Measures over 2 GHz with the HP 8971b NF test-set extension

Version 2

Overview

1- Choice of gain/Nf analyser type :
The AGILENT / HP 8970 gain/noise analyser family is limited to frequencies beyond 1.6 GHz.

- The HP 8970a isn't compatible with the HP 8971 family because of it's incomplete GPIB commands.
- In order to extend its possibilities over 2 GHz the only way is to use an outside broadband mixer. And measures can only be done in DSB.

- Only the **HP 8970b** is compatible with the HP 8971 NF test set extension. And **either SSB and DSB measures can be done.**
- The HP 8350b sweep (version b) is mandatory.

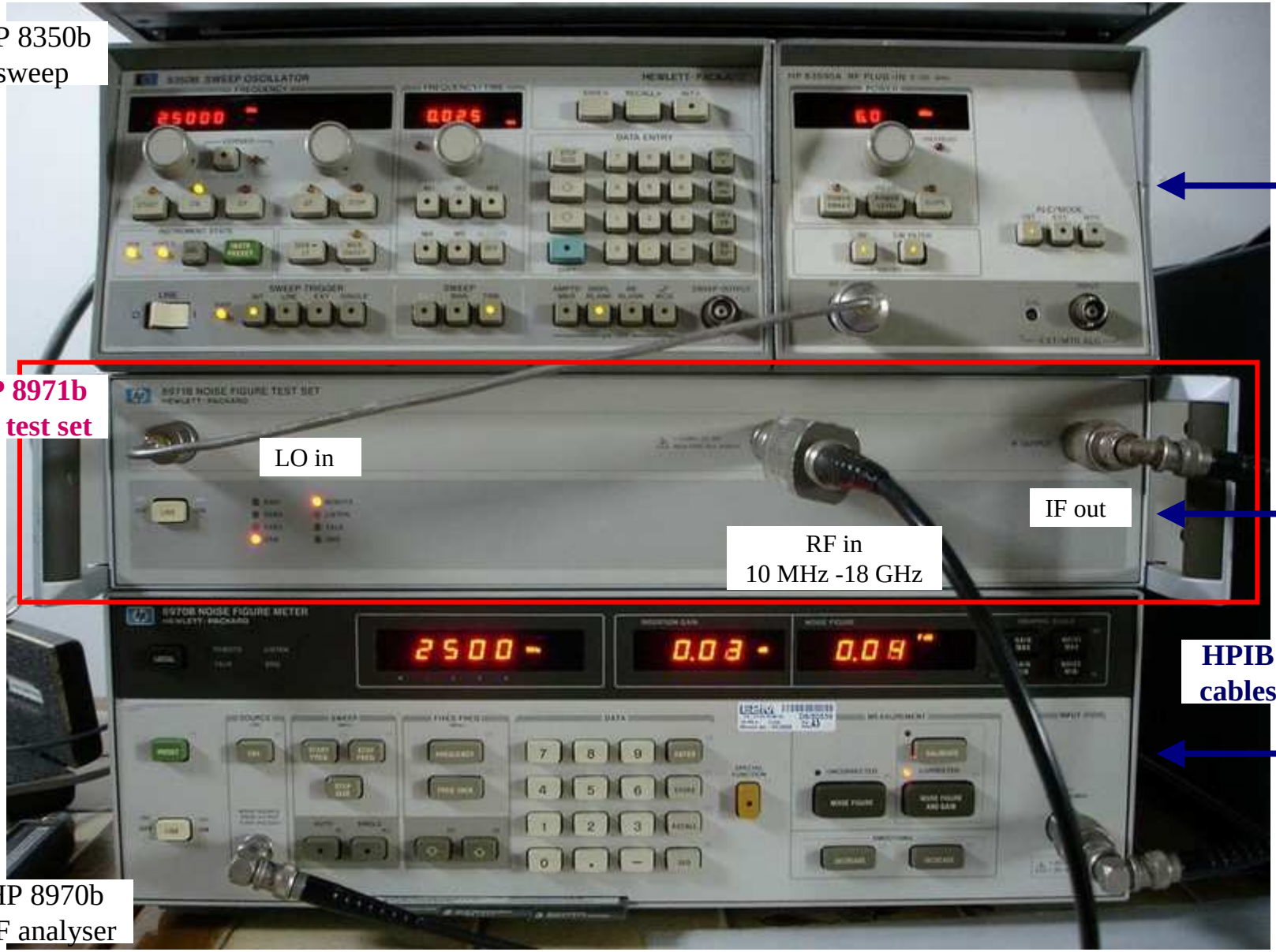
2- Choice of Nf test-set type :

-**HP 8971b** up to 18 GHz
-**HP 8971c** up to 26.5 GHz

Abstract

1- Whole configuration hardware

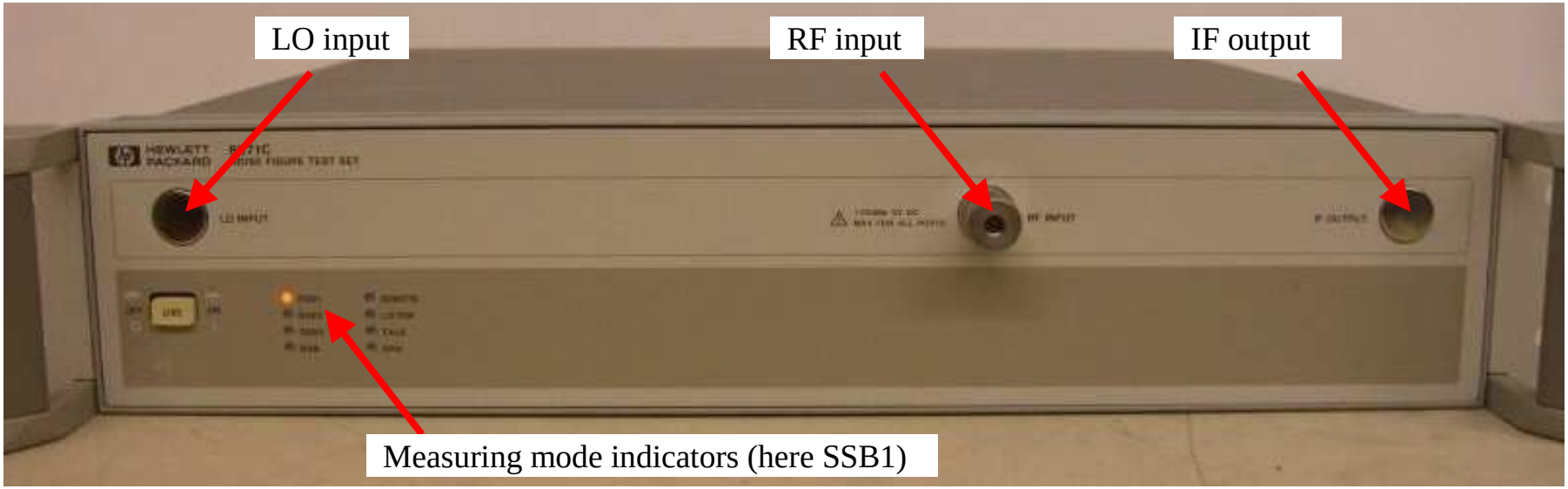
HP 8971b NF extension set



HP 8971b NF extension set

Agilent HP 8971b (or c model) noise figure test-set

- Model b goes up to 18 GHz and c, up to 26 GHz
- 2 HPIB cables needed between analyser, extention and sweep



It's principally constitued by:
- a YIG following filter with HPIB tracking software
- an RF front-end broadband preamp (optional)
- a broadband mixer

Operation Modes:
- Band 1 - SSB1 (10-1600 MHz) using HP 8970b internal mode
- Band 2 - SSB2 (1601-2400 MHz, 700 MHz IF) → **mandatory !**
- Band 3 - SSB3 (2401-18000 MHz, 450 MHz IF) → choice of both possibilities
- Band 4 - DSB (2401-18000 MHZ, 10 MHz IF) → choice of both possibilities

2- GPIB (or HPIB) commands

GPIB commands

GPIB command addresses

	HP 8970b gain/Nf analyser		
	master		
	default address 18		
		HPIB cable	
	HP 8971b NF test-set		
	slave sweep		
	default address 19		
		HPIB cable	
	HP 8350b sweep		
	slave sweep		
	default address 8		

GPIB commands

GPIB command examples

	1,5	SP	10 MHz to 18 GHz, no user LO		40,0	SP	8	HP 8970b address
	45,0	SP	enables HP 8971b in mode 1.5 to 1.9		40,1	SP	19	Sys LO address
	45,1	SP	enables HP 8971b in all modes		40,2	SP	10	HP 8971b address
	41,0	SP	Takes the HP 8350b control		40,4	SP	8	SIB address
			or					
	41,2	SP	Takes the HP 8571b synth control					
	42,5	SP	Power level in dBm					
4,1 puis	46,0	SP	Enable system LO on SIB					
	17,0	SP	SSB meases	→	36,0	SP		enable HP 8671b fine tuning in cal
			or				or	
	17,1	SP	DSB meases		36,1	SP		disable HP 8671b fine tuning in cal
Start	6000	Enter	Start 6 GHz					
Stop	12000	Enter	Stop 12 GHz					
Step size	100	Enter	Step size					

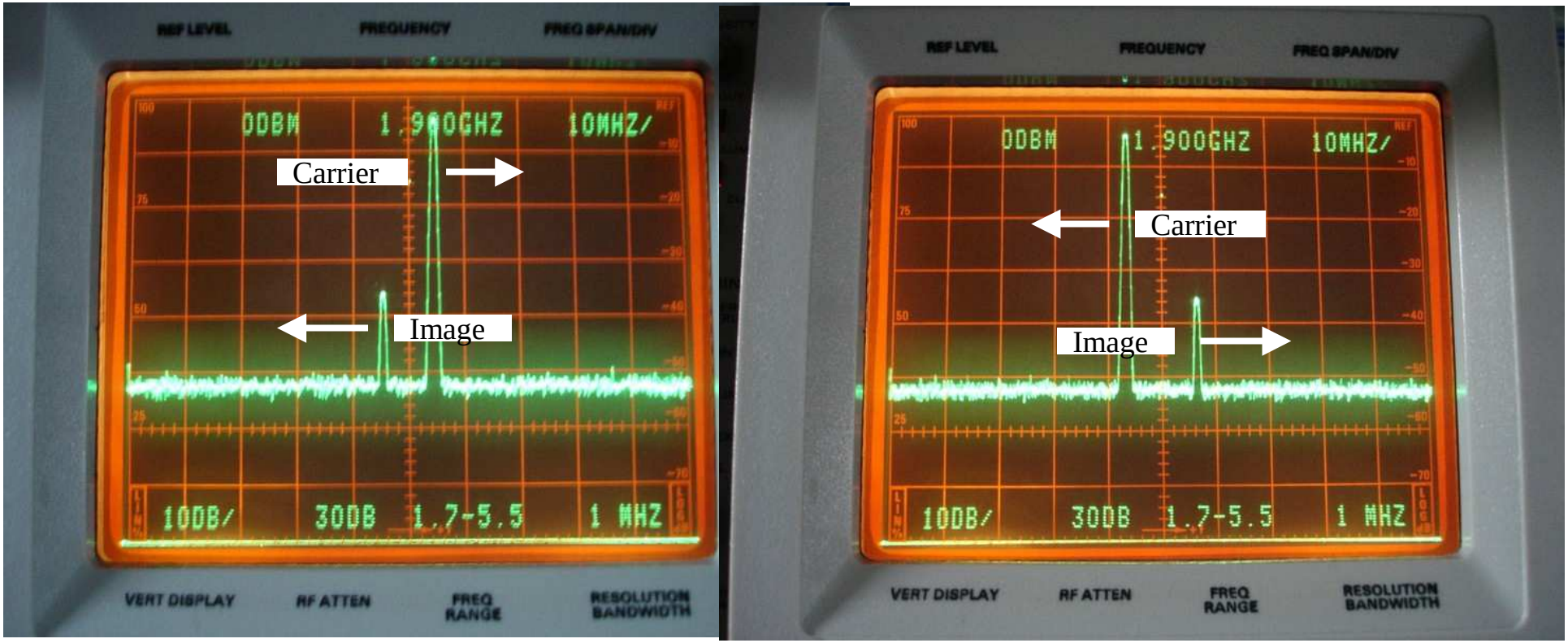
3- SSB mode between 1.6 and 2.4 GHz ??

SSB mode from 1.601 GHz to 2.401GHz mandatory : why ?

Spectrum around 1.9 GHz, generated by an HP 83522a (also 8.4 GHz HP 83525a) plugin

- The HP 8970 above 1.6 GHz needs a normal broadband mixer feeded with an HP 8350 sweep LO
- Normal gain/Nf zeroiing in DSB mode à (1.9 +- 0.3) GHz is totally unstable
- @ 1.9 GHz the sweep plugin is generating an image frequency only 35 dBc (under carrier) !

- The only way to solve the problem is to translate the LO frequency 700 MHz up → **SSB mode**



4- DSB or USB mode : why ?

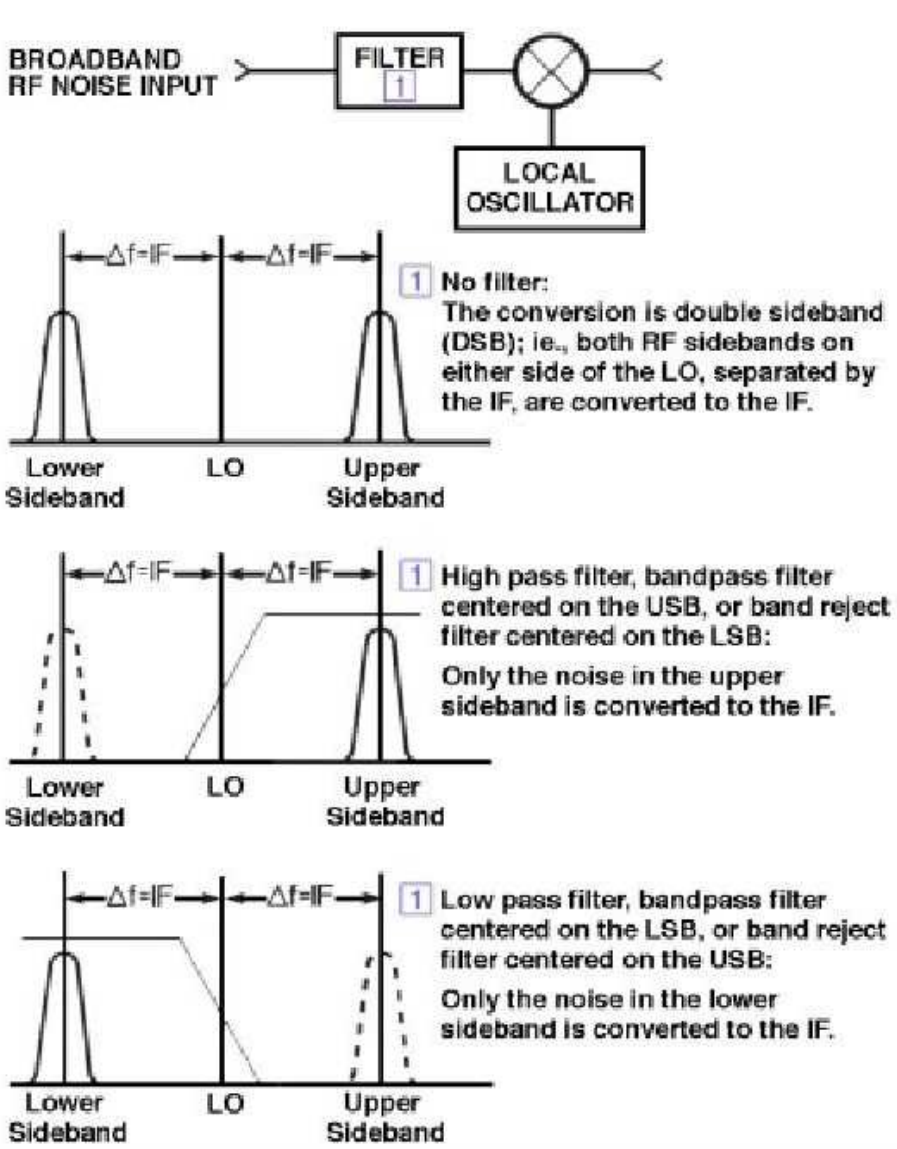
DSB and USB mode explanation

Agilent HP 8971b (or c model) noise figure test-set

DSB mode

USB mode

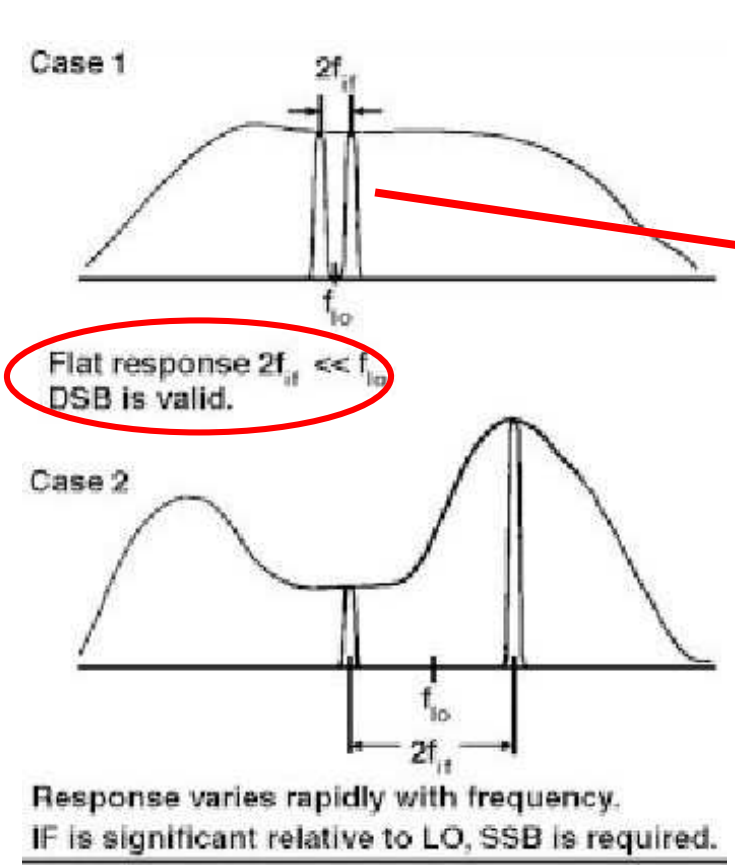
LSB mode

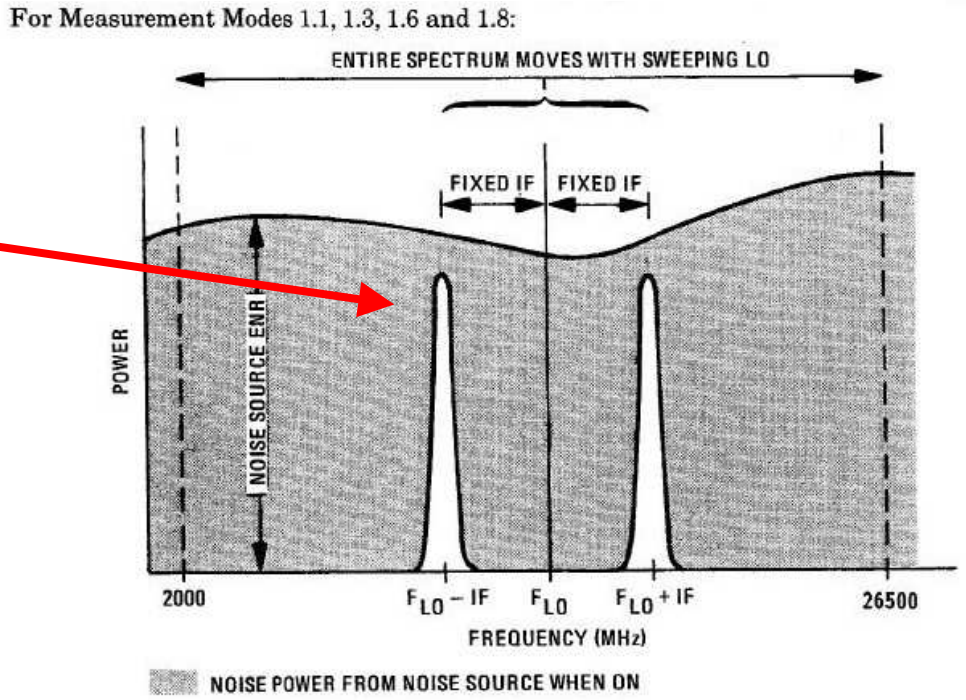


DSB and USB mode explanation

Agilent HP 8971b (or c model) noise figure test-set

- With relatively broadband amps, the DSB mode is preferred
- In this case the error between DSB and SSB mode is little, because IF signal of equal strengths
- No need of additional filter or preamplifier

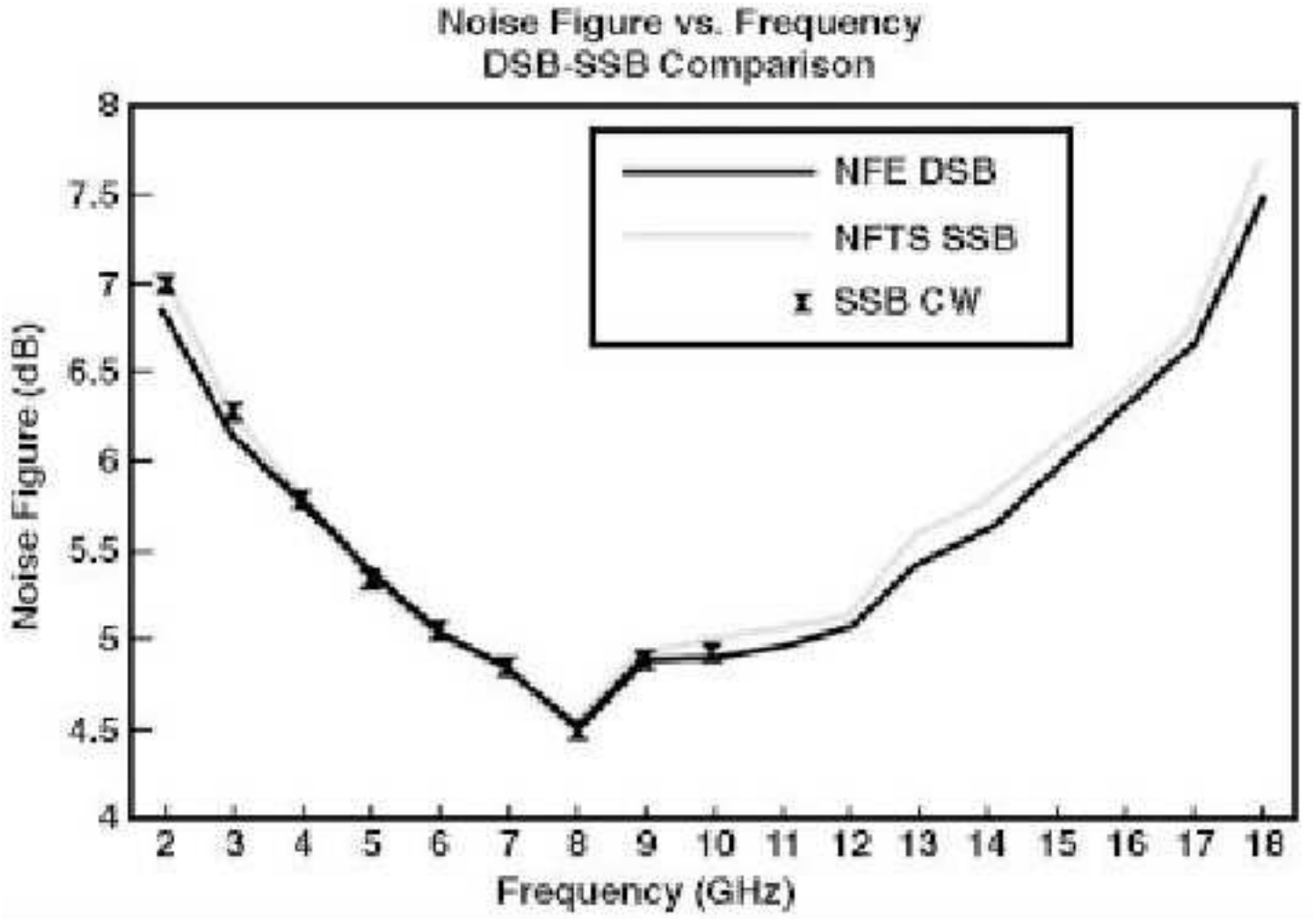




The choice in the industry

Comparaison between Agilent/HP and Eaton/Maury designs

DSB and SSB measures comparaisons, according to Eaton



5- Unstable zeroiing in USB mode after calibrating & cure

Unstable gain/Nf zero in SSB mode after calibrating

Direct DSB and SSB modes from 2.41 to 18 GHz : great calibration stability differences

- DSB mode : no Yig filter use - - very stable gain/ Nf zeroiing - - no problem
- SSB mode : unstable calibration !
  - -the HP 8971b internal Yig is decreasing the uncorrected NF about 10 to 15 dB down
  - -the dynamical measure range is falling about 15 dB and SSB DUT meases on DUT are quite impossible

Cure : stable broadband amplifier inserting and calibrating again

Putting an additional amp after noise source and before NF test-set input

- 1st try with an LNA 3000a broadband amp « under hand » (Fmax=3 GHz), giving 15 dB gain from 50 MHz to more than 3 GHz
USB zeroiing calibration **from 1.61 to 3.5 GHz** on bands 2 and 3 → **immediate stable gain/Nf zero**

- 2nd try with a Miteq broadband amp (Fmax= 12 GHz), giving 25 dB stable gain from 50 MHz to more than 3 GHz
USB zeroiing calibration **from 1.61 to 12 GHz** on bands 2 and 3 → **immediate stable gain/Nf zero**

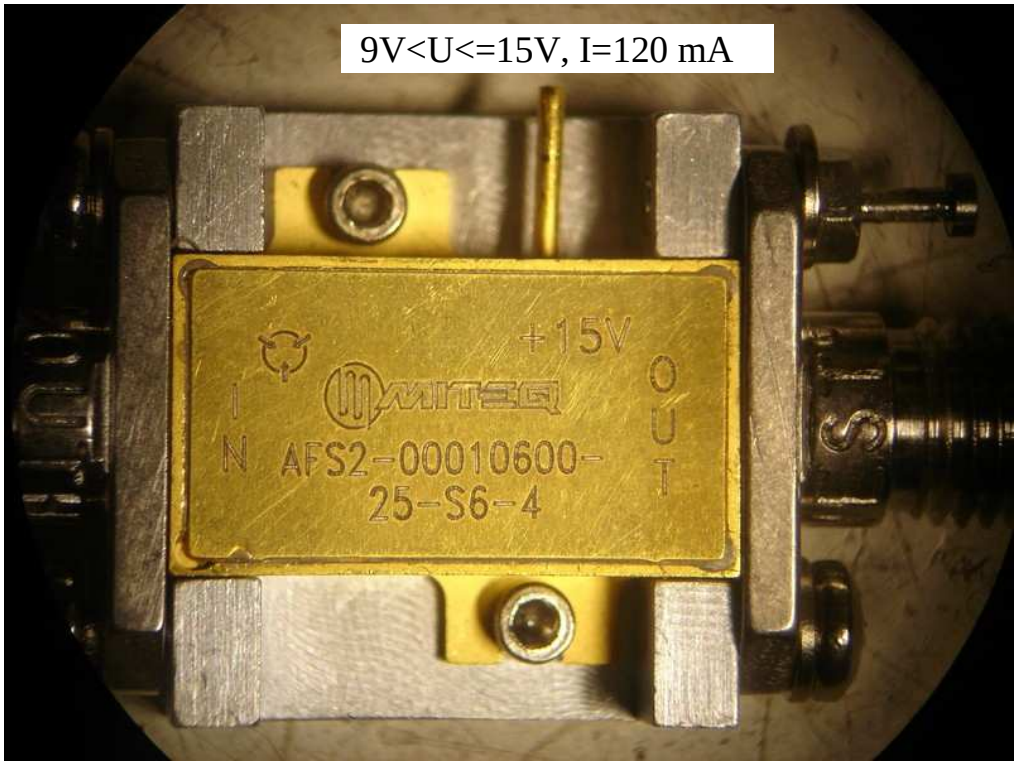
Then the DUT is inserted between noise source output and add amp input

Miteq 12 GHz broadband amp addition for SSB mode

SSB mode measures : adding a broadband stable amplifier gain>10 dB

Model found : Miteq 45 MHz – 12 GHz 20 dB broadband amplifier

- Direct calibration in DSB mode : no problem and stable gain/ Nf zeroiing
- In SSB mode this case the error between DSB and SSB mode is little, because IF signal of equal strengths
- No need of additional filter or preamplifier



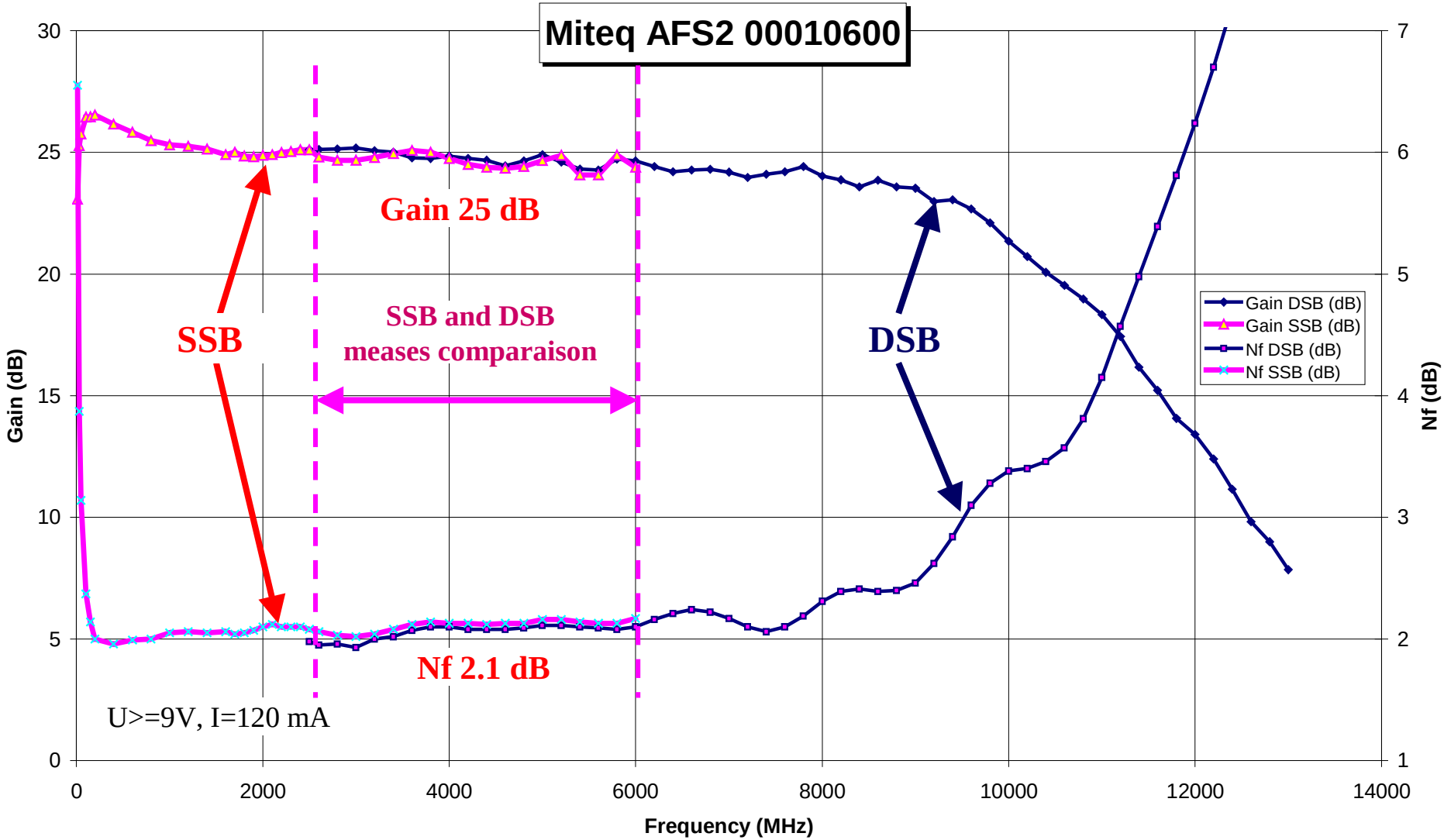
Miteq 12 GHz broadband amp addition for SSB mode

Miteq model AFS2-00010600-25-S6-4 : scalar meases

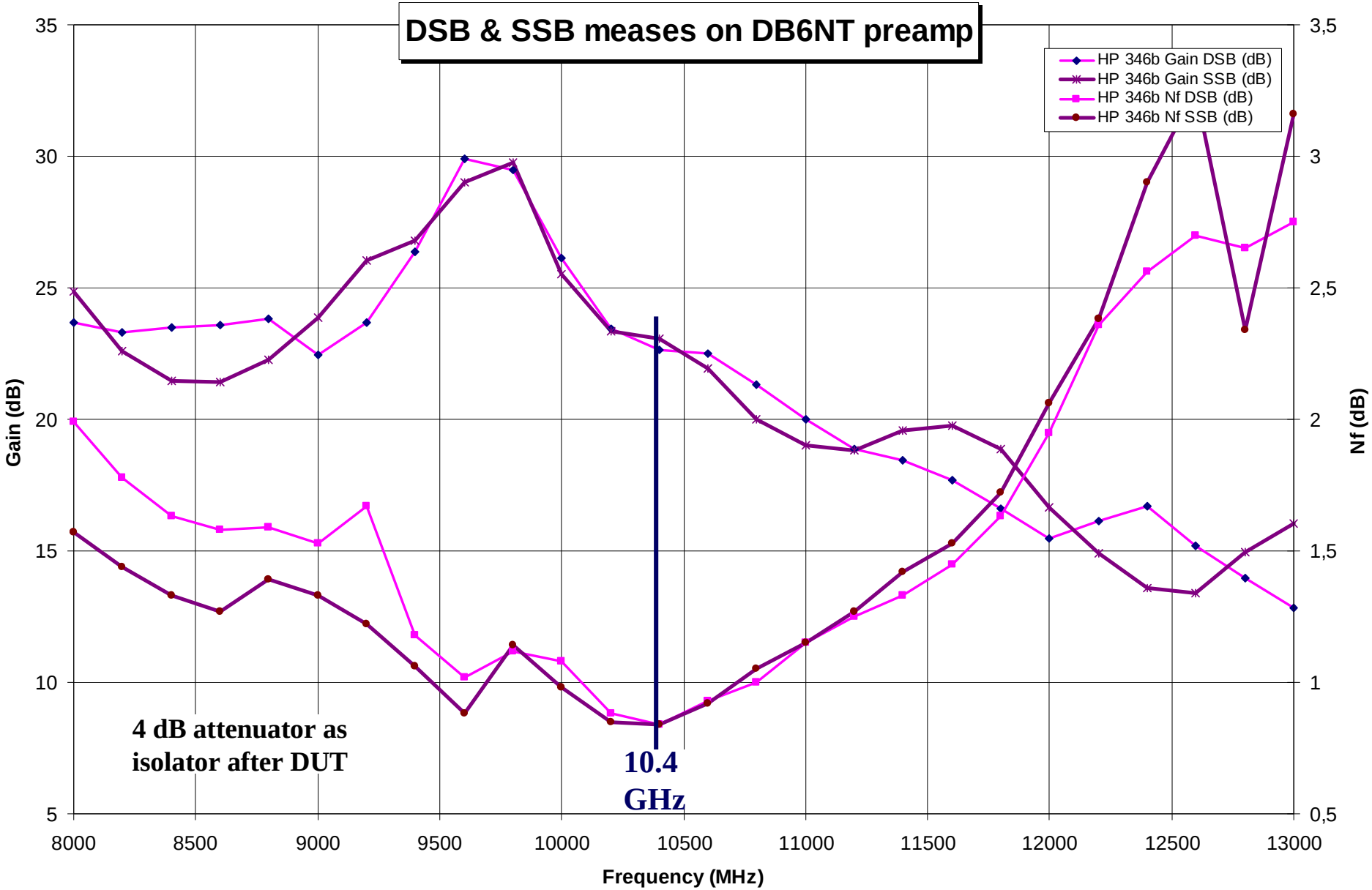
6- DSB and USB comparaison measurements on 2 amps

Miteq 12 GHz broadband amp addition for SSB mode

Miteq model AFS2-00010600-25-S6-4 : gain & NF mesures in DSB & USB modes



Miteq 12 GHz broadband amp addition for SSB mode



7- Conclusion

Conclusion

- In order getting a same initial stable calibration as on DSB, the SSB mode needs a further 10 to 15 dB broadband amplifier at the Nf test-set input
- An additional 3 to 4 dB front-end attenuator between DUT output and broadband amp input gives a little better isolation
- DSB and SSB meases are giving roughly same results in the horizontal part of the gain curve
- On the side of the gain curve, better precision is achieved in SSB