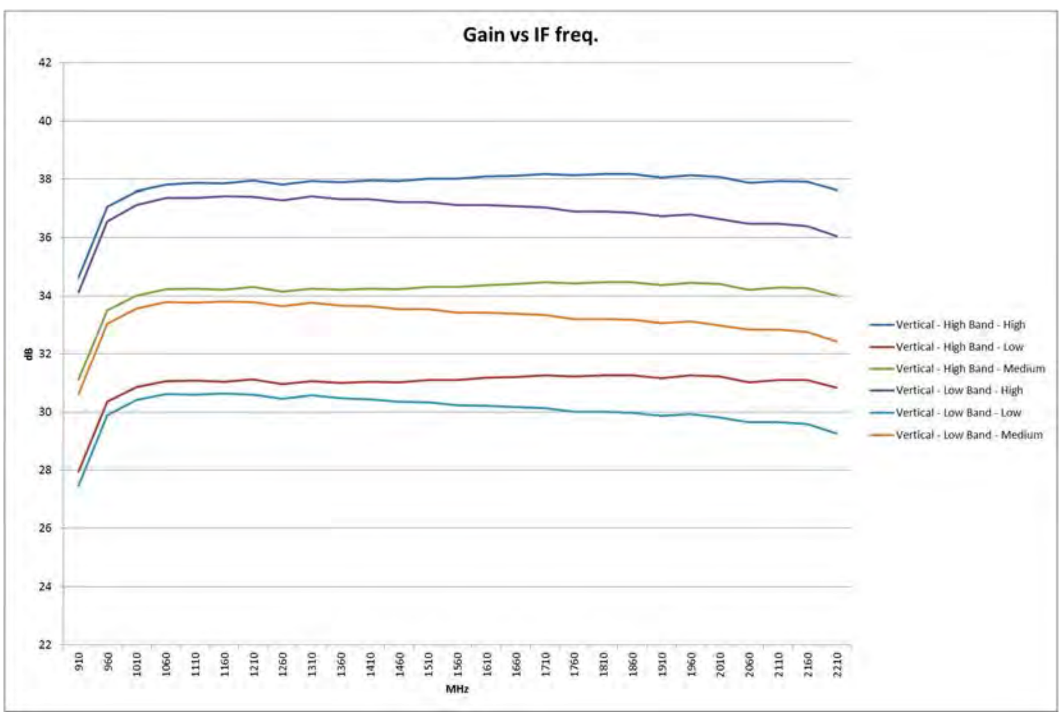


Figure 10 – Gain vs IF freq on IF2 Ver (Only IF2 ON)

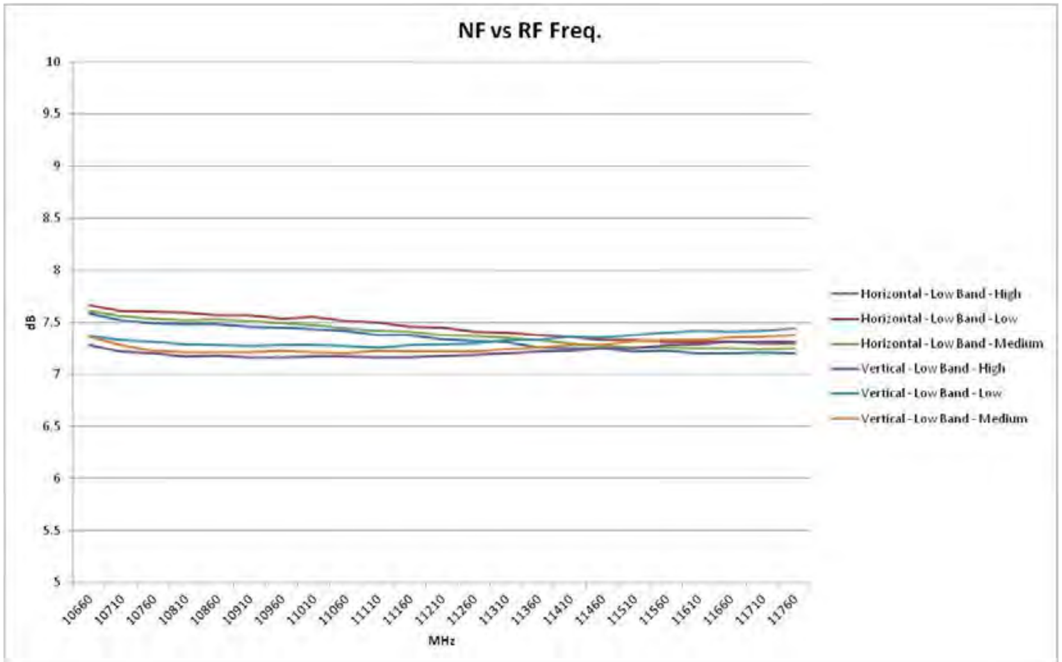


Figure 11 – NF vs LB RF freq on IF3 (Only IF3 ON)

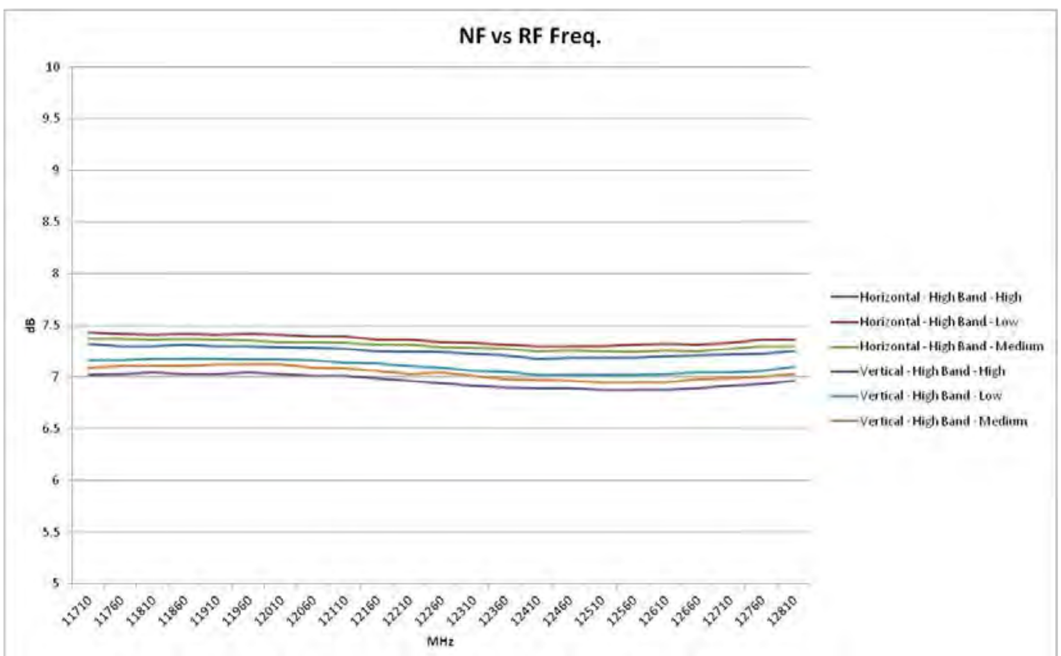


Figure 12 – NF vs HB RF freq on IF3 (Only IF3 ON)

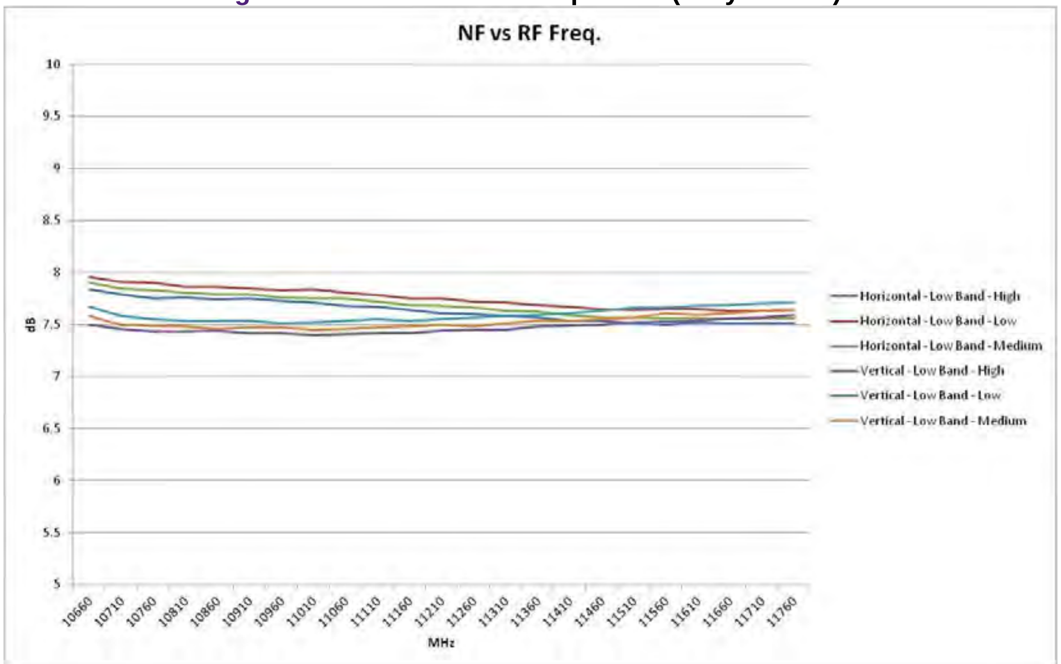


Figure 13 – NF vs LB RF freq on IF3 (All IF ON)

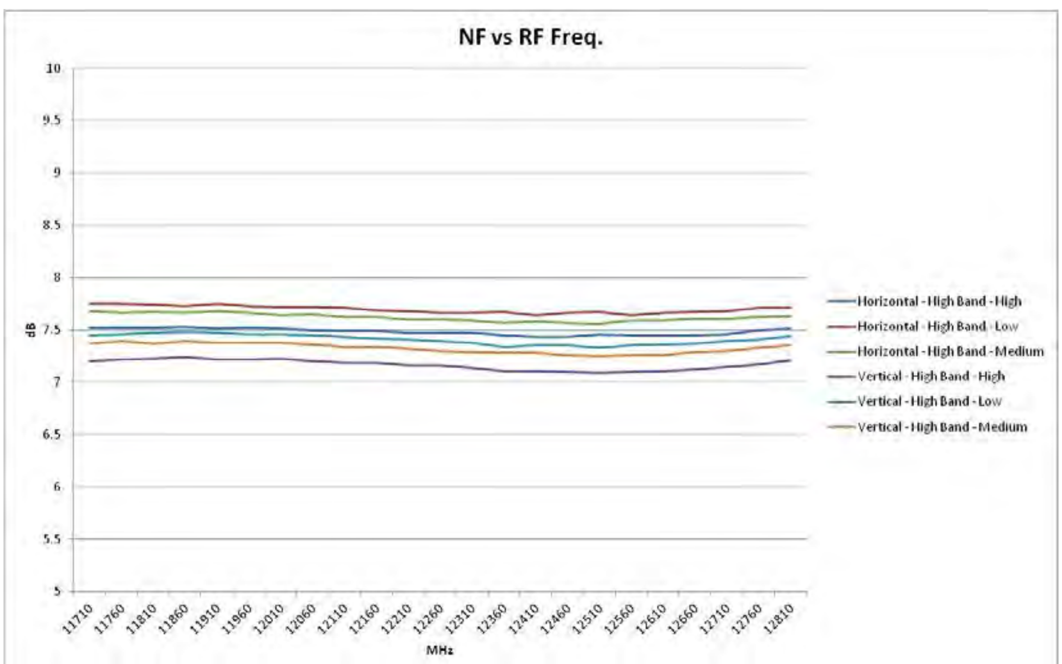


Figure 14 – NF vs HB RF freq on IF3 (All IF ON)

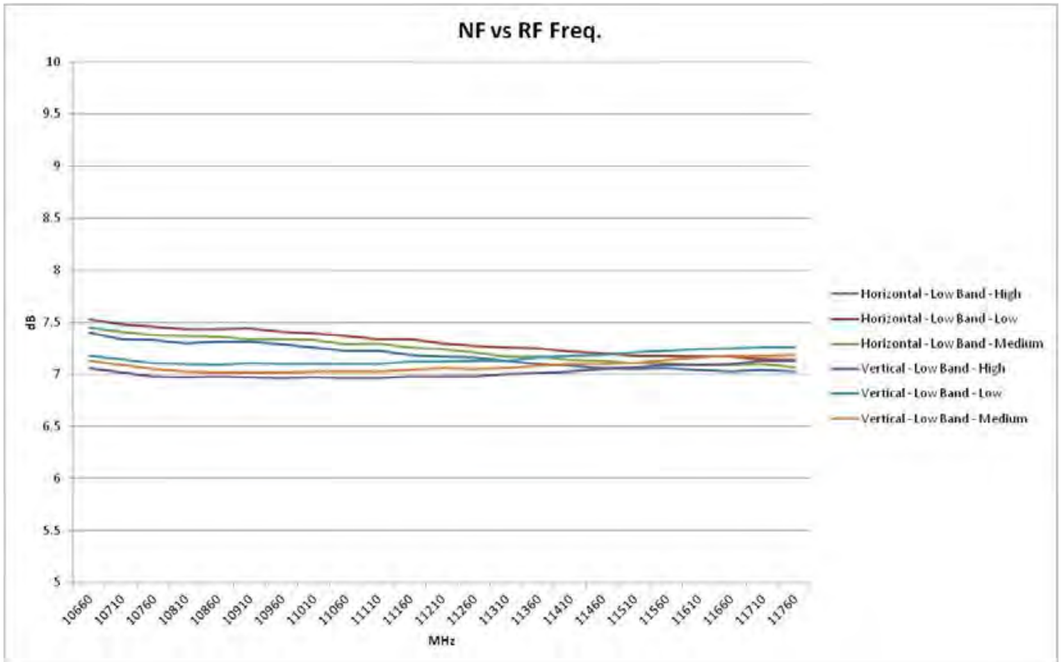


Figure 15 – NF vs LB RF freq on IF4 (Only IF4 ON)

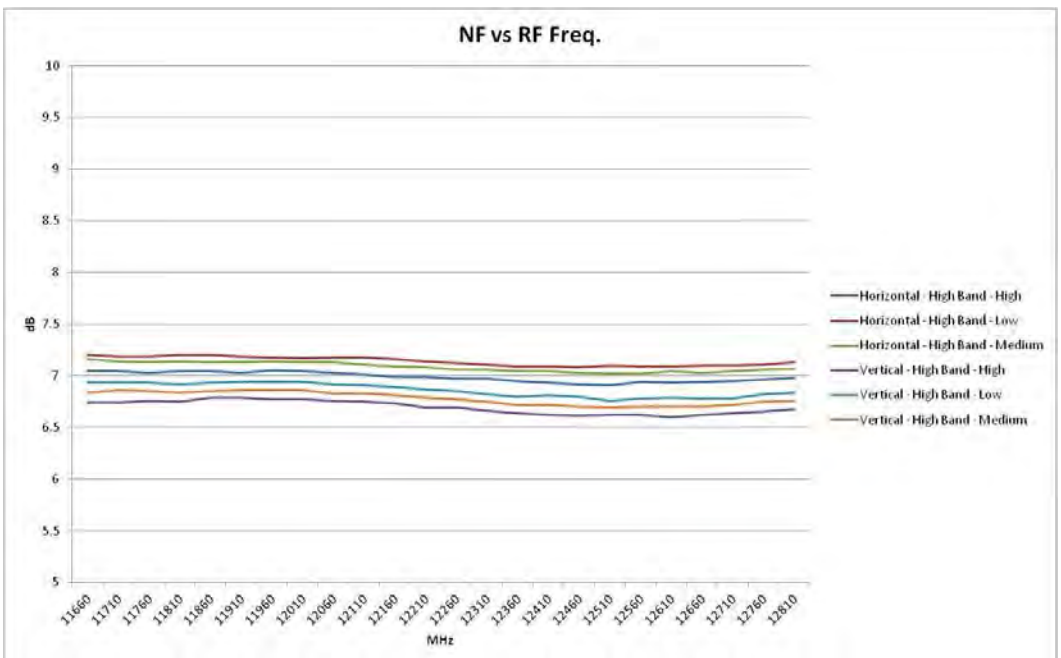


Figure 16 – NF vs HB RF freq on IF4 (Only IF4 ON)

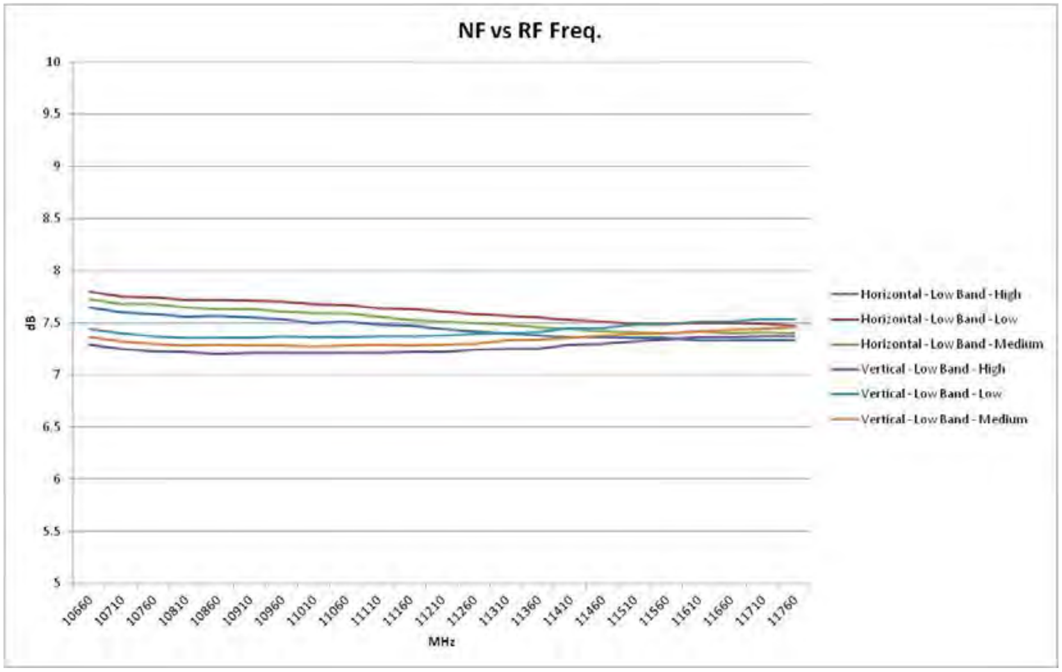


Figure 17 – NF vs LB RF freq on IF4 (All IF ON)

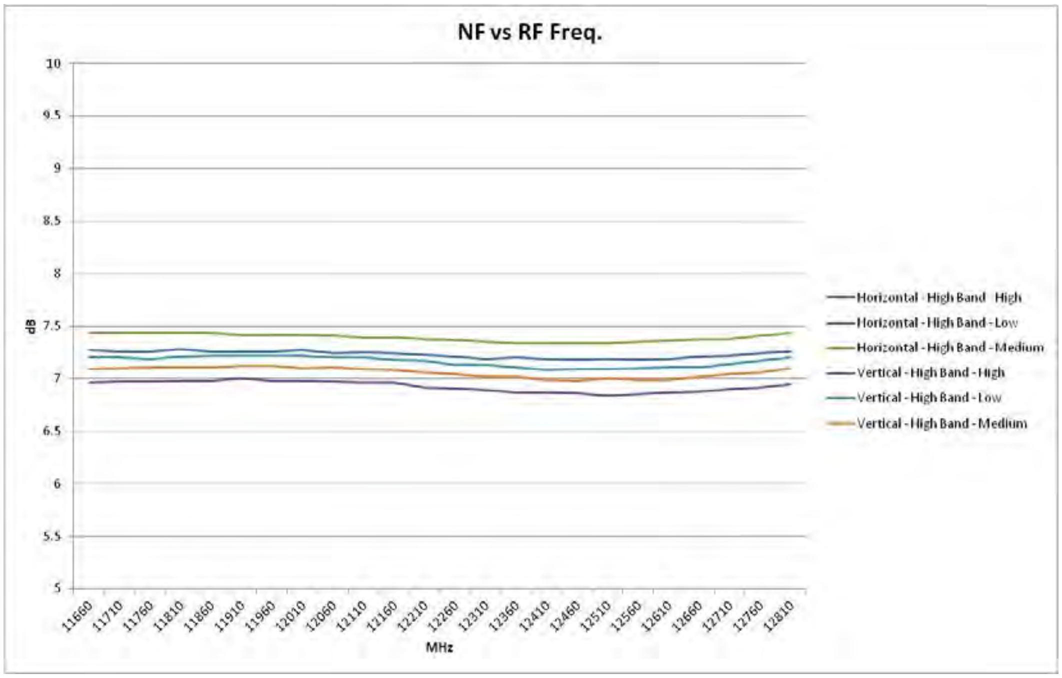


Figure 18 – NF vs HB RF freq on IF4 (All IF ON)

3.2 Conversion Gain Variation and Image Rejection (GMI)

Gain Match and Image rejection - measurement settings								
Measurement	RF input at		IF output at				LNB control switches	
	Vertical	Horizontal	CH1	CH2	CH3	CH4	Output CH1 / CH2 / CH3 / CH4	Polarity CH1 / CH2 / CH3 / CH4
GMimR V CH1	Src	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / V / V / V
	Src	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / H / H / H
GMimR V CH2	Src	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / V / V / V
	Src	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / V / H / H
GMimR V CH3	Src	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / V / V / V
	Src	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / H / V / H
GMimR V CH4	Src	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	Vcc / Vcc / Vcc / Vcc	V / V / V / V
	Src	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	Vcc / Vcc / Vcc / Vcc	H / H / H / V
GMimR H CH1	50 Ω load	Src	SA	50 Ω load	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / H / H / H
	50 Ω load	Src	SA	50 Ω load	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / V / V / V
GMimR H CH2	50 Ω load	Src	50 Ω load	SA	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / H / H / H
	50 Ω load	Src	50 Ω load	SA	50 Ω load	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / H / V / V
GMimR H CH3	50 Ω load	Src	50 Ω load	50 Ω load	SA	50 Ω load	Vcc / Vcc / Vcc / Vcc	H / H / H / H
	50 Ω load	Src	50 Ω load	50 Ω load	SA	50 Ω load	Vcc / Vcc / Vcc / Vcc	V / V / H / V
GMimR H CH3	50 Ω load	Src	50 Ω load	50 Ω load	50 Ω load	SA	Vcc / Vcc / Vcc / Vcc	H / H / H / H
	50 Ω load	Src	50 Ω load	50 Ω load	50 Ω load	SA	Vcc / Vcc / Vcc / Vcc	V / V / V / H
Duplicate the test list for three different gain settings								

The results are the same for IF1, IF4 and IF2, IF3. In this document, only IF1 and IF2 are represented.

In this test all IF's are active.

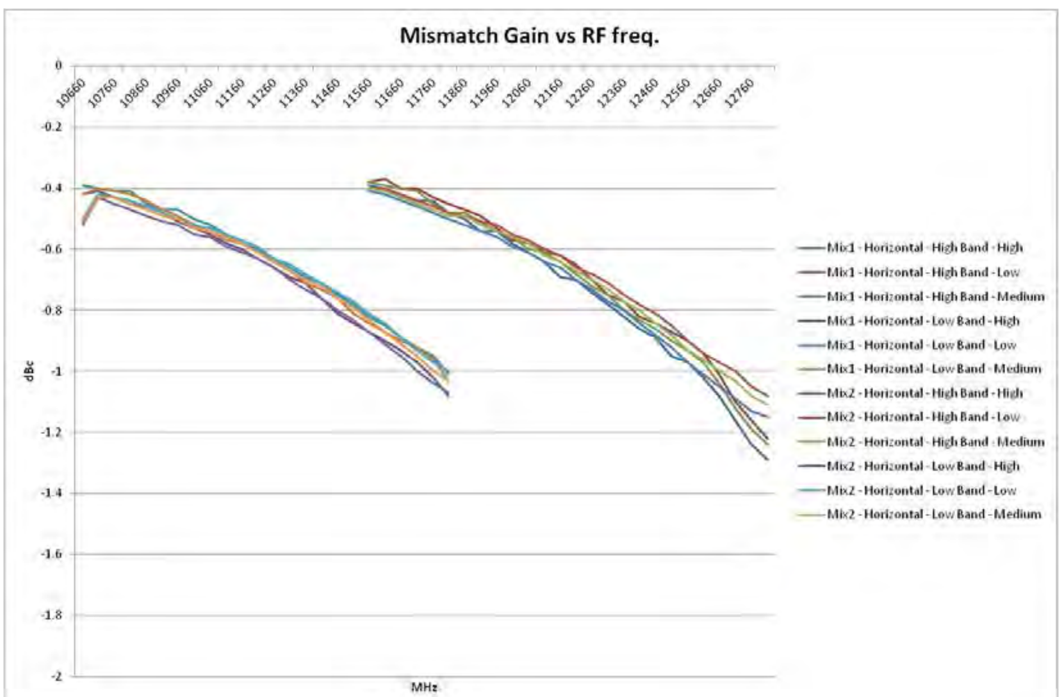


Figure 19 –Conversion Gain Variations Vs RF freq on IF1 and 2 Horizontal

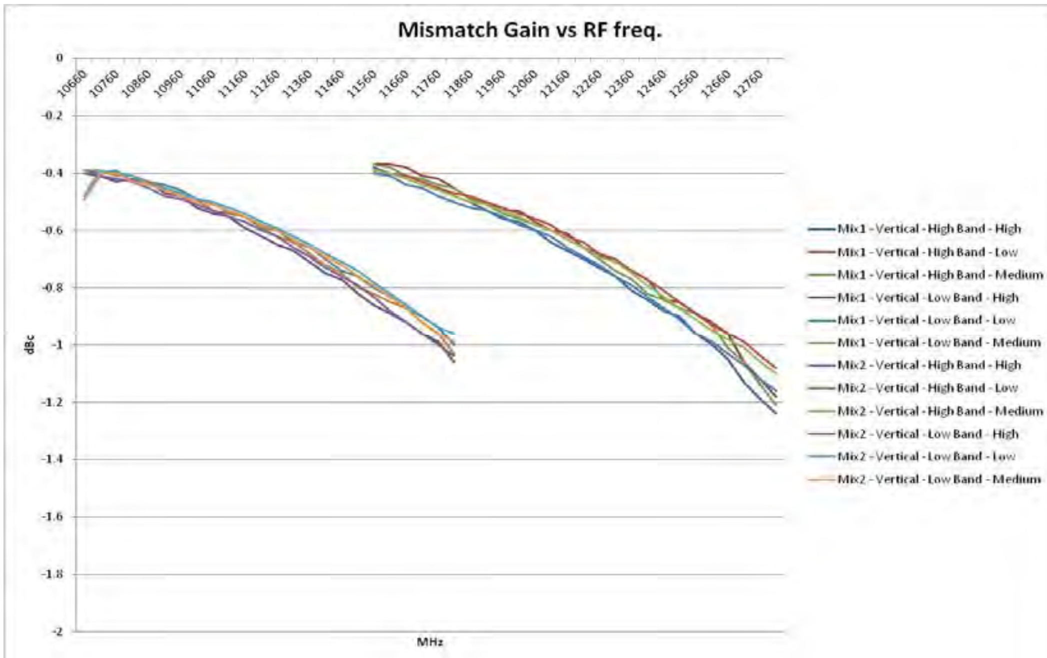


Figure 20 –Conversion Gain Variations Vs RF freq on IF1 and 2 Vertical

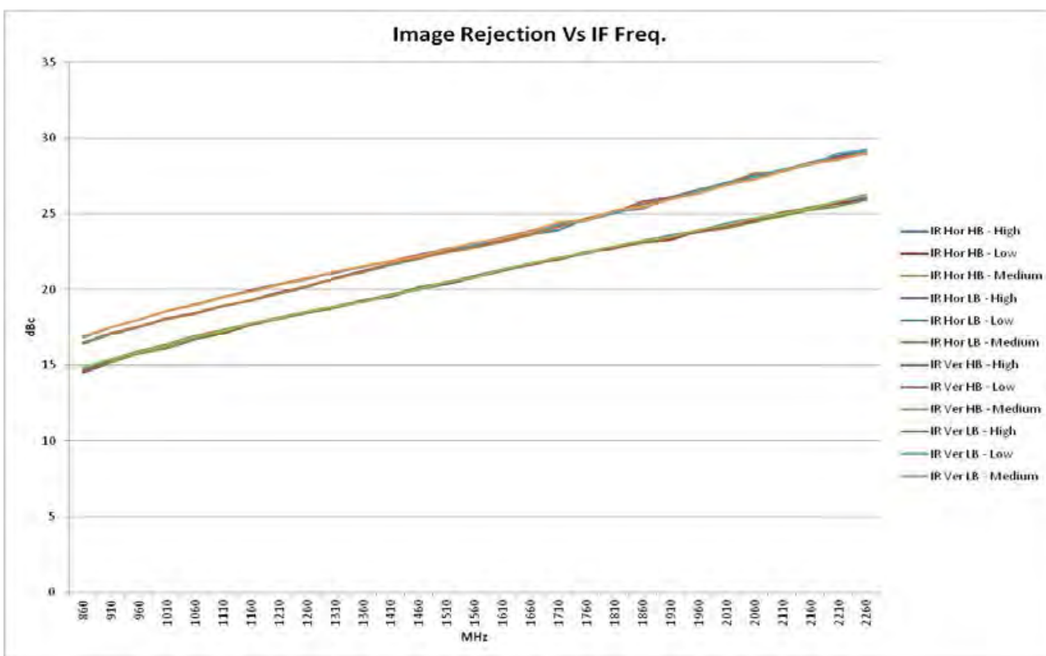


Figure 21 – Rejection Vs IF freq on IF1 for all gain

Remark: The Image Rejection Filters are implemented in front of the mixers. Therefore, the image rejection for all IF outputs are identical.

3.3 Cross Polar and Cross Talk Isolation (Xpol)

Cross polar and cross talk isolation - measurement settings					
			LNB control board switches setting		
Measurement	Signal path	RF switch active on	Output CH1 / CH2 / CH3 / CH4	Polarity CH1 / CH2 /CH3 / CH4	Band CH1 / CH2 / CH3/ CH4
LB V CH1 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	V / H / H / H	LB / LB / LB / LB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
LB V CH2 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / V / H / H	LB / LB / LB / LB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
LB V CH3 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / V / H	LB / LB / LB / LB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
LB V CH4 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / V	LB / LB / LB / LB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	LB / LB / LB / LB
LB H CH1 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	H / V / V / V	LB / LB / LB / LB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
LB H CH2 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	V / H / V / V	LB / LB / LB / LB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
LB H CH3 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / H / V	LB / LB / LB / LB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
LB H CH4 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / H	LB / LB / LB / LB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	LB / LB / LB / LB
HB V CH1 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	V / H / H / H	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
HB V CH2 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / V / H / H	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
HB V CH3 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / V / H	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
HB V CH4 XpolHV	direct	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / V	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / V	HB / HB / HB / HB
HB H CH1 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	H / V / V / V	HB / HB / HB / HB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
HB H CH2 XpolVH	direct	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	V / H / V / V	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
HB H CH3 XpolVH	direct	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
	cross polar	Vertical	Vcc / Vcc / Vcc / Vcc	V / V / H / V	HB / HB / HB / HB
	cross talk	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
HB H CH4 XpolVH	direct	Vertical	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
	cross polar	Horizontal	Vcc / Vcc / Vcc / Vcc	V / V / V / H	HB / HB / HB / HB
	cross talk	Horizontal	Vcc / Vcc / Vcc / Vcc	H / H / H / H	HB / HB / HB / HB
LB: V or H / RF = 11.2GHz (-55dBm) / fIF @ 1.45GHz					
HB: V or H / RF = 12.25GHz (-55dBm) / fIF @ 1.65GHz					

In this test all IF are ON

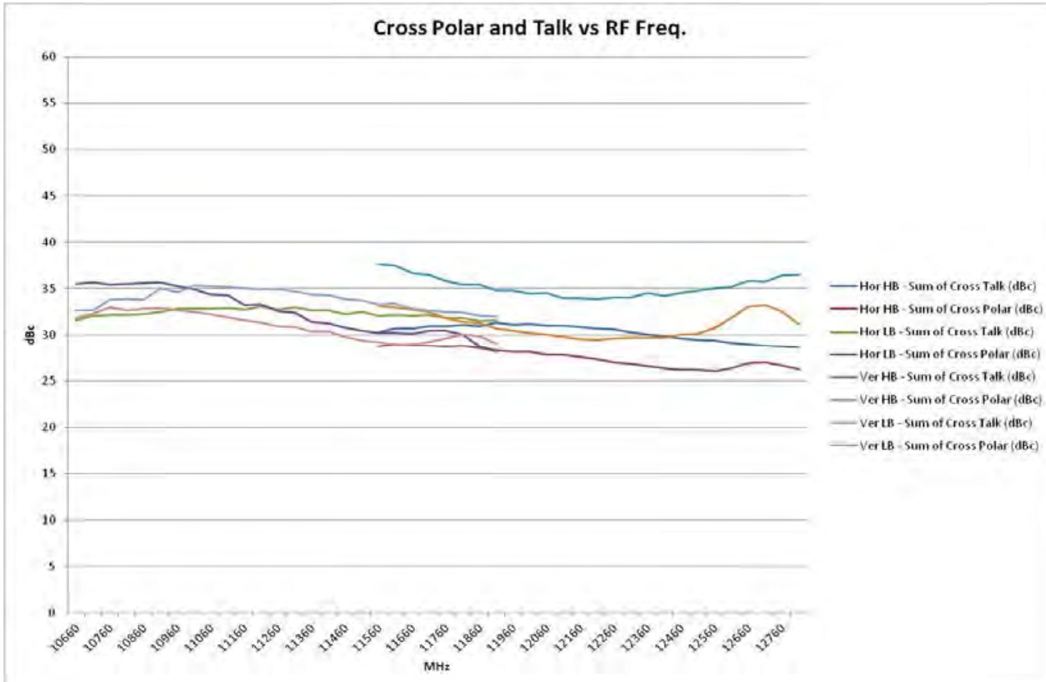


Figure 22 – Cross Polar and Talk vs RF freq on IF1 for High Gain

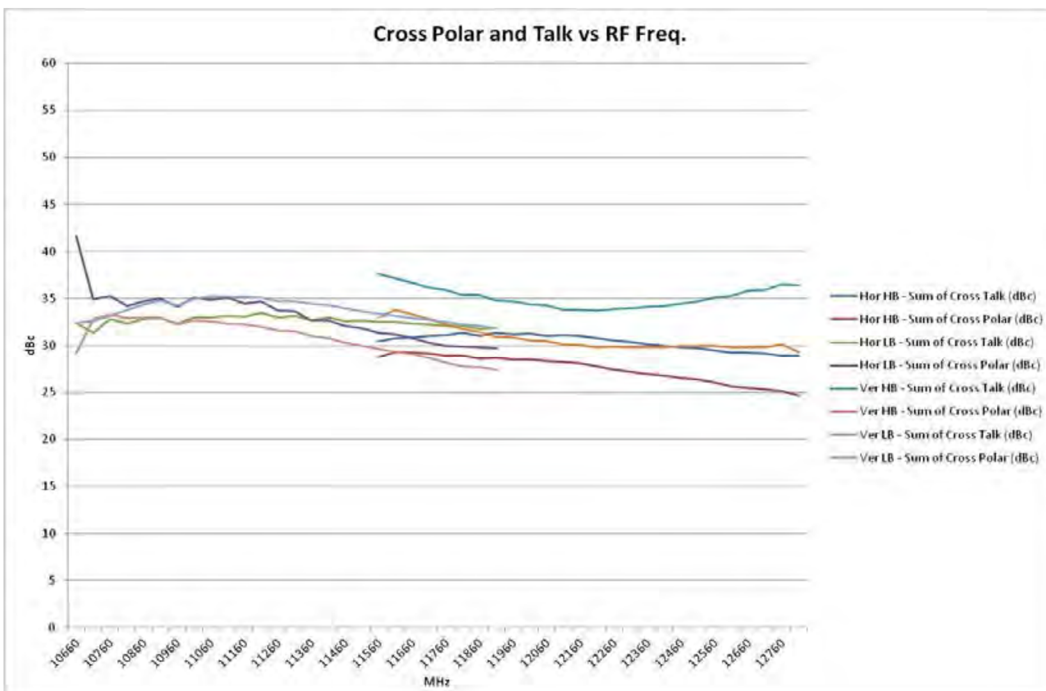


Figure 23 – Cross Polar and Talk vs RF freq on IF2 for High Gain

3.4 Output third-order intercept point (OIP3)

OIP3 - measurement settings							
Measurement	RF input at any of	IF output at CH1	IF output at CH2	IF output at CH3	IF output at CH4	LNB control switches: Polarity CH1 / CH2 / CH3 / CH4	LNB control switches: Band CH1 / CH2 / CH3 / CH4
OIP3 LB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	LB / LB / LB / LB
OIP3 HB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	HB / HB / HB / HB
LB: fRF1 = 11.295GHz / fRF2 = 11.305GHz / PwrIF1 = PwrIF2 = -10dBm							
HB: fRF1 = 12.145GHz / fRF2 = 12.155GHz / PwrIF1 = PwrIF2 = -10dBm							

In this test all IF are ON

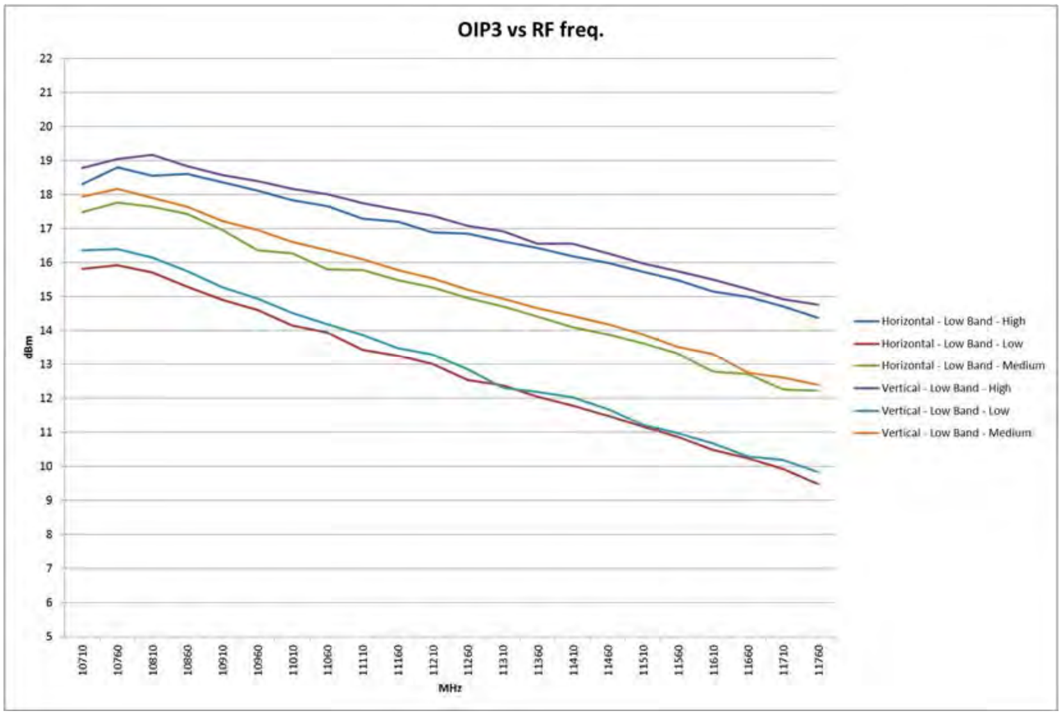


Figure 24 – OIP3 vs LB RF freq on IF3 (All IF ON)

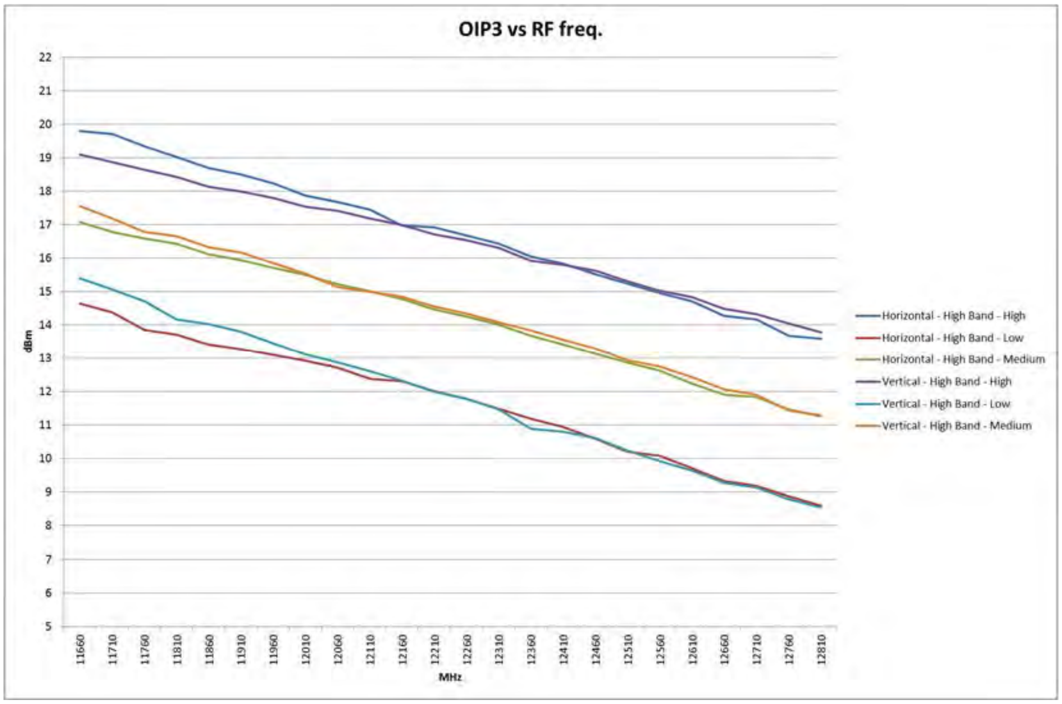


Figure 25 – OIP3 vs HB RF freq on IF3 (All IF ON)

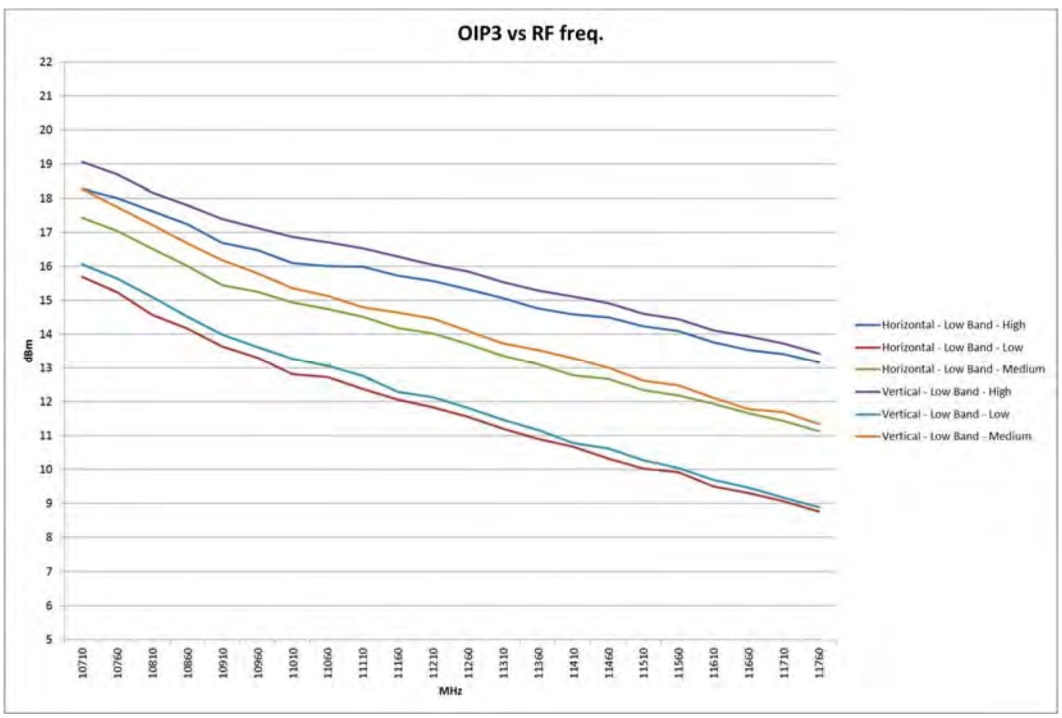


Figure 26 – OIP3 vs LB RF freq on IF4 (All IF ON)

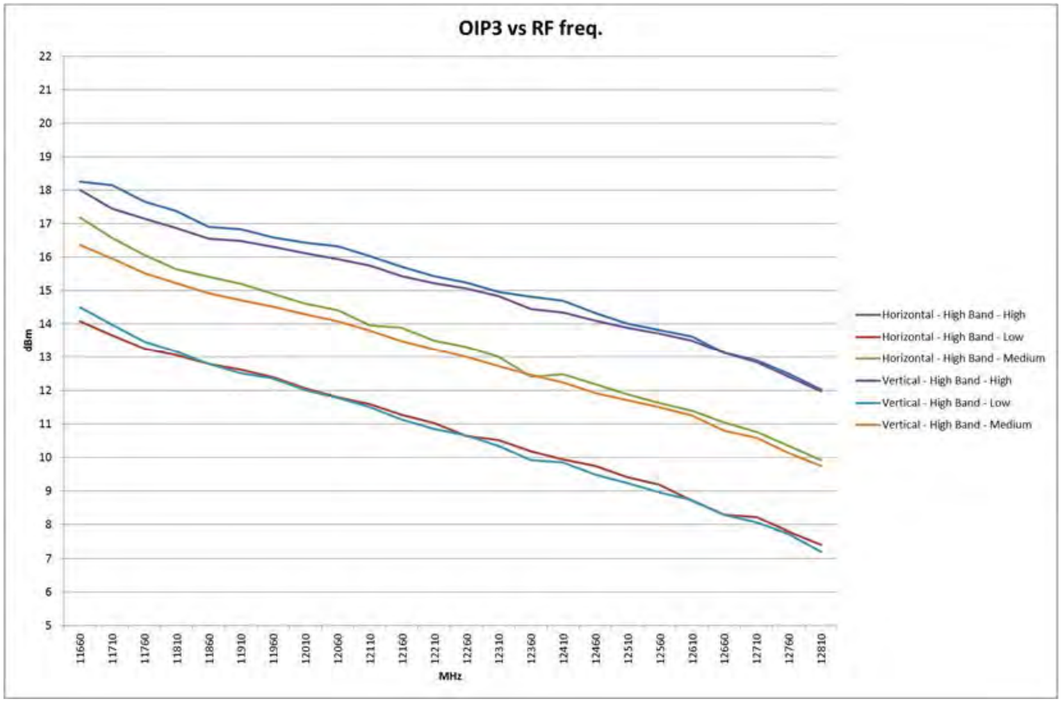


Figure 27 – OIP3 vs HB RF freq on IF4 (All IF ON)

3.5 Output power at 1dB gain compression (OCP1)

OCP1 - measurement settings							
Measurement	RF input at	IF output at				LNB control switches	
		CH1	CH2	CH3	CH4	Polarity CH1 / CH2 / CH3 / CH4	Band CH1 / CH2 / CH3 / CH4
OIP3 LB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	LB / LB / LB / LB
OIP3 LB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	LB / LB / LB / LB
OIP3 HB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	HB / HB / HB / HB
OIP3 HB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	HB / HB / HB / HB
LB: V or H / RF = 11.2GHz							
LB: V or H / RF = 12.25GHz							

For this test the test setup is the same than the gain measurement

In this test all IF are ON

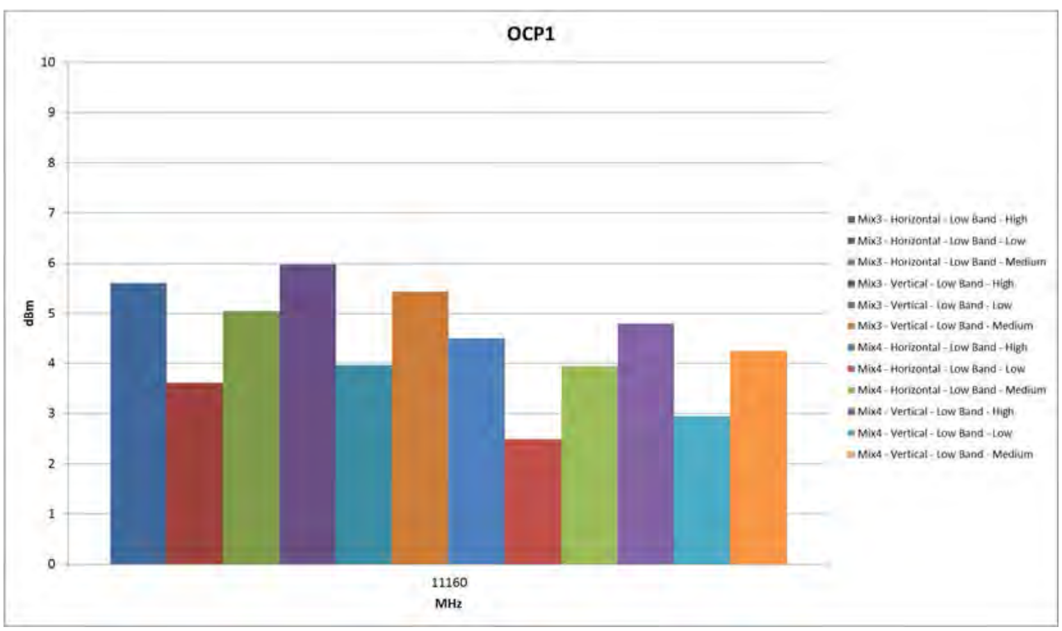


Figure 28 – OCP1 LB band on IF3 and IF4 for all gains (All IF ON)

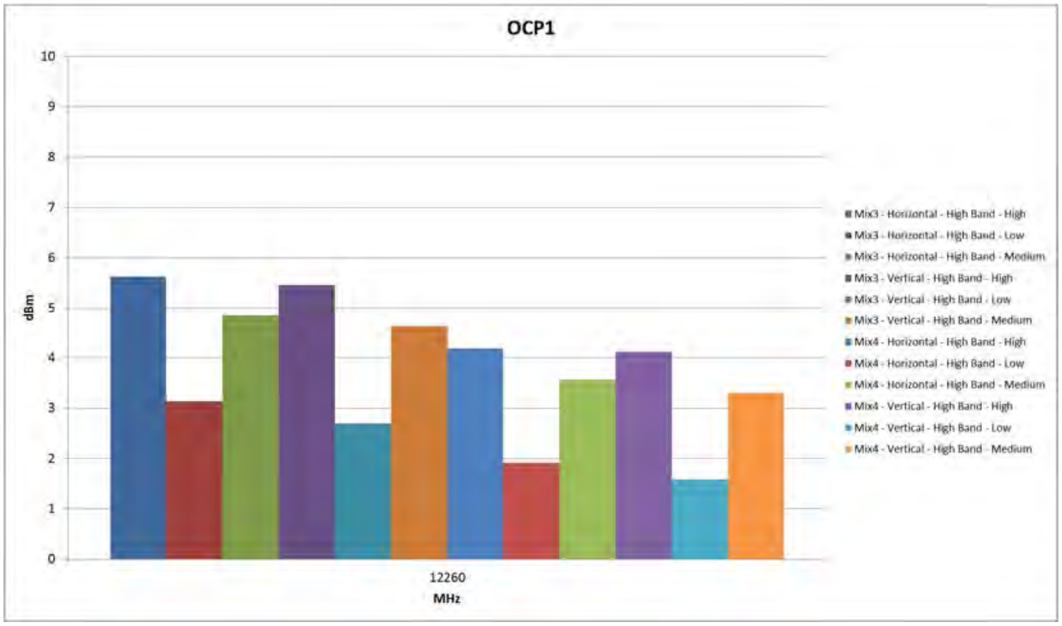


Figure 29 – OCP1 HB band on IF3 and IF4 for all gains (All IF ON)

3.6 Frequency Accuracy

The frequency accuracy for the Local Oscillators (LO) is entirely dependent on the accuracy of the 25 MHz crystal oscillator (XO). The following table was measured using a crystal that employs typical 8pF load capacitance:

Board Serial:	LO LB [MHz]	LB Error [PPM]	LO HB [MHz]	HB Error [PPM]
1	9748.15	-190	10598.0	-189
2	9748.05	-200	10597.9	-198
3	9748.1	-195	10597.9	-198
4	9748.093	-196	10597.925	-196

Remark(s):

1) Due to the increased load capacitance compared to TFF1015 and derivatives the reference frequency of the PLL is shifted downwards. This can be compensated by using a crystal with a somewhat higher load capacitance.
2) The PPM figures for LB and HB should be equal, differences is likely due to measurement accuracy.
3) Due to the thermal dissipation in the TFF1044 the application tends to heat up, it is recommended to measure the LO frequencies after a few minutes of warm-up.

3.7 Current consumption for EVB

The EVB was controlled by the IF outputs and fed by external DC (5 Volts). There is no LNA (PHEMT, BJT) connected to the TFF1044. Worse case values taken (All IF switched to Hor. Mode, LB).

Nb. of IF o/p activated	DC supply current [mA] (worse case)
Off	126
1	140
2	154
3	168
4	182

Remark(s):

- **Power saving mode:** When there is no user connected to an IF output, the corresponding IF section is turned off. When no user is using one of the two RF polarization path (horizontal or vertical), the corresponding external LNA 1st stage and second stage are cut off.

3.8 Spurs

3.8.1 Spurs 1.7GHz (Sp1G7)

Spurs 850MHz - 1700MHz - 2550MHz - measurement settings							
Measurement	RF input at	IF output at				LNB control switches	
		CH1	CH2	CH3	CH4	Polarity CH1 / CH2 /CH3 / CH4	Band CH1 / CH2 /CH3 / CH4
Spur 1.7GHz CH1	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
	50 Ω load	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur 1.7GHz CH2	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
	50 Ω load	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur 1.7GHz CH3	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	HB / HB / HB / HB
	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	LB / LB / LB / LB
	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	HB / HB / HB / HB
	50 Ω load	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur 1.7GHz CH4	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	HB / HB / HB / HB
	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	LB / LB / LB / LB
	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	HB / HB / HB / HB
	50 Ω load	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	LB / LB / LB / LB
fIF = 850MHz, 1.7GHz, 2.55GHz / SPAN=1MHz / RBW = 20KHz							

In those tests all IF are ON, and the RF inputs are loaded by 50ohms

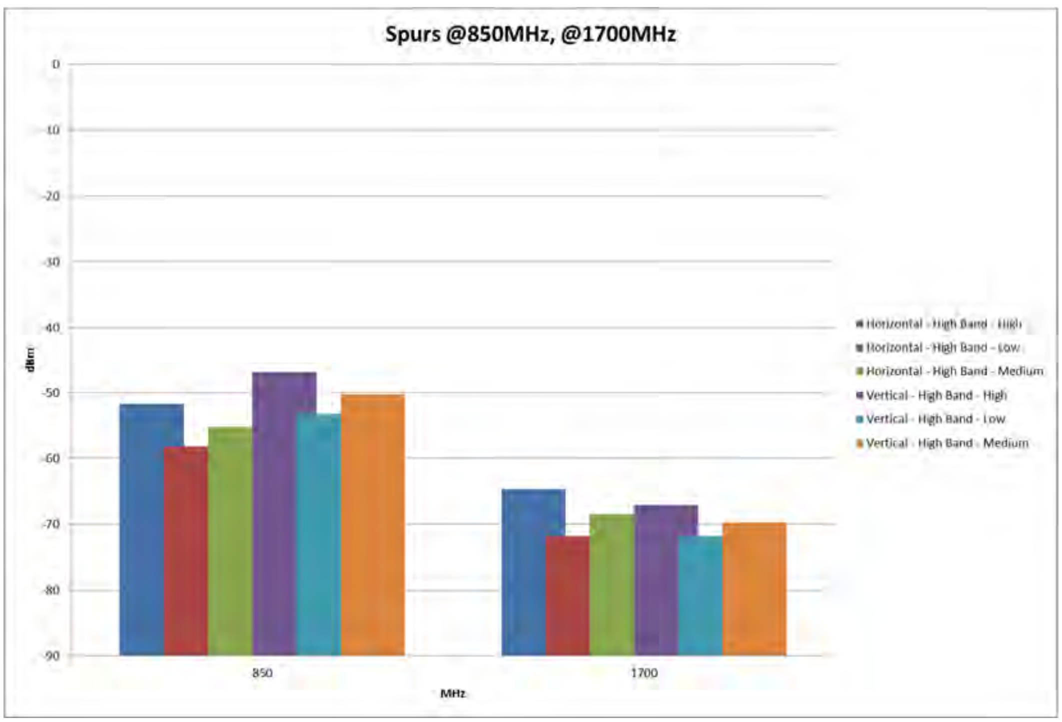


Figure 30 – Spurs 850MHz, 1700MHz for IF3 High Band

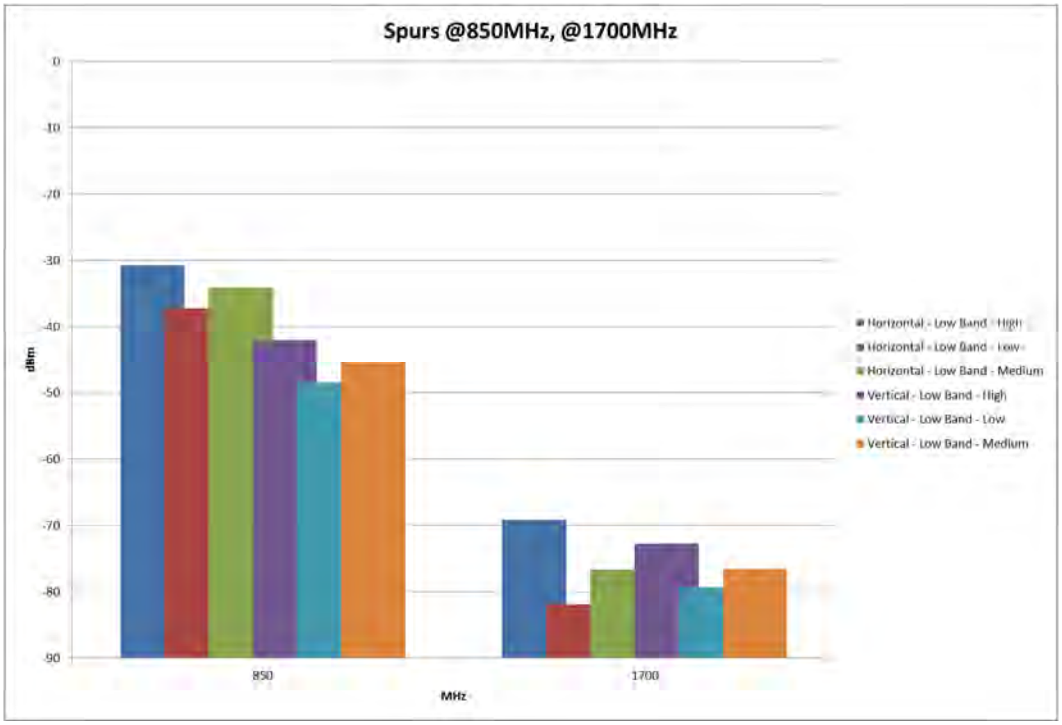


Figure 31 – Spurs 850MHz, 1700MHz for IF3 Low Band

Remark: Trap fitler@850MHz embedded on board

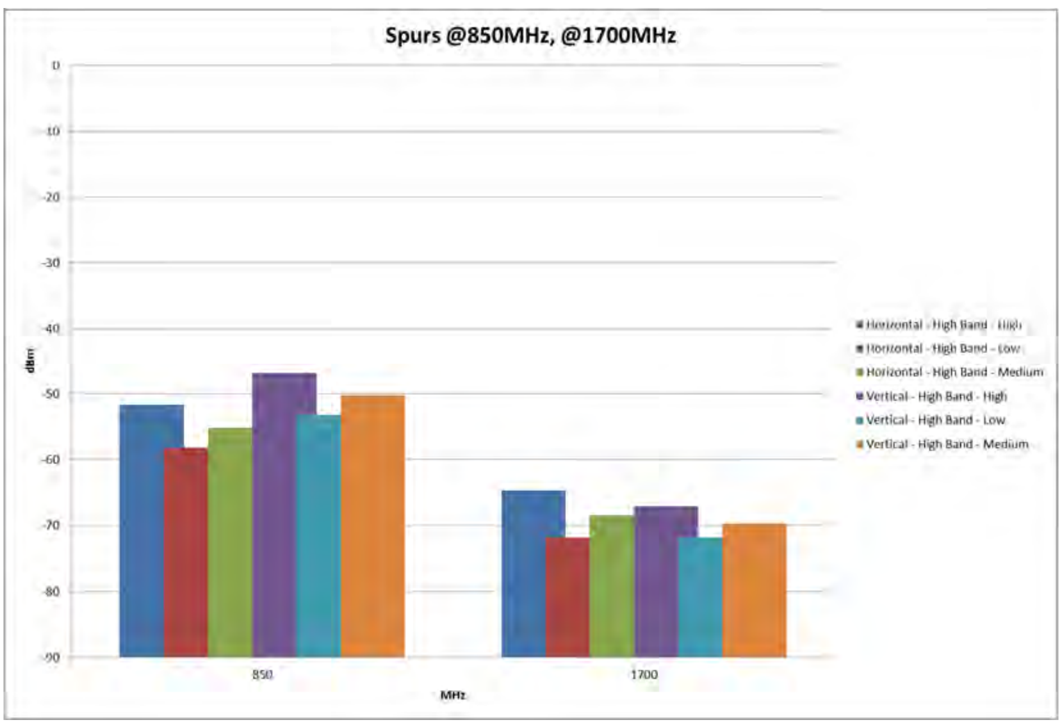


Figure 32 – Spurs 850MHz, 1700MHz for IF4 High Band

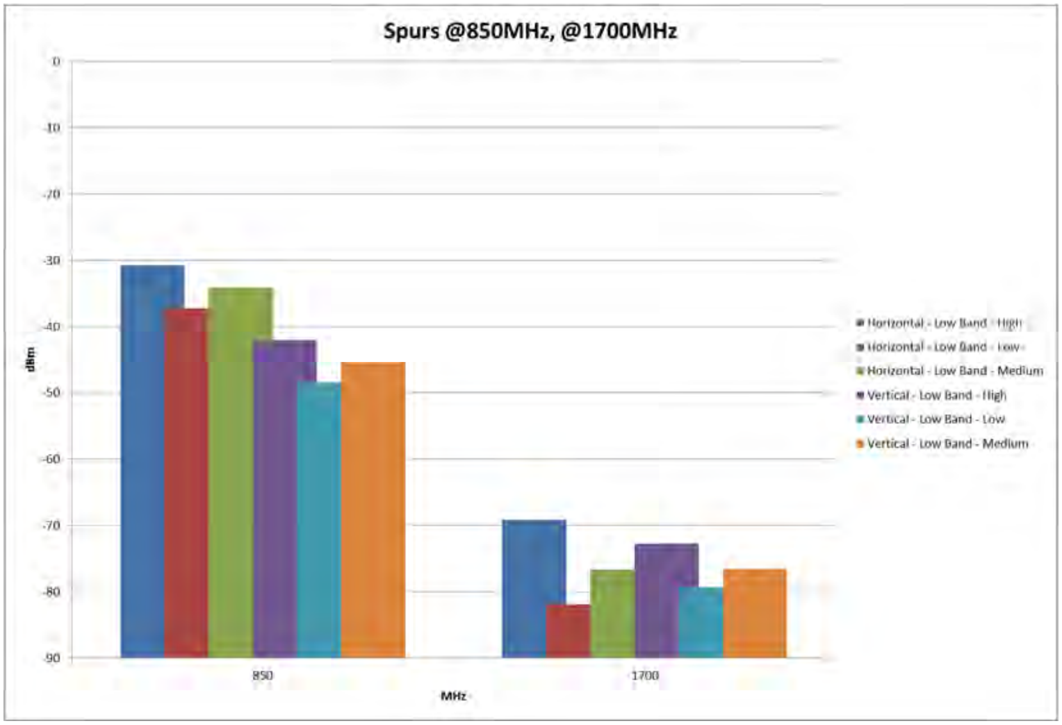


Figure 33 – Spurs 850MHz, 1700MHz for IF4 Low Band

3.8.2 Spurs Nx25MHz (SpNx25)

Spur Nx25 - measurement settings							
Measurement	RF input at	IF output at				Control Switches	
		CH1	CH2	CH3	CH4	Polarity CH1 / CH2 / CH3 / CH4	Band CH1 / CH2 / CH3 / CH4
Spur Nx25 LB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur Nx25 LB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur Nx25 LB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	LB / LB / LB / LB
Spur Nx25 LB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	LB / LB / LB / LB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	LB / LB / LB / LB
Spur Nx25 HB CH1	Vertical	SA	50 Ω load	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	SA	50 Ω load	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
Spur Nx25 HB CH2	Vertical	50 Ω load	SA	50 Ω load	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	SA	50 Ω load	50 Ω load	H / H /H / H	HB / HB / HB / HB
Spur Nx25 HB CH3	Vertical	50 Ω load	50 Ω load	SA	50 Ω load	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	SA	50 Ω load	H / H /H / H	HB / HB / HB / HB
Spur Nx25 HB CH4	Vertical	50 Ω load	50 Ω load	50 Ω load	SA	V / V / V / V	HB / HB / HB / HB
	Horizontal	50 Ω load	50 Ω load	50 Ω load	SA	H / H /H / H	HB / HB / HB / HB
LB => fRF = 11.2GHz tuned for Δfspur ≤ 50KHz / PwrIF = -10dBm							
HB => fRF = 12.25GHz tuned for Δfspur ≤ 50KHz / PwrIF = -10dBm							

Same results on other IF are observed.

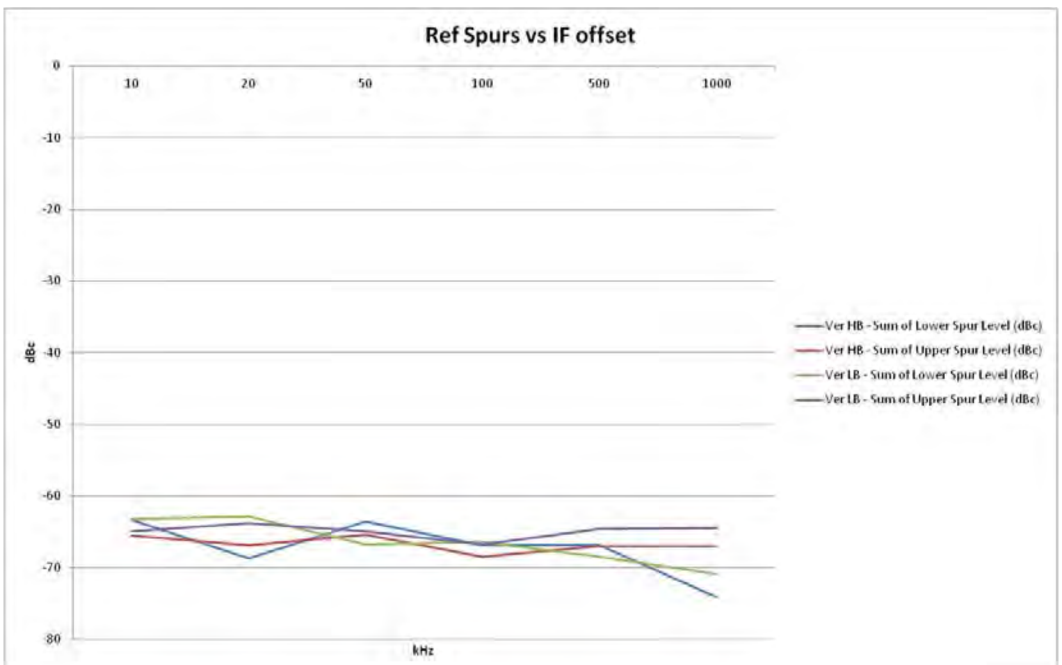


Figure 34 – Reference Spurs vs IF offset on IF1 for Medium Gain

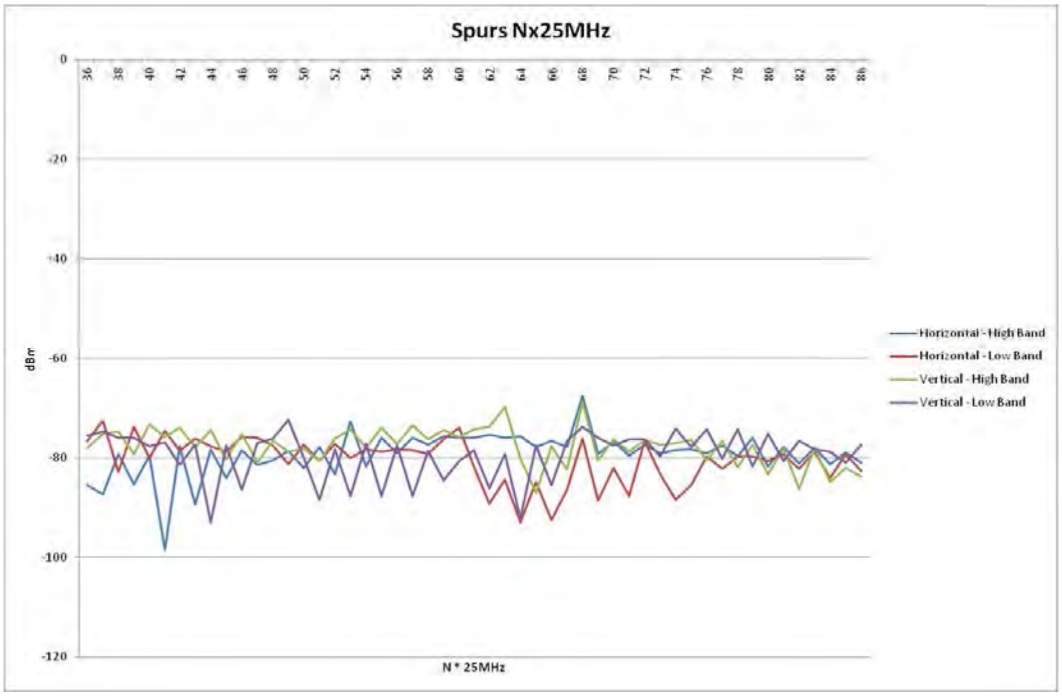


Figure 35 – Spurs N*25MHz on IF1 for Medium Gain

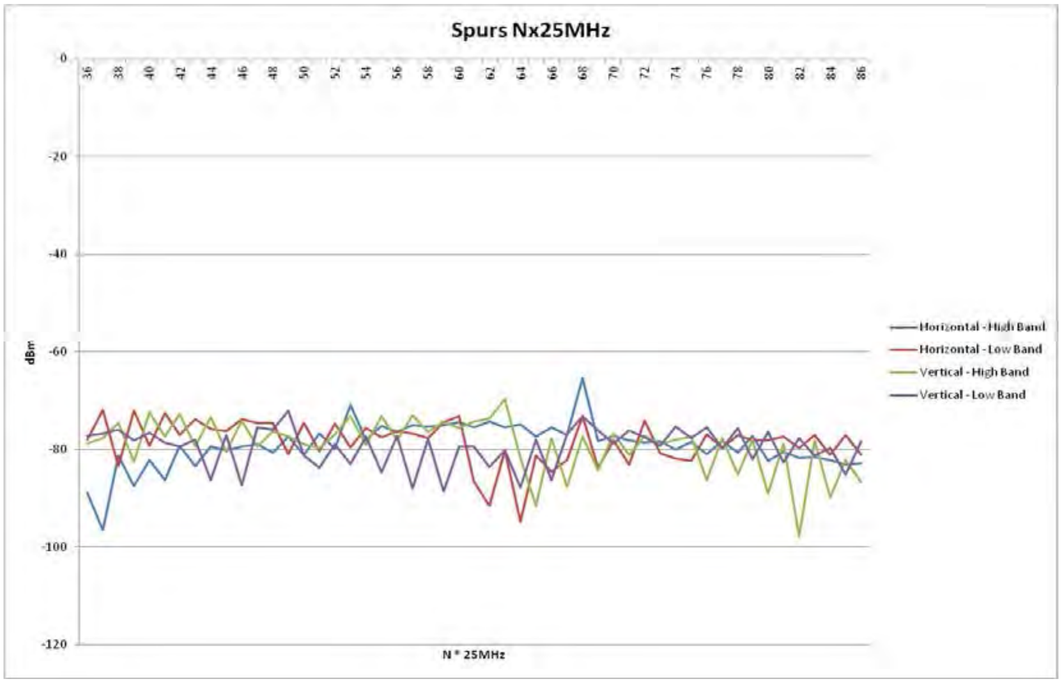


Figure 36 – Spurs N*25MHz on IF2 for Medium Gain

3.9 Phase Noise and Jitter (PN/PJ)

PhN - measurement settings					
Measurement	IF output at				LNB switches
	CH1	CH2	CH3	CH4	Band CH1 / CH2 /CH3 / CH4
PhN LB CH1	SA	50 Ω load	50 Ω load	50 Ω load	LB / LB / LB / LB
PhN LB CH2	50 Ω load	SA	50 Ω load	50 Ω load	LB / LB / LB / LB
PhN LB CH3	50 Ω load	50 Ω load	SA	50 Ω load	LB / LB / LB / LB
PhN LB CH4	50 Ω load	50 Ω load	50 Ω load	SA	LB / LB / LB / LB
PhN HB CH1	SA	50 Ω load	50 Ω load	50 Ω load	HB / HB / HB / HB
PhN HB CH2	50 Ω load	SA	50 Ω load	50 Ω load	HB / HB / HB / HB
PhN HB CH3	50 Ω load	50 Ω load	SA	50 Ω load	HB / HB / HB / HB
PhN HB CH4	50 Ω load	50 Ω load	50 Ω load	SA	HB / HB / HB / HB
LB: V or H / RF = 11.2GHz / PN @ 1.45GHz / PwrIF = -10dBm					
HB: V or H / RF = 12.25GHz / PN @ 1.65GHz / PwrIF = -10dBm					

Remark: the Phase Noise is measured in the IF domain as there is no direct access to the LO outputs. The results are independent from the IF output used.

3.9.1 RMS Phase Jitter:

Band	RMS Phase Jitter [degr] (10kHz – 13MHz interval)
LB	1.29
HB	1.36

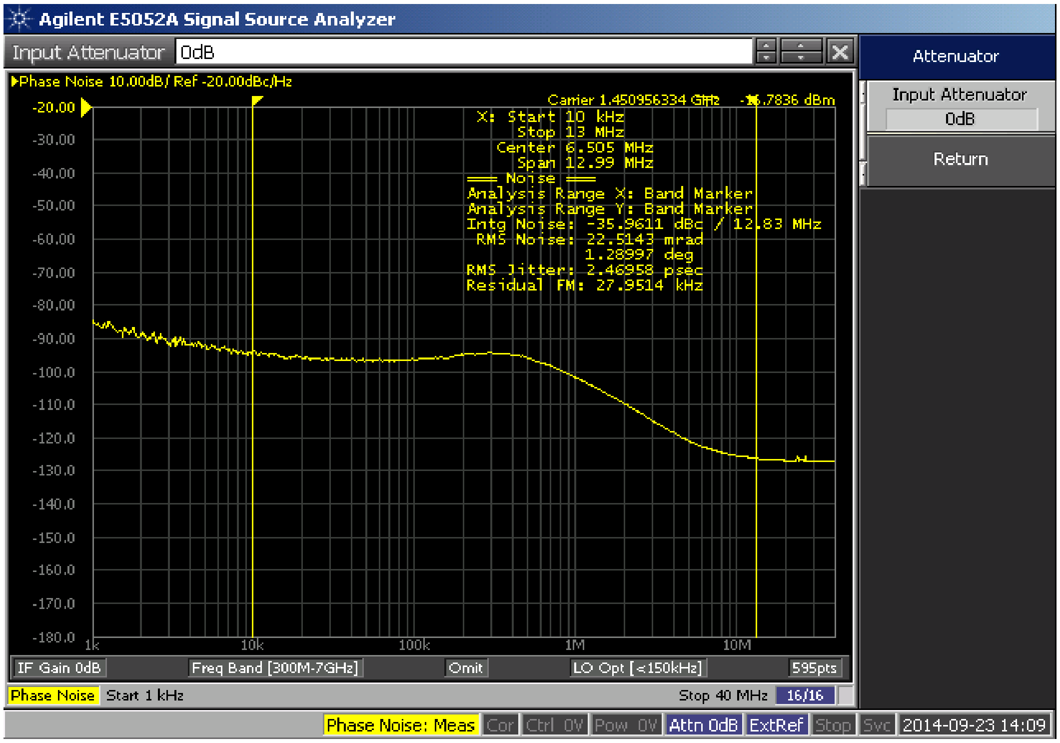


Figure 37 – LB Phase Noise is function of offset frequency on IF3

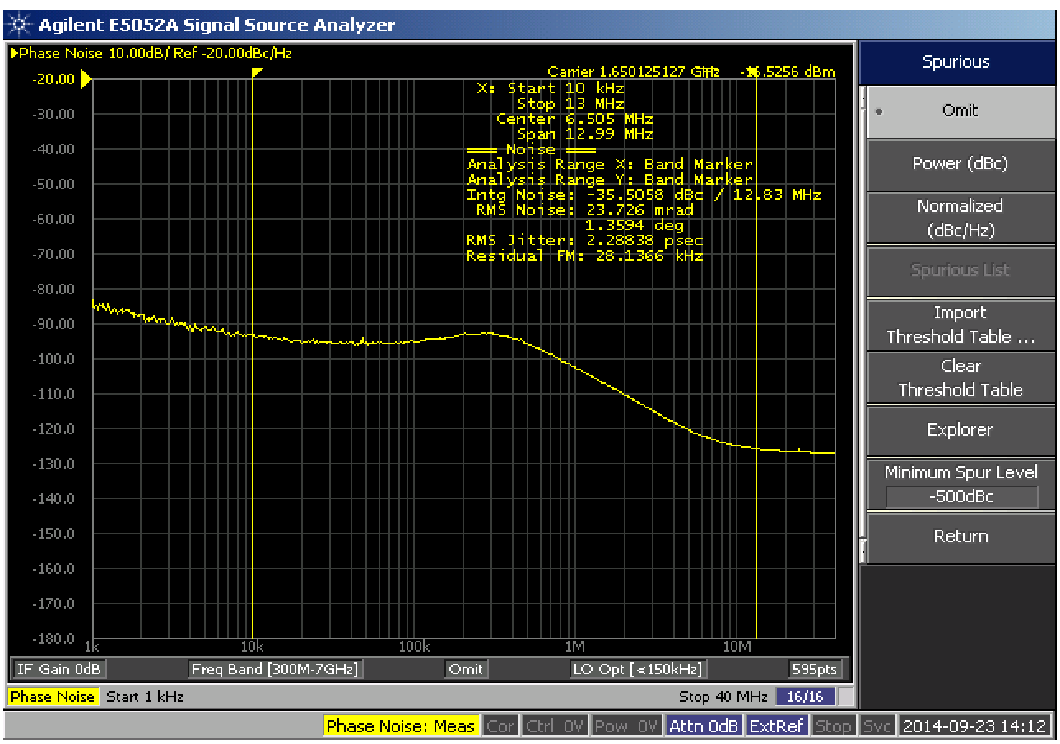


Figure 38 – HB Phase Noise is function of offset frequency on IF3

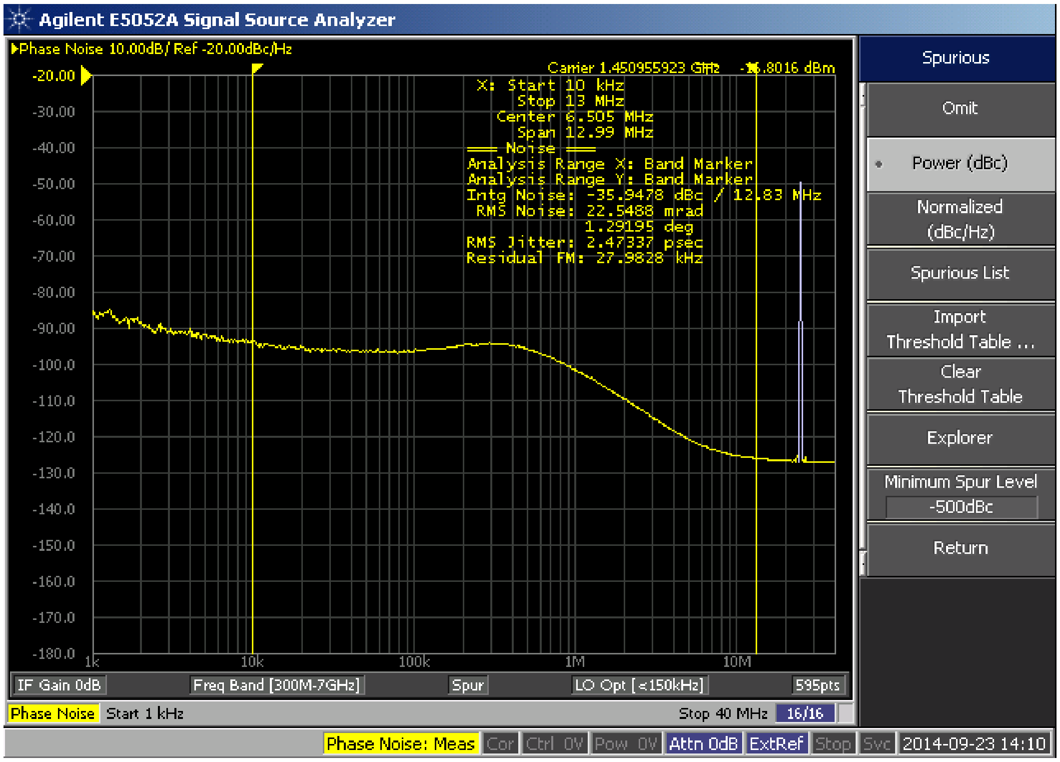


Figure 39 – LB Phase Noise including spurious on IF3

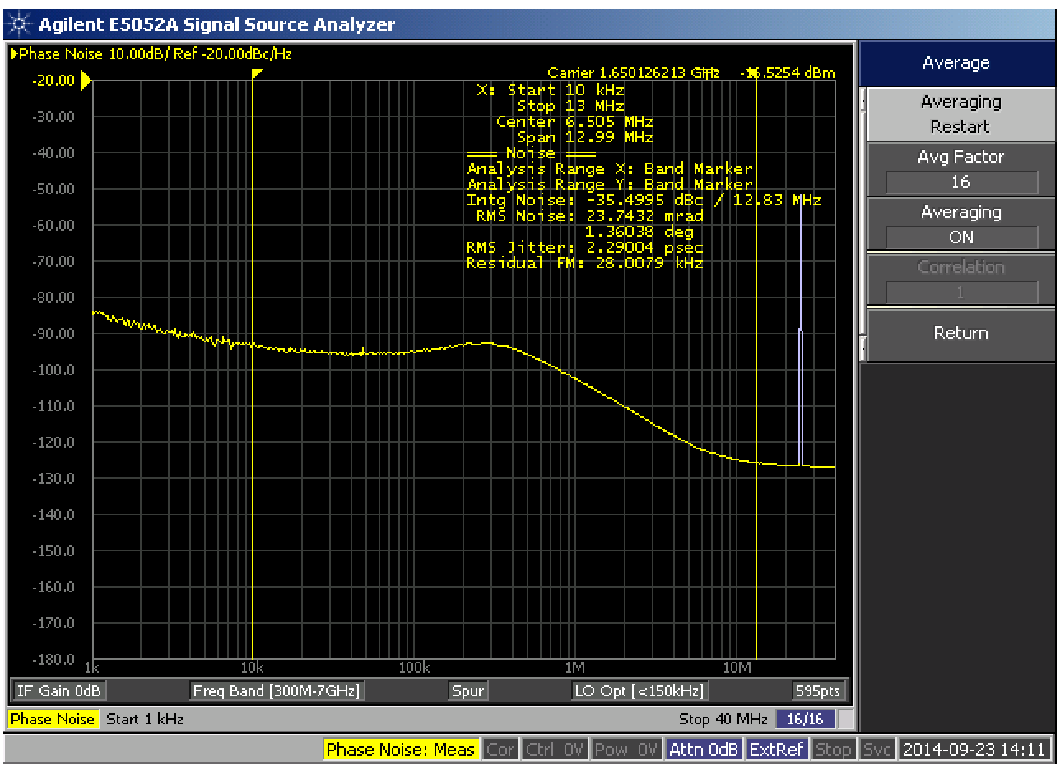


Figure 40 – HB Phase Noise including spurious on IF3

Remark(s)

1) Note that the spur frequency is a multiple integer of the Reference frequency (25MHz)

4. Legal information

4.1 Definitions

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