

LNA's for 10 GHz

What did change in LNA design?

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Introduction

- In the past LNA's were designed, built, tested, redesigned, tested, modified, tested...
- Beginning 2015 EME LNA's came on the market without any tuning elements
- Repeatability and thus industrial production became a fact
- The well-known TV LNB design has reached Ham gear

Agenda

- The Past
- Traditional LNA development and design
- Time consuming LNA work
- The Future: NO-Tune **Sandwich Design**
- About measuring Noise and Gain
- Comparison of various LNA's
- Conclusions

Appendix: The EME beacon DL0SHF with 1m dish

The Benchmark LNA

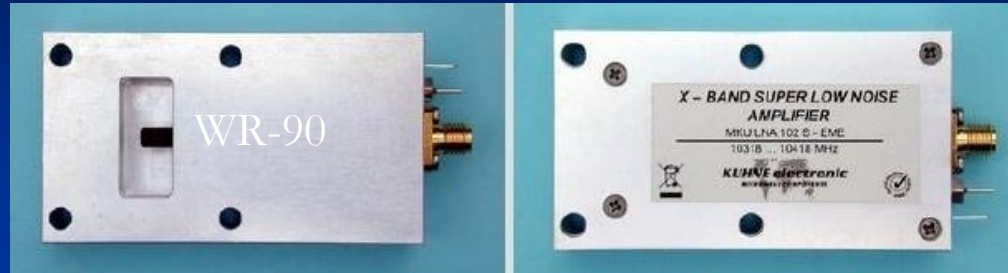
DB6NT, Michael Kuhne



Örebro 2017 Dominique Fässler
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The Benchmark LNA

The first commercial 10 GHz LNA mit WG input for HAMs



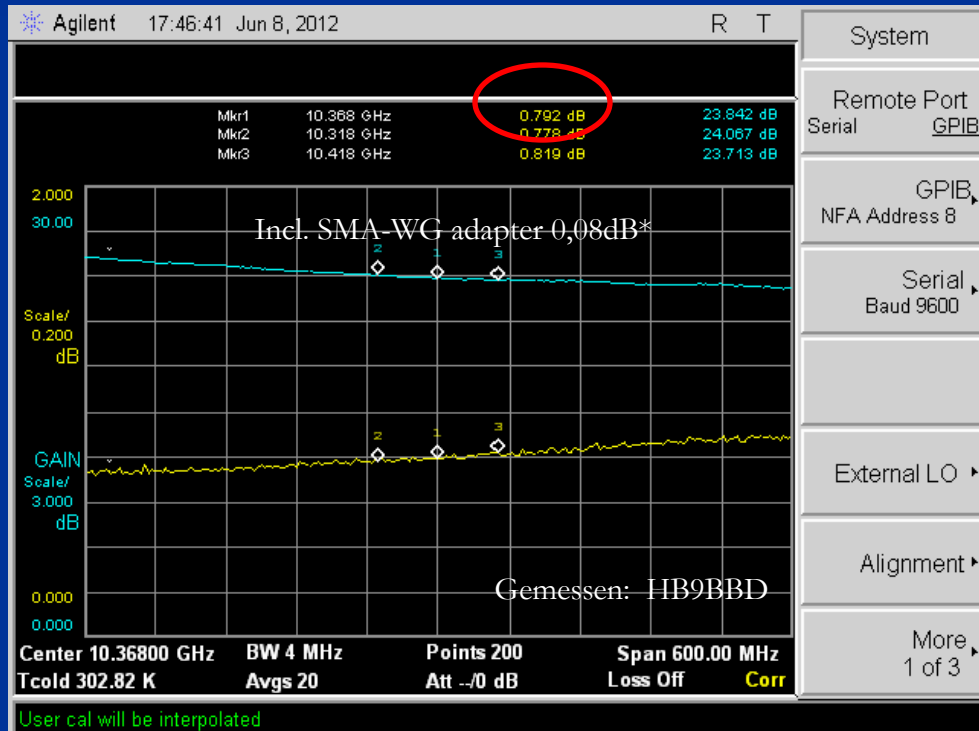
DB6NT
 F = 0,7 dB&18C
 G = 22 dB
 R100

Testgear of DB6NT



Agilent 8975A
 N4000A

* Insertion Loss by SMA/WG adapter p.



What if no DB6NT ?

- Homebrewing – phantastic!
- The microwave community would be very small
- Newcomer would have a difficult access to microwave communication
- Inspiration by DB6NT
- It is just fair to thank DB6NT for his exploring work

The traditional Methode

„DB6NT – inspired“ Projects:
„Design, construction, measurments, endless tuning“

F5BUU und F6BVA

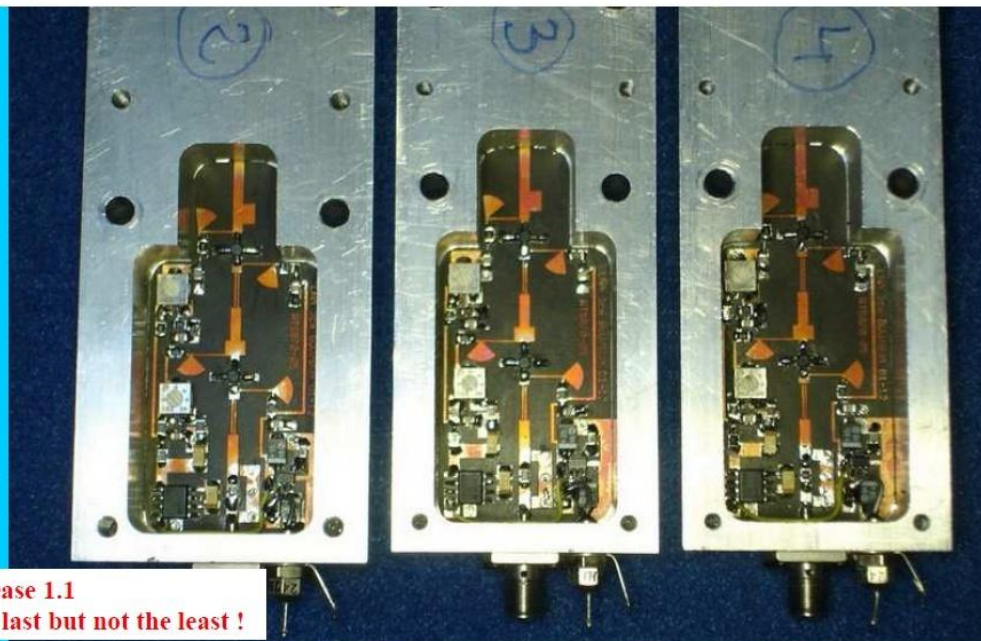
OK2AQ

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F5BUU + F6BVA tried to outperform DB6NT

http://f1chf.free.fr/F5DQK/3_Preamplis_LNAs/Preamplis_10_GHz_DB6NT.pdf

Préamplis 10 GHz à entrée guide



Release 1.1
The last but not the least !

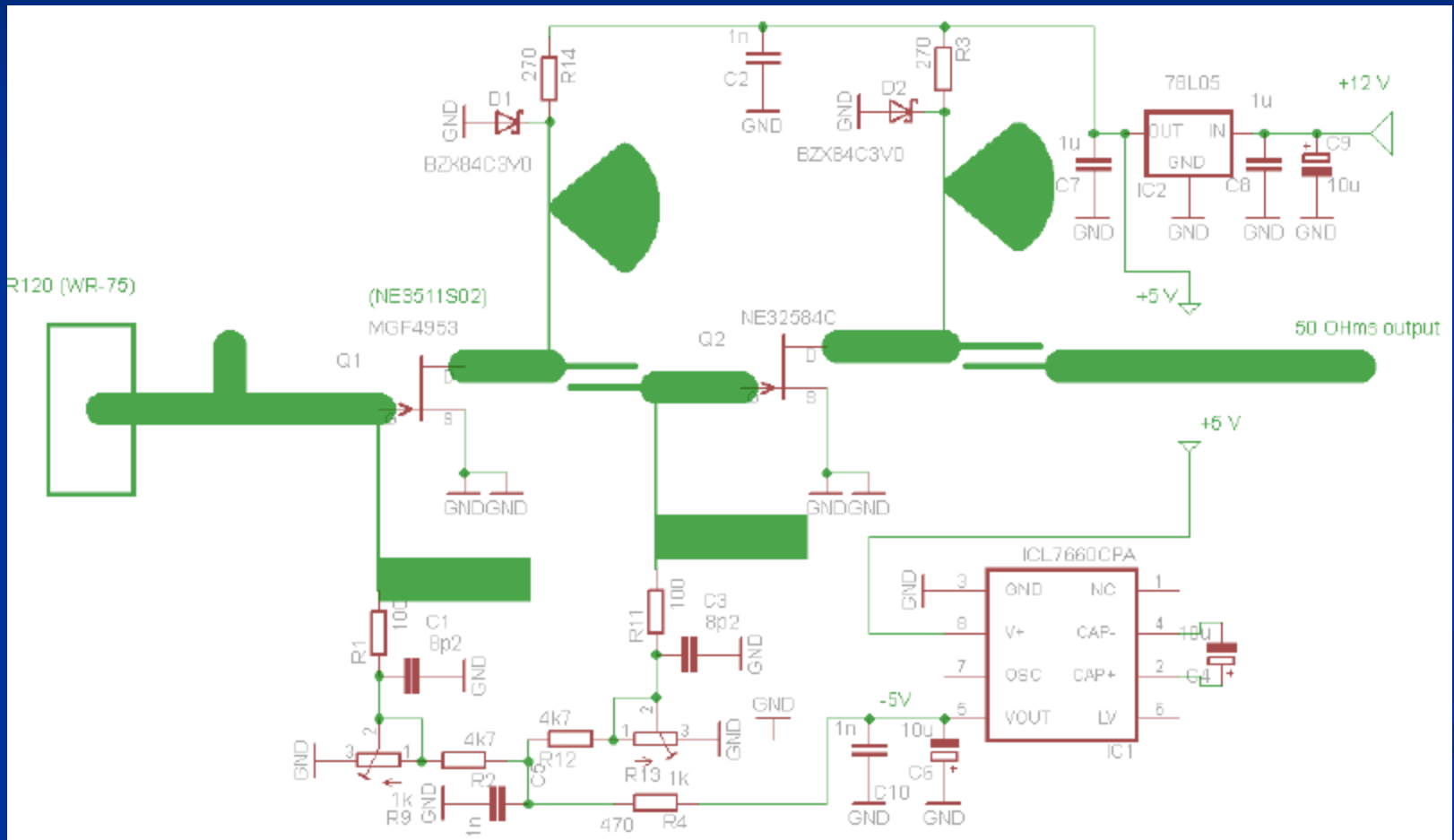
F5DQK – juin 2012

LNAs 10 GHz F6BVA-F5BUU guide rel 1.1

1

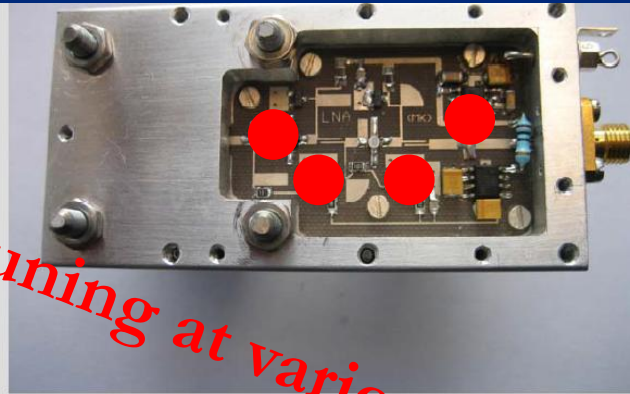
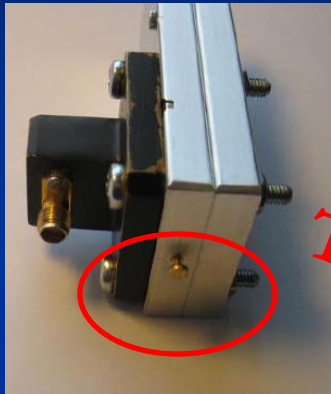
OK2AQ's Design

<http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf>

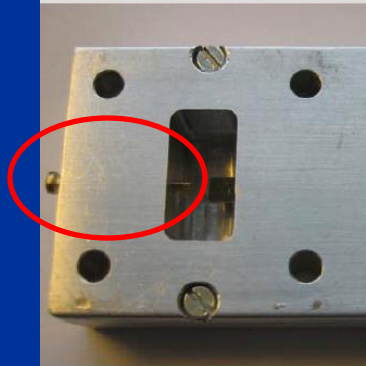


OK2AQ' design

<http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf>



NE3511S02
DiCLAD 870



MGF4953A
Duroid 5880

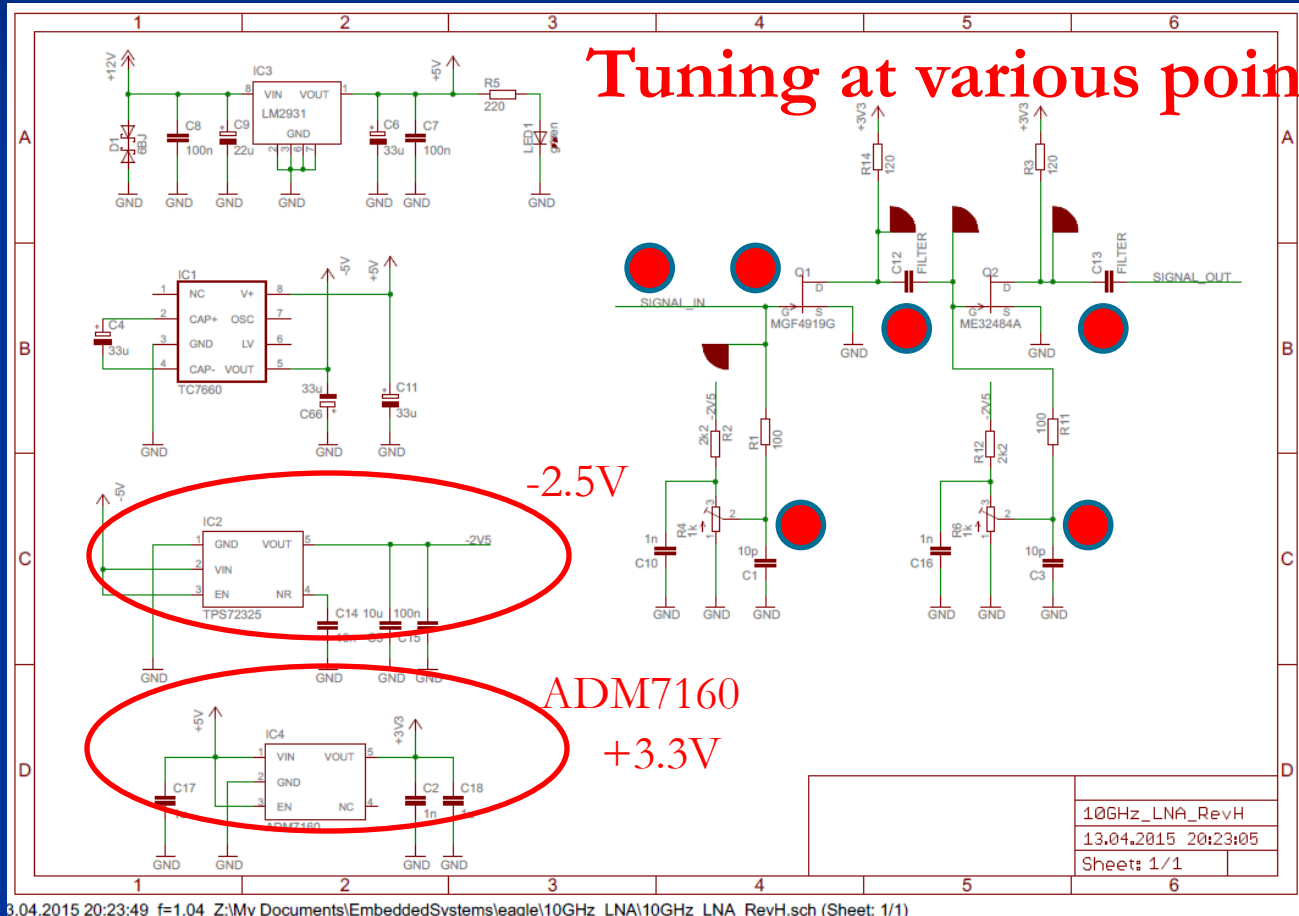
Tuning at various points..

EME a MW seminář 2014
Tři Studně, Duben 11-13, 2014

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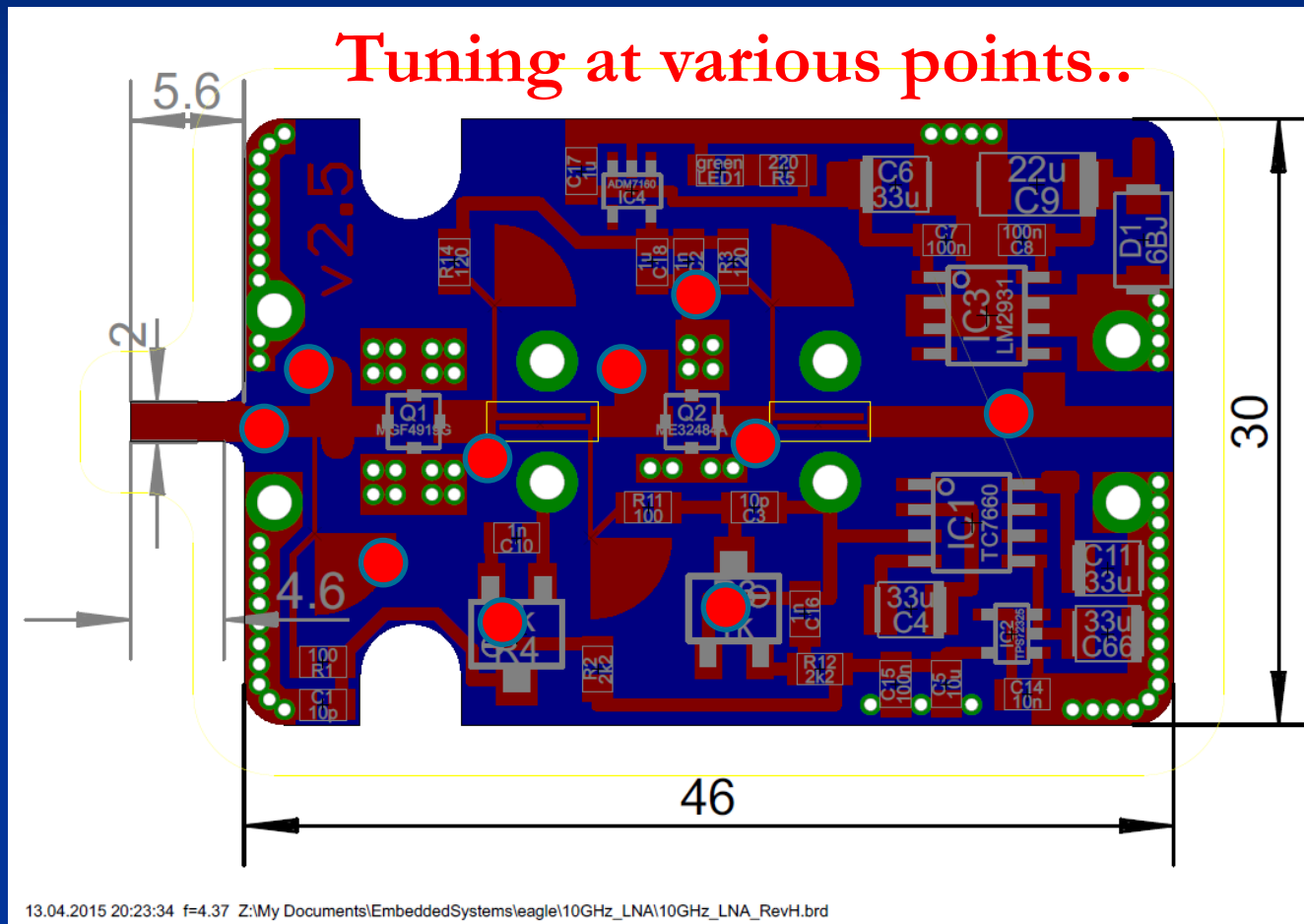
Even more tuning ..

Tuning at various points..



3.04.2015 20:23:49 f=1.04 Z:\My Documents\EmbeddedSystems\leagle\10GHz_LNA\10GHz_LNA_RevH.sch (Sheet: 1/1)

Print Layout HB9BBD



Tuning work at PCB in body..

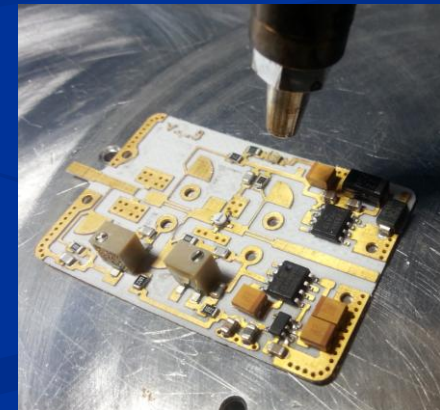
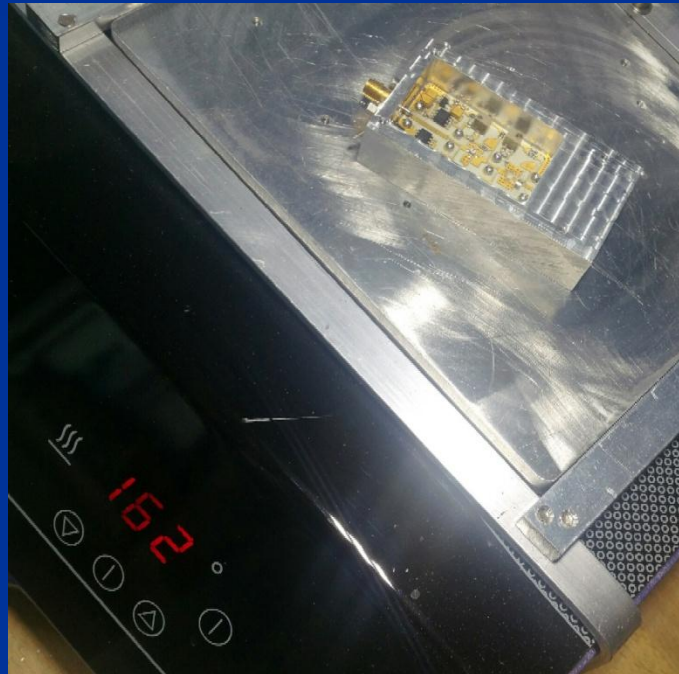
We all know the heat dissipating when soldering in LNA..



Stickstoff bei 350 Grad C

I heat the whole LNA without removing the PCB

Nitrogen at 350 degrees C



Too much work and time..

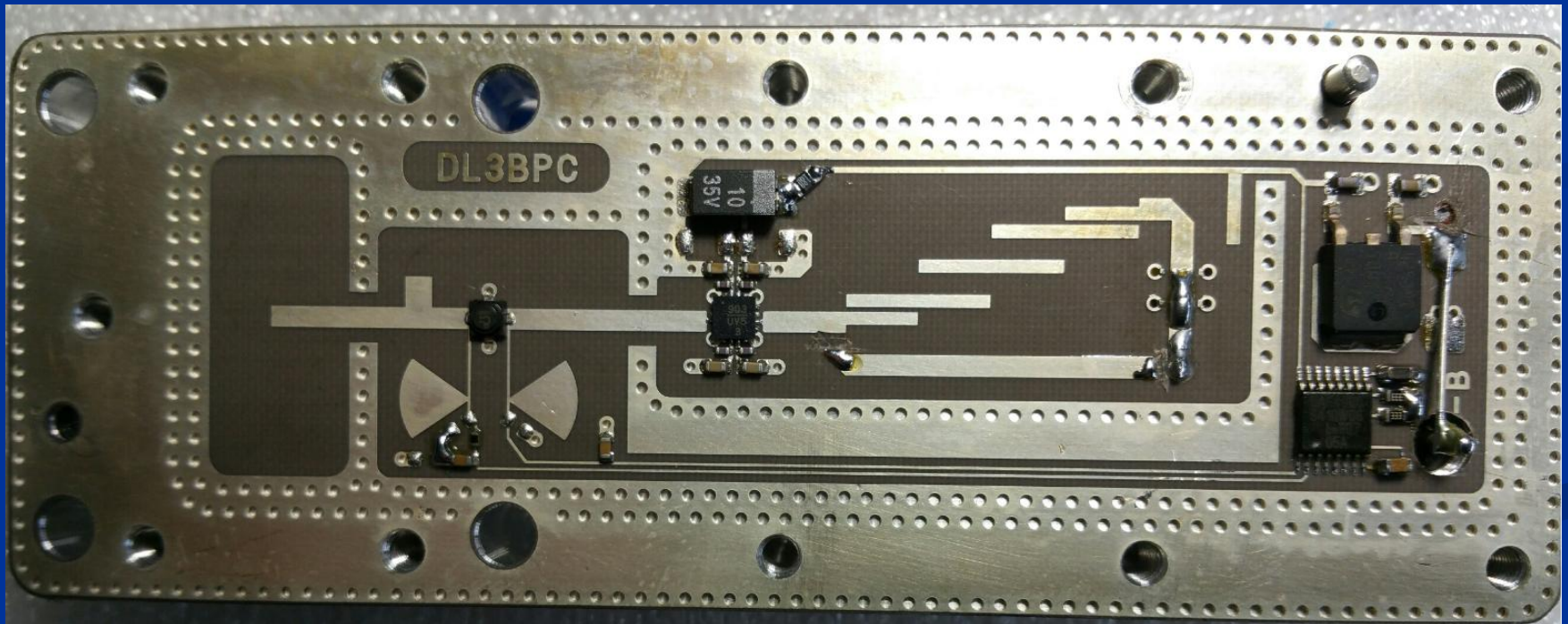
There is a more efficient way to achieve good results



Some of us have studied TV LNBS..

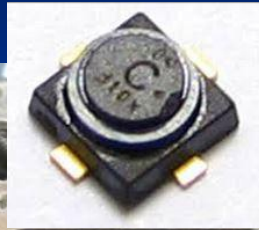
Very cheap, reasonable qualities
„Simulation – industrial manufacturing, NO tuning“

Sandwich LNA by DL3BPC

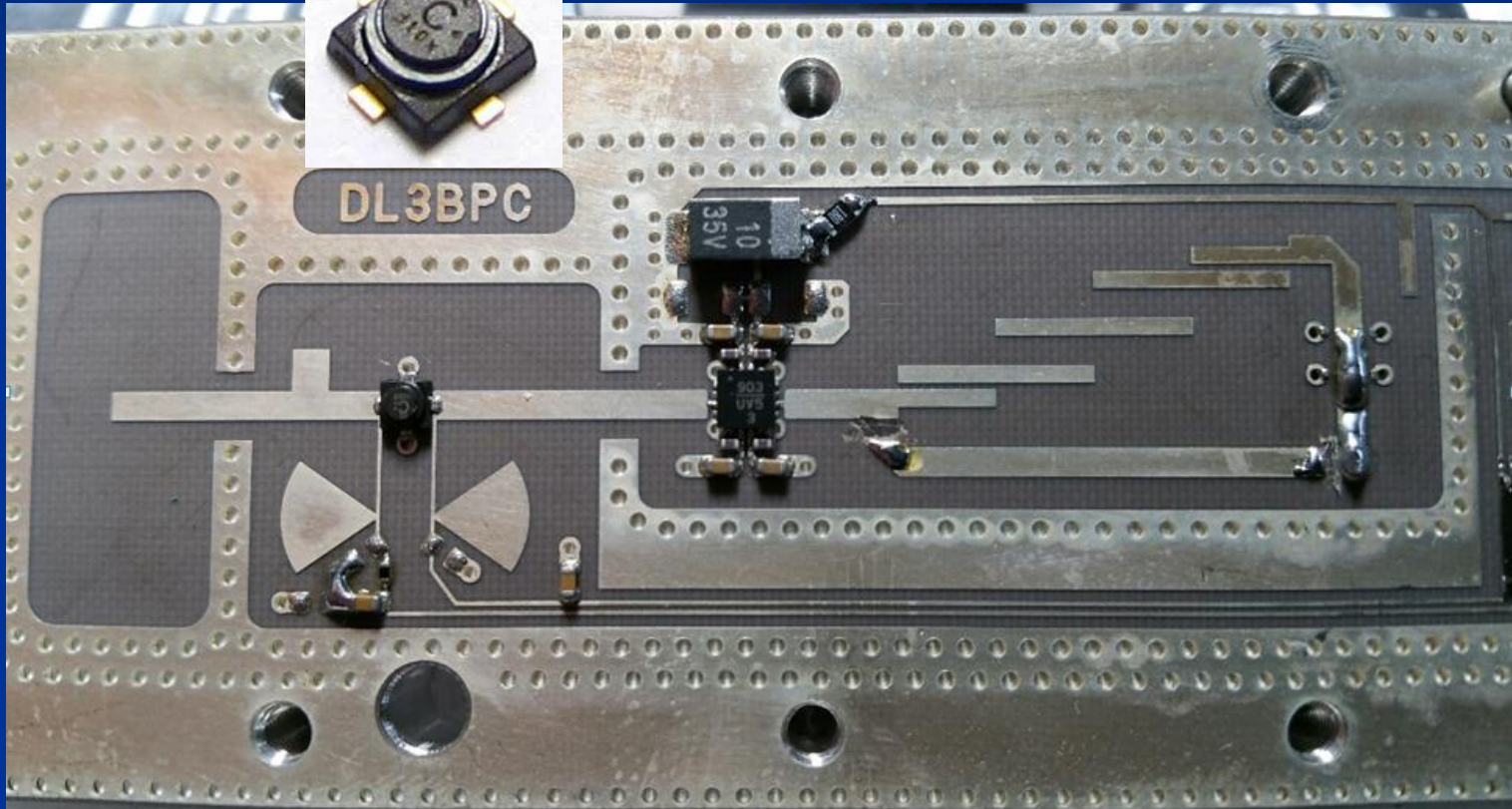


DL3BPC

NE3512S02



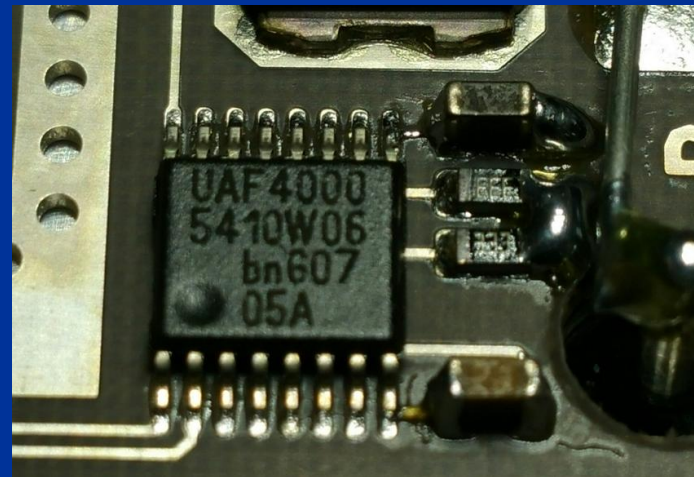
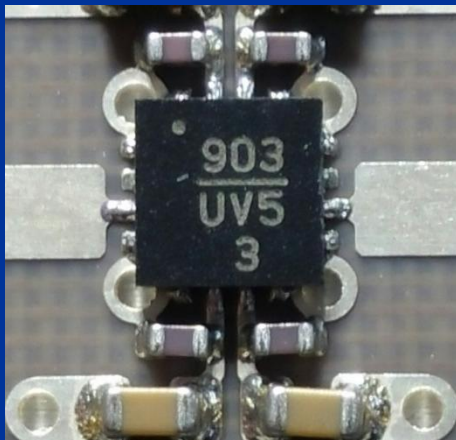
DL3BPC



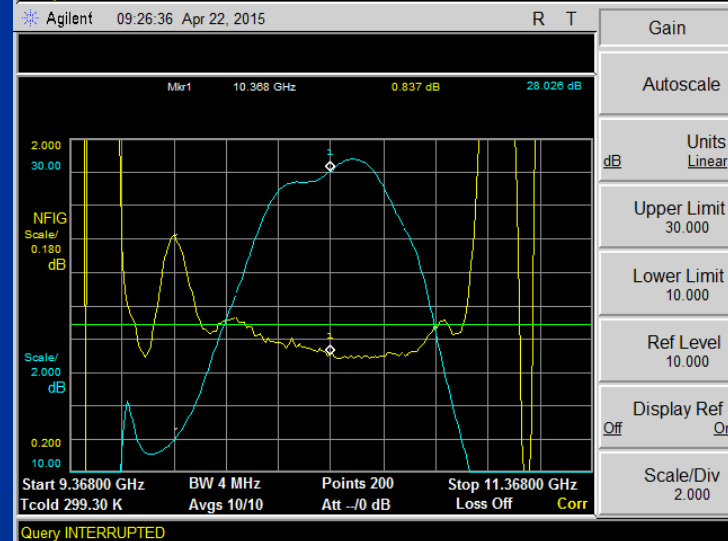
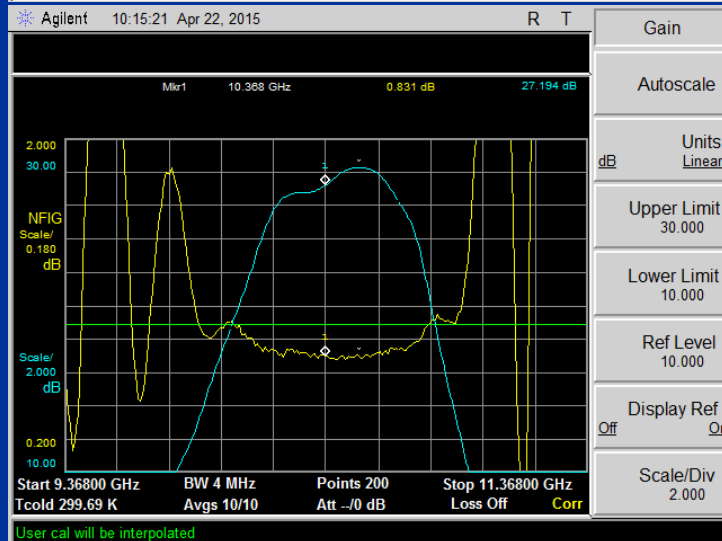
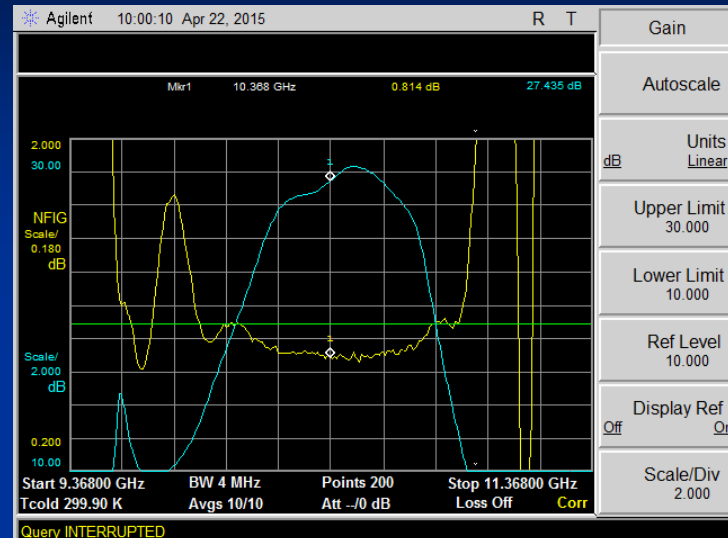
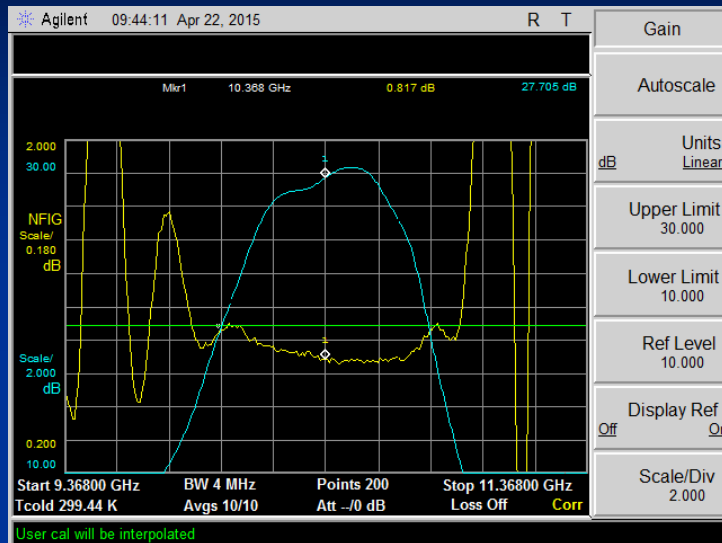
DL3BPC

Charakteristics:

- Industrial design
- Interdigital Filter *after* 2-stage amplifier
- No Tuning, no flaps, no tunable Gate supply
- some components are not standards
- perfectly repeatable specifications. NF within 3/100 dB, identical Gain)



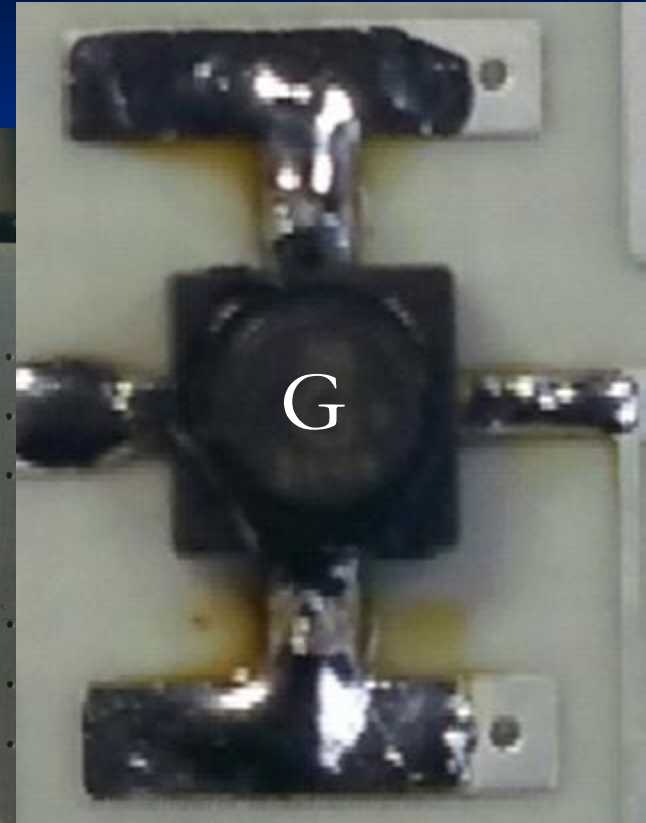
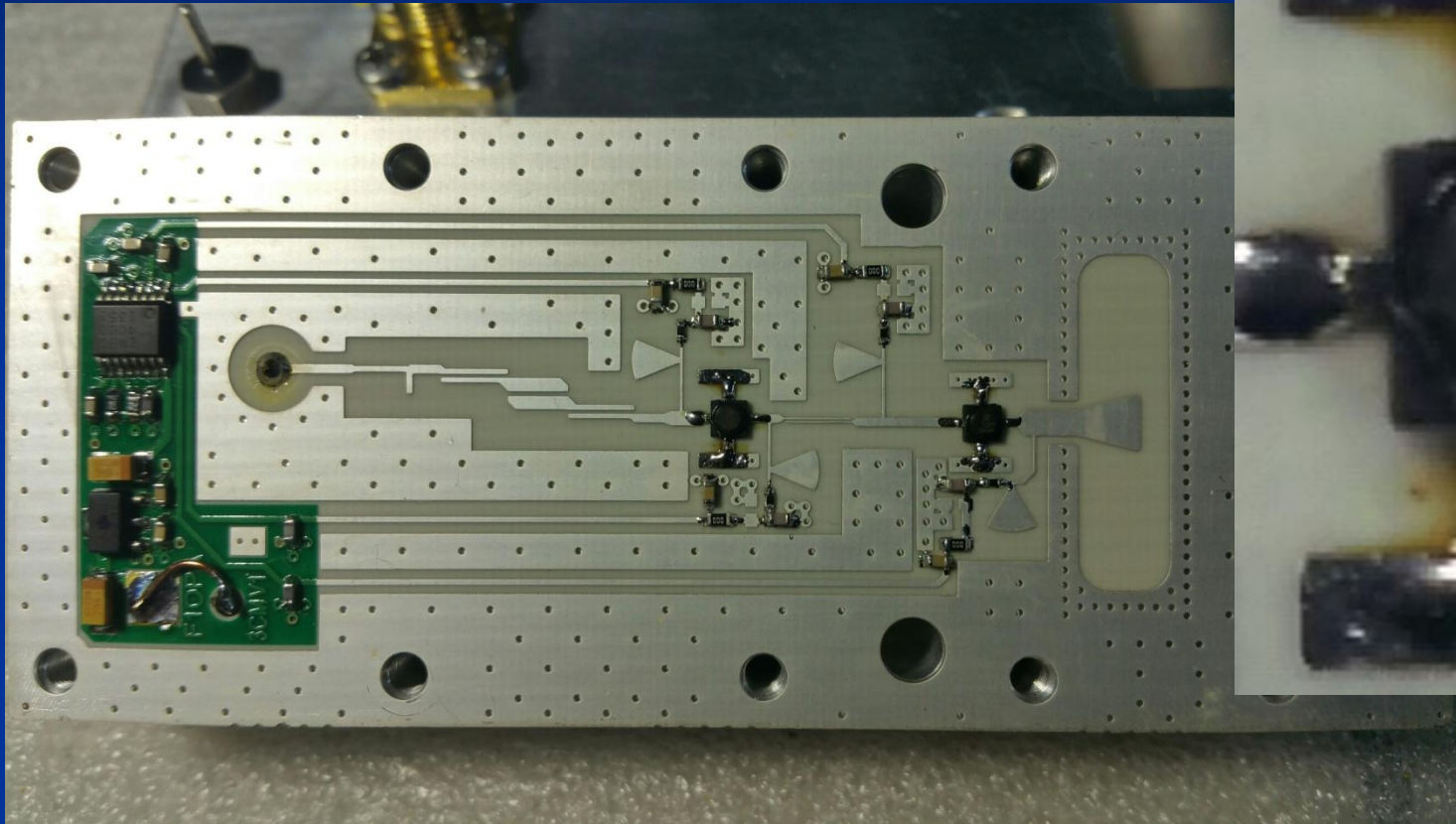
4 measured LNAs, all identical



F1OPA

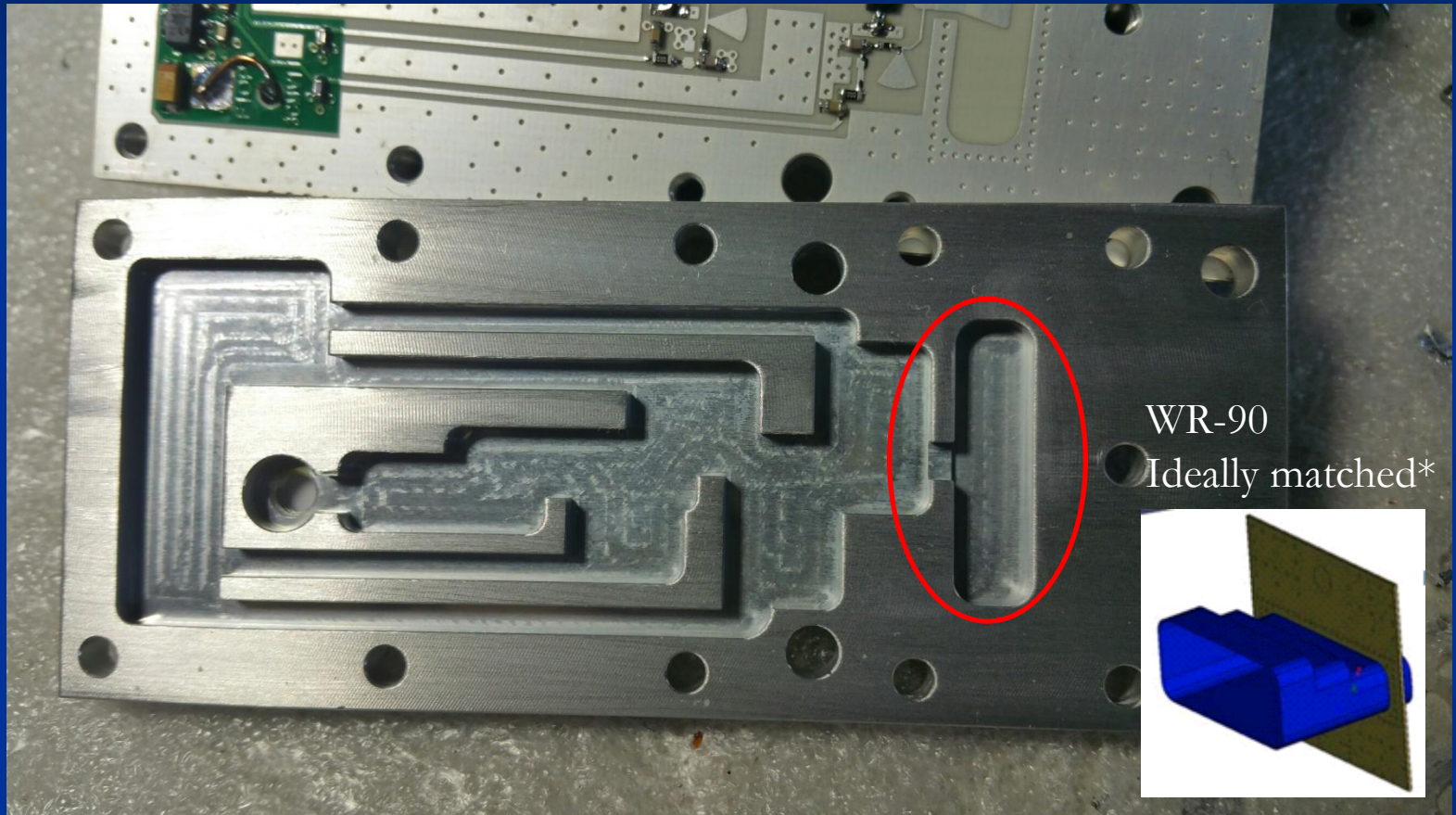


F1OPA



NE 3515S02

F1OPA



*ref. Dubus 3/2016

F1OPA

Charakteristics

- Matched WG-Input stage
- **Interdigital Filter** following 2 stage amplifier
- **No tuning**, no flaps, **no adjustable Gate supply**
- Industrial make
- **Standard components**
- Reference: Dubus 3/2016 description

https://sites.google.com/site/vincentf1opa/STORE_F1OPA

Currently used Hemts by:

** discontinued types



NE32484A **

„T“

0,6 dB@12 GHz



NE32584C**

„D“

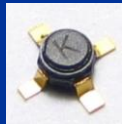
0,45 dB@12 GHz



MGF4919G **

0,45 dB@12 GHz

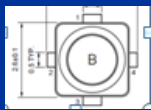
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NE3210S01 **

„K“

0,35 dB@12 GHz



NE3511S02

„B“

0,30 dB@12 GHz **DB6NT OK2AQ**



NE3512S02

„C“

0,35 dB@12 GHz

DL3BPC



NE3515S02

„G“

0,30 dB@12 GHz

F1OPA

Measuring Noise

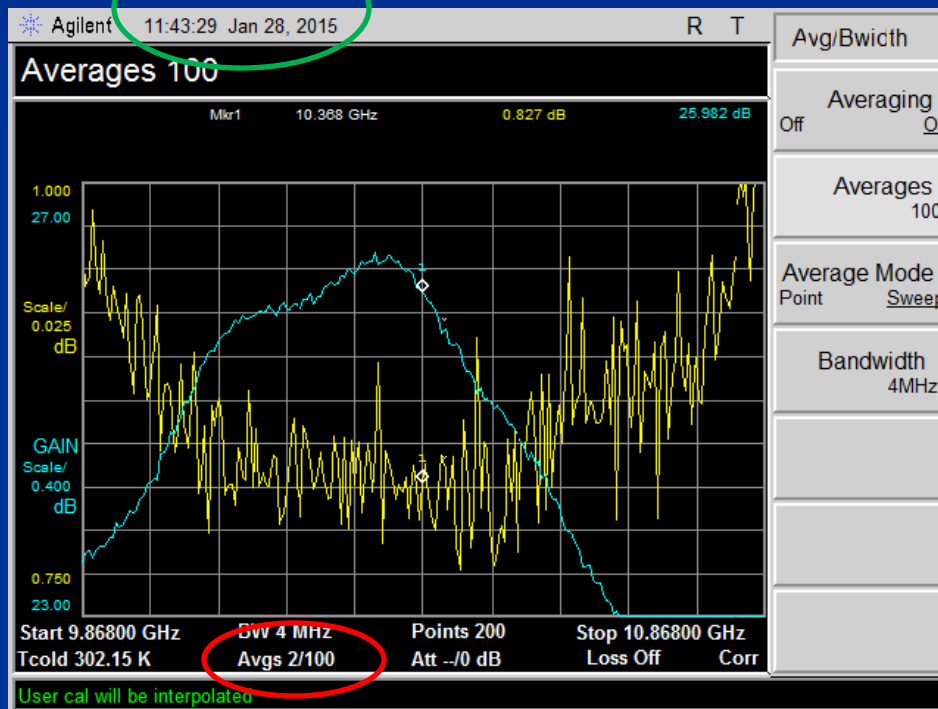
- Noise is very volatile – It is therefore that averaging many measurements only can characterize an LNA
- WG LNA need an adapter to measure Noise.
We have to know the loss of WG-coaxial adapters to quantify the LNA's Noise Figure
- Temperature matters. 290K (17 deg.C.) is specified for Agilent 8975A/N4000A. Usually, our Lab temp. is much higher! So NF measured may be close to, but not correct
- Calibration of the test equipment is significant



Averaging

2 averages

Time required for 20'000 Measurements: >1h..



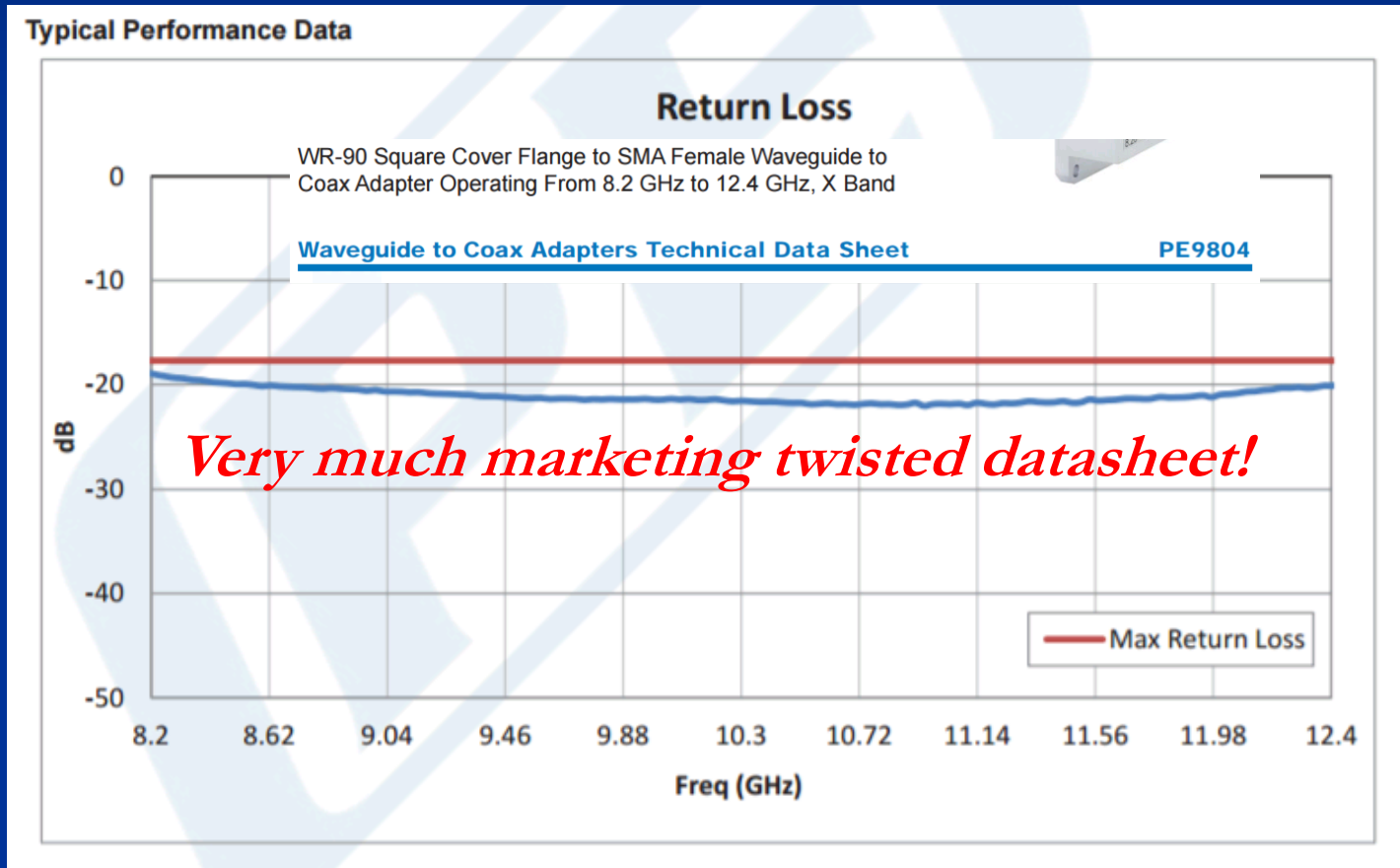
100 averages



Wo bitte ist das Rauschminimum?

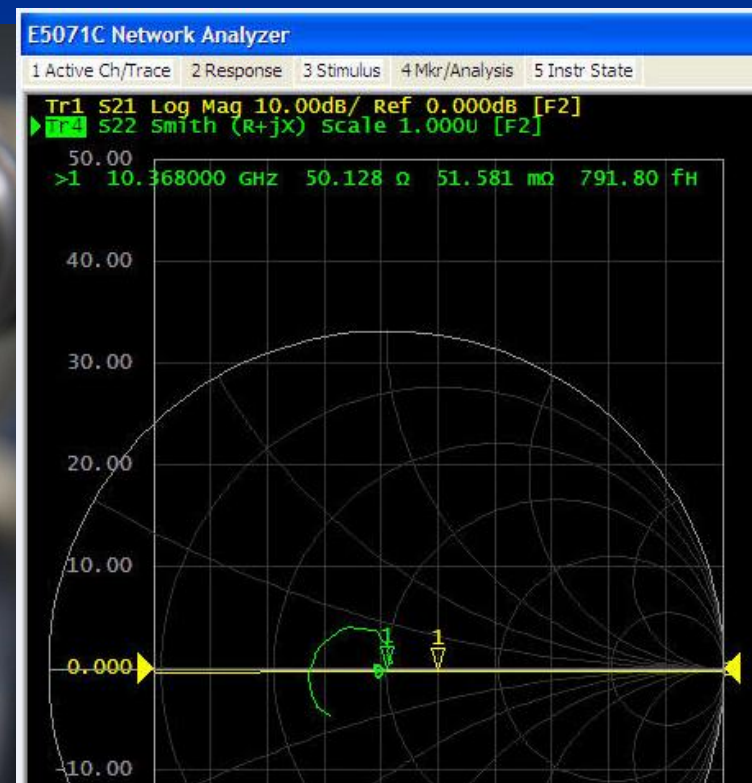
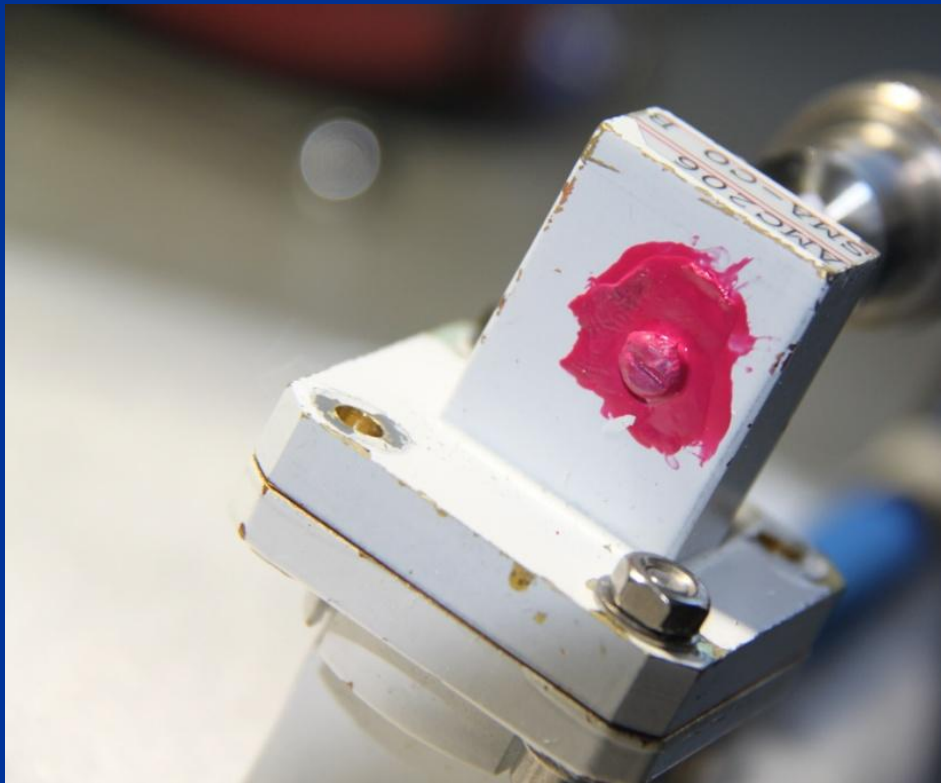
SMA-WG Adapter

Commercial WG adapters are broadband and not good enough for Noise measurements



Match of SMA-WG Adapter

WR90	RG52 (b) RG67 (a)	WG16	R100	8.20-12.40	6.56	0.900	0.400
WR75	RG346 (c) RG347 (a)	WG17		10.0-15.0	7.87	0.750	0.375



SMA-WG Adapters

Some home made WG-coaxial adapters

It is very much a question of testequipment and cost!



SMA-WR75 for 10'368 MHz

Near to perfect match can reduce the insertion loss and reduce reflections and thus is reducing measurement uncertainty

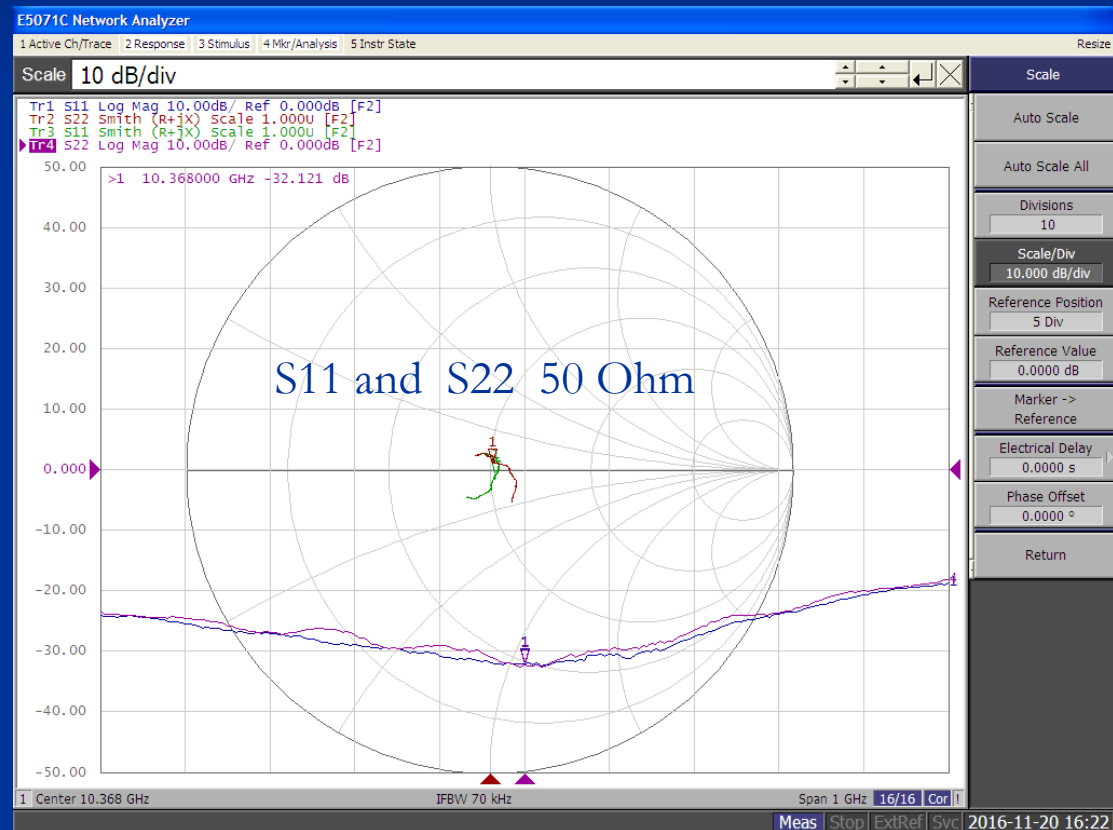


Es ist vollkommenwert, unsere Adapter für 10'368 MHz zu optimieren

Match of WR-75 for 10'368 MHz

Match at 10'368 MHz

S11 and S22 -32 dB



WR-75 for 10'368 MHz

Insertion loss for two adaptors is -0,13 dB, > 1 Adapter 0.07 dB

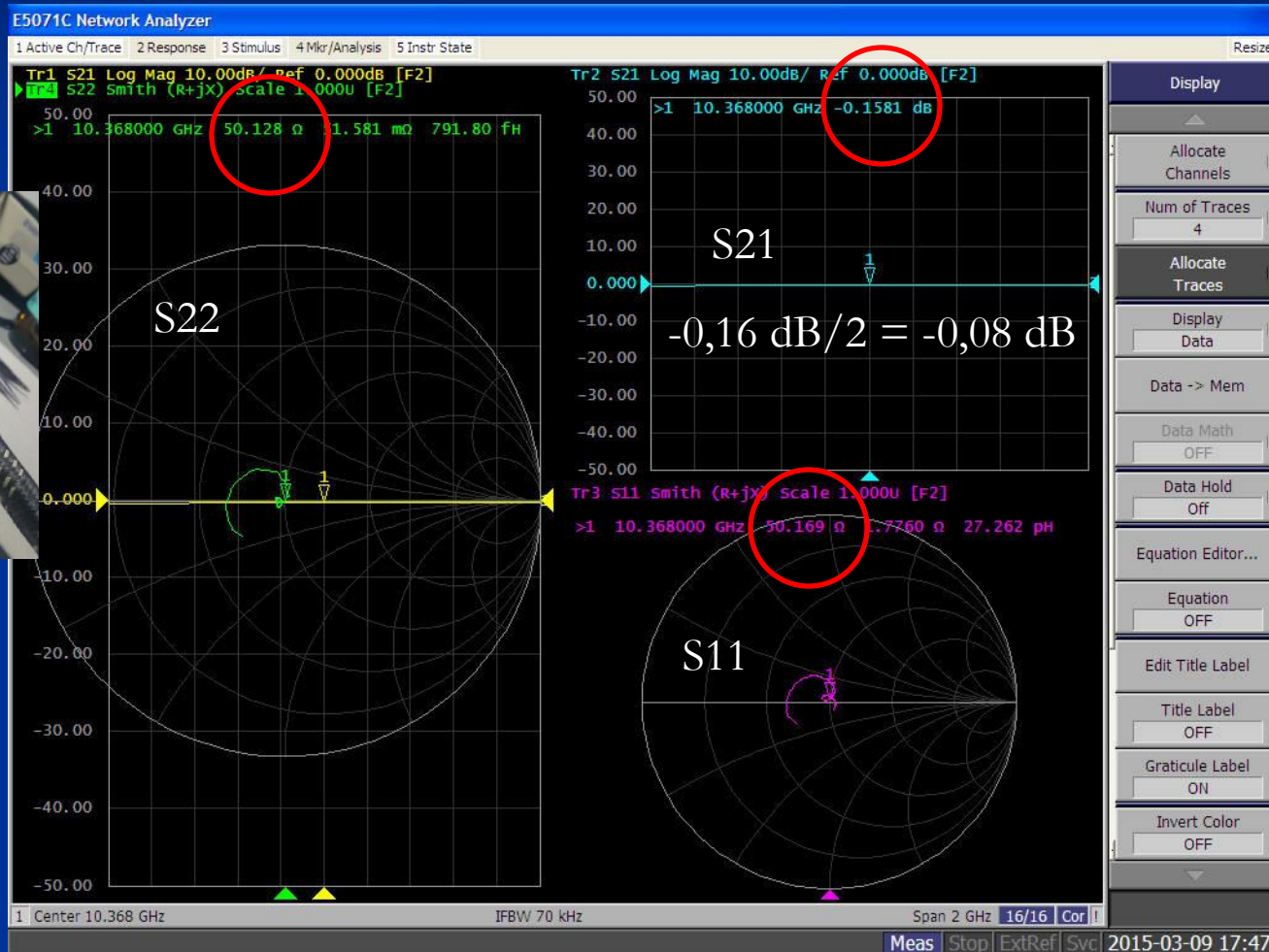


Insertion loss

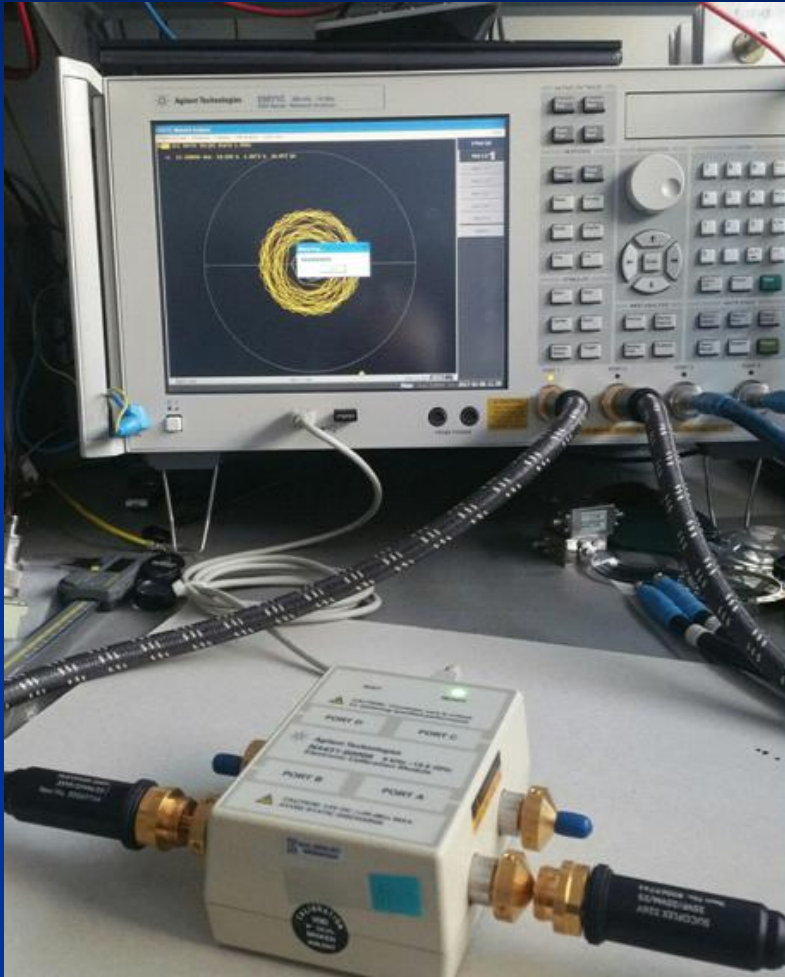


SMA-WR90 für 10'368 MHz

S-Parameters S11, S22, S21 an overview



Calibration of Testequipment



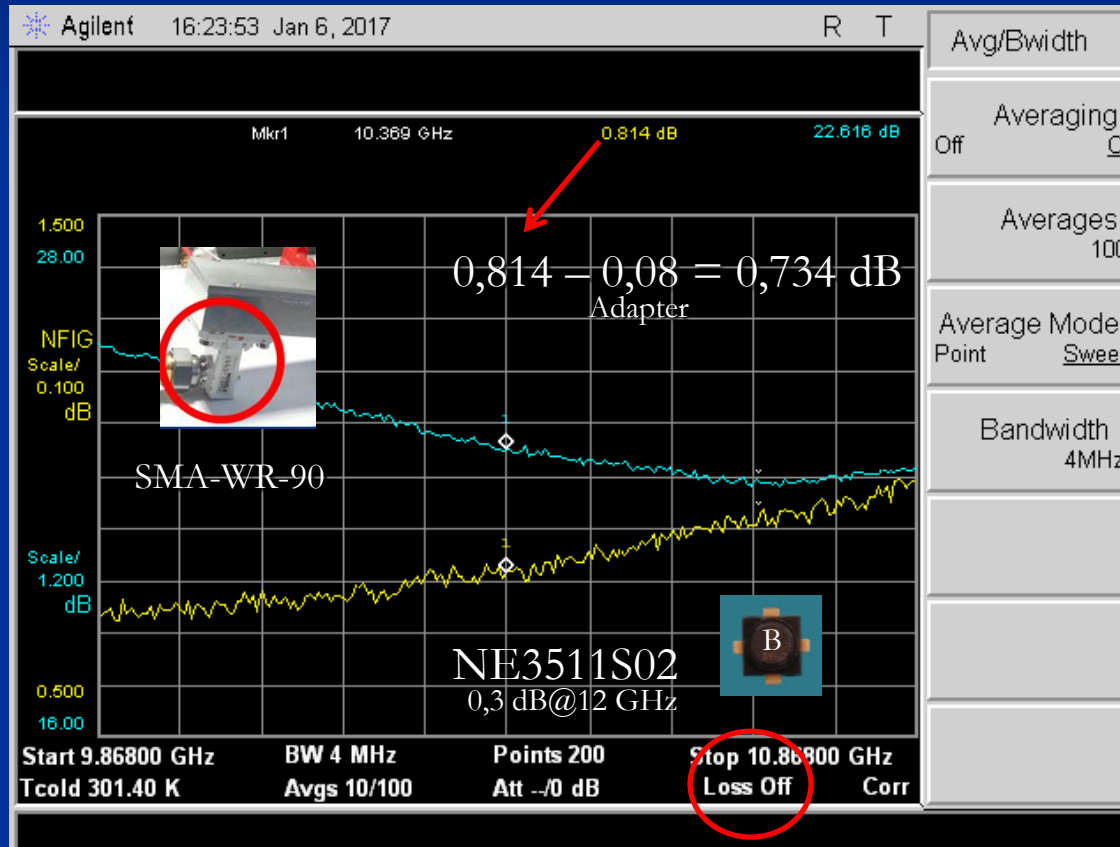
Calibration is essential for reliable results

Temperature matters for testequipment
And DUT

**Amateurs are by 1 decade more critical
Than professionals (*but sometimes
dont calibrate carefully !*)**

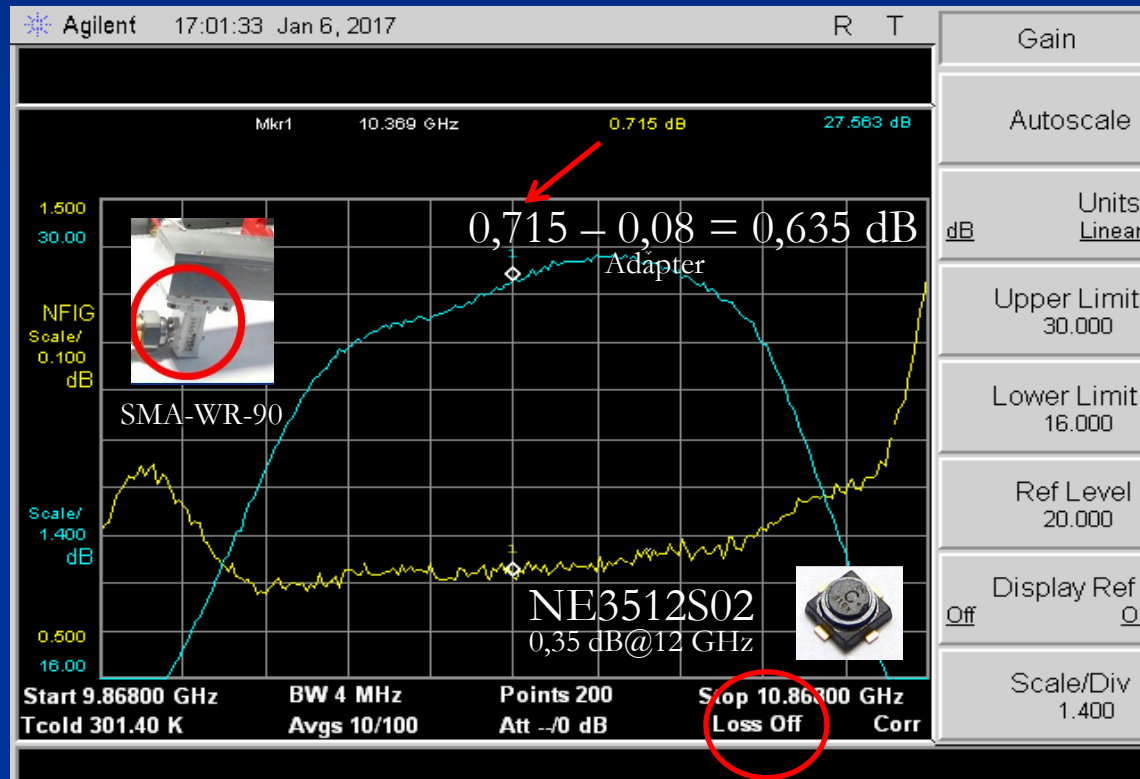
Summary

DB6NT (Seal undestroyed..)



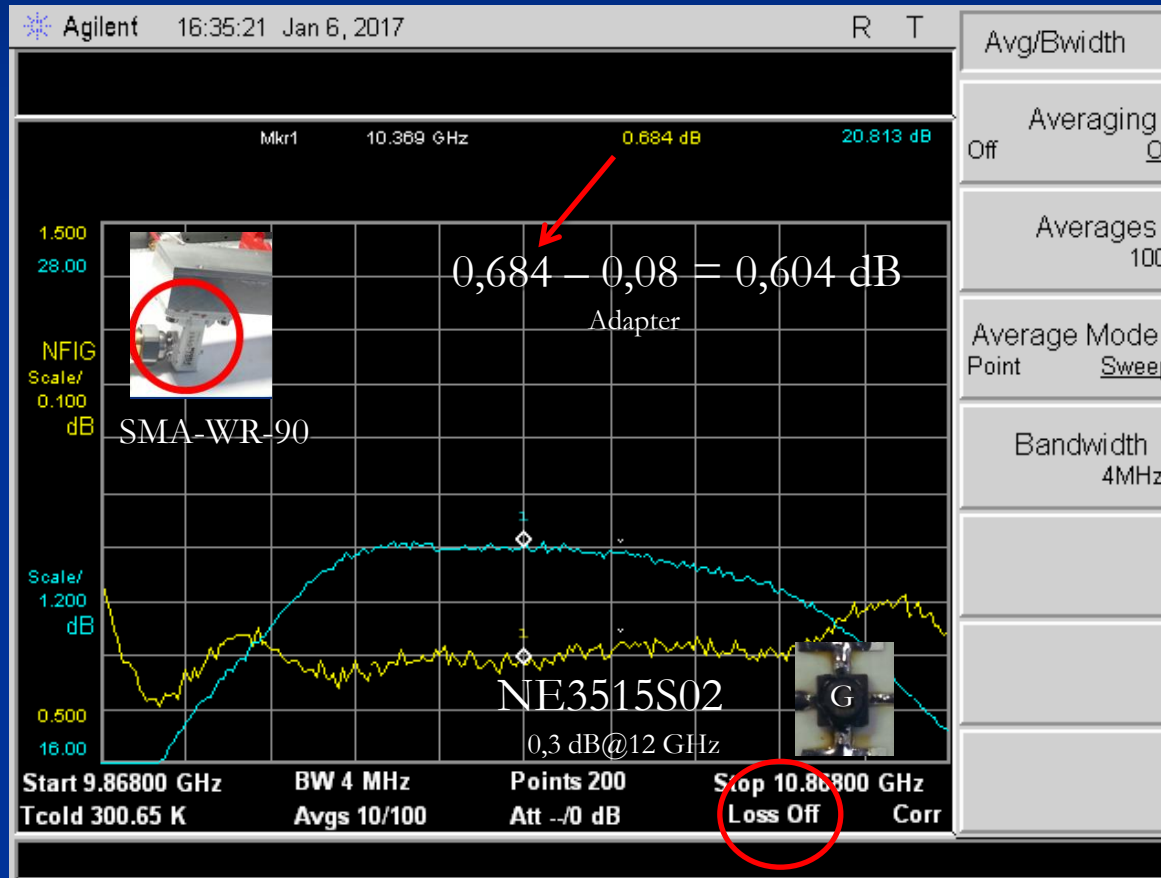
Summary

DL3BPC #10



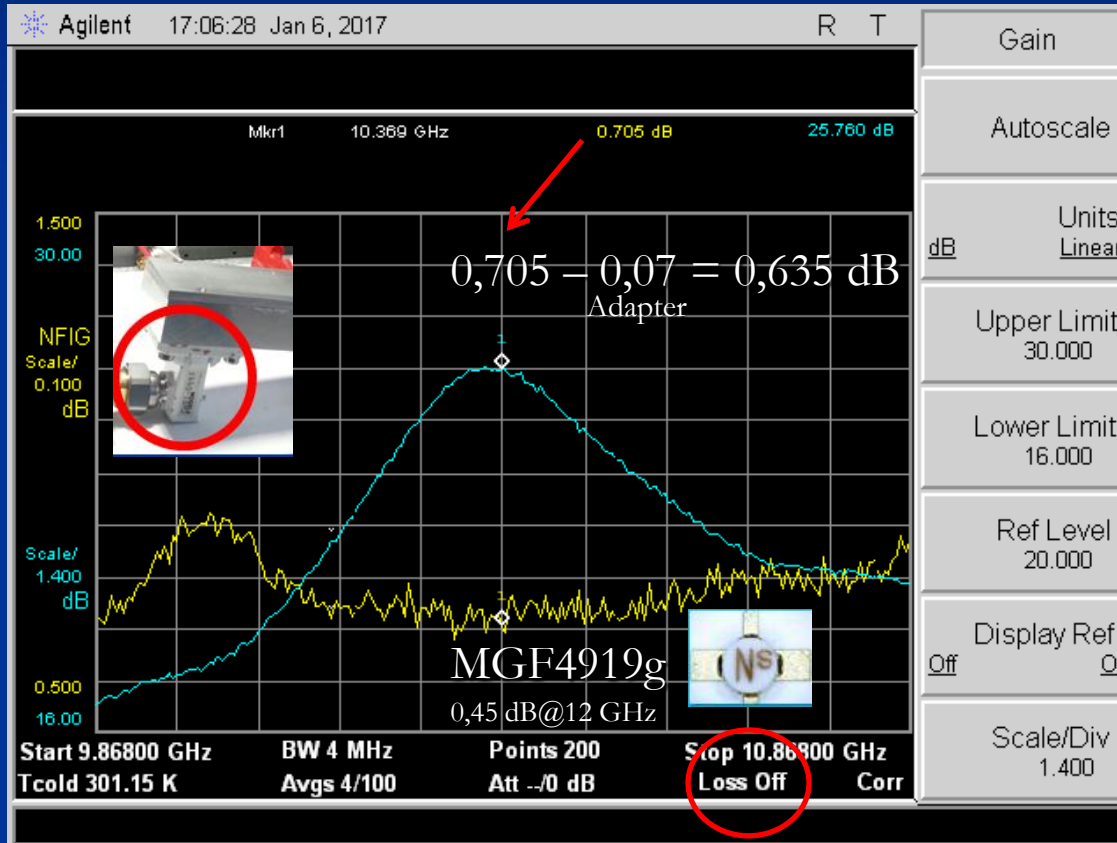
Summary

F1OPA #1628



Summary

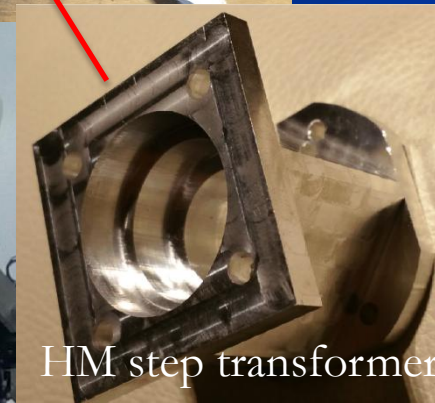
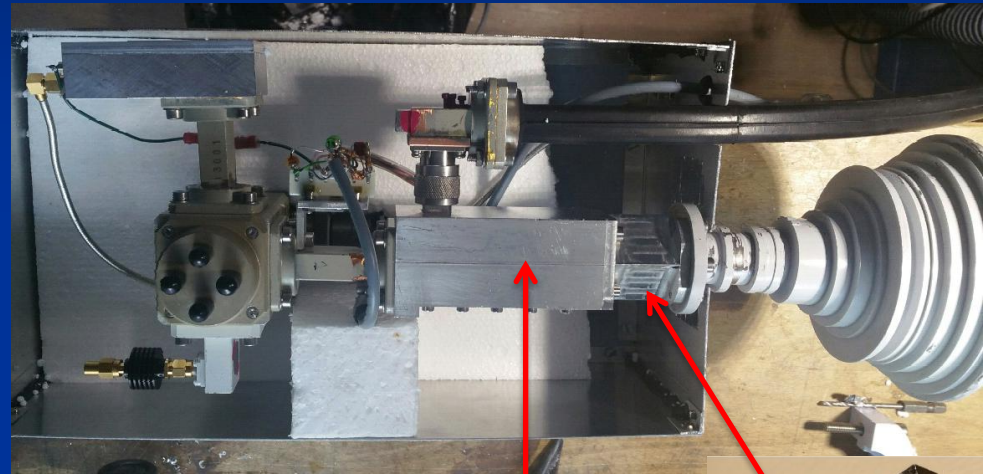
HB9BBD # 3-V2.3



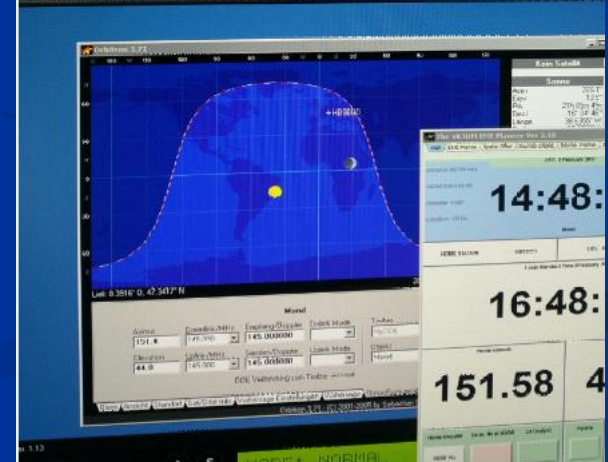
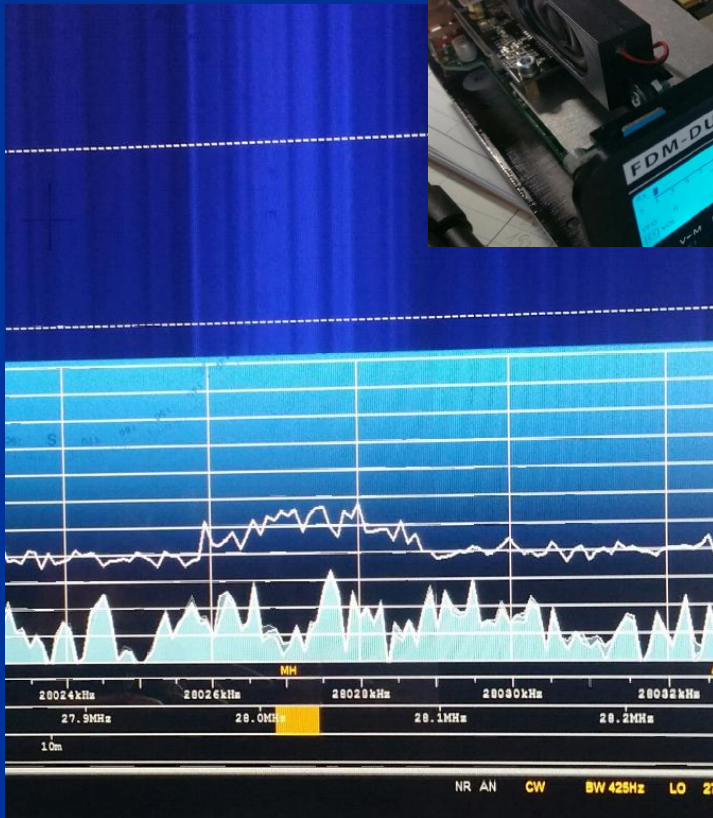
Conclusions

- Traditional LNA construction clearly suffers disadvantages in design. It requires more time and efforts to work as desired
- Broadband WG-Coaxial Adaptors do not fit for measurement purposes without manual retuning on the specified frequency. No passive device is linear over a span of >4 GHz at 10'388 MHz
- Much emphasis is needed to match WG to LNA at Gate of first stage
- Best achievable NF on 3cm band today is probably 0,5 dB at ambient temperature
Losses occur by all components, by radiation, by mismatch and by any temperature above absolute Zero
- Measurement of NF is meaningless without averaging several sweeps and still, we have to accept uncertainty by temperature and NF of testequipment etc!
- The future belongs to LNAs designed by simulation and built in „sandwich format“

EME Beacon DL0SHF with 1m off-set dish



EME Beacon DL0SHF with 1m off-set dish



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Questions ?

