LTCC-Breitband-Balun

für einen Gegentaktverstärker

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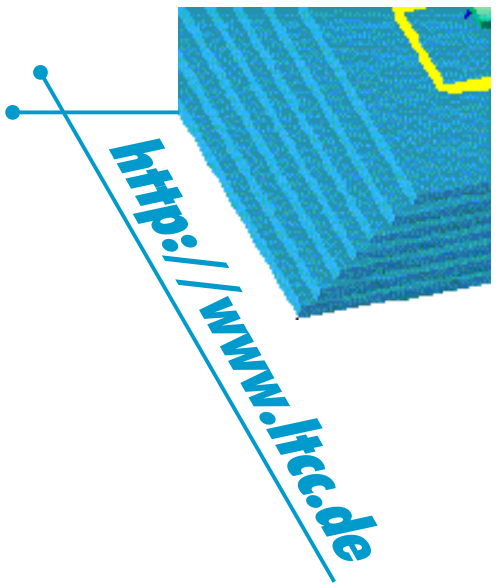
- Reinhard Kulke, RF-Modules
- Dr. Andreas Lauer, Field Simulation and Modelling
- Dr. Dietmar Köther, Measurement Techniques
- Customer: Thomas Molière, Siemens AG

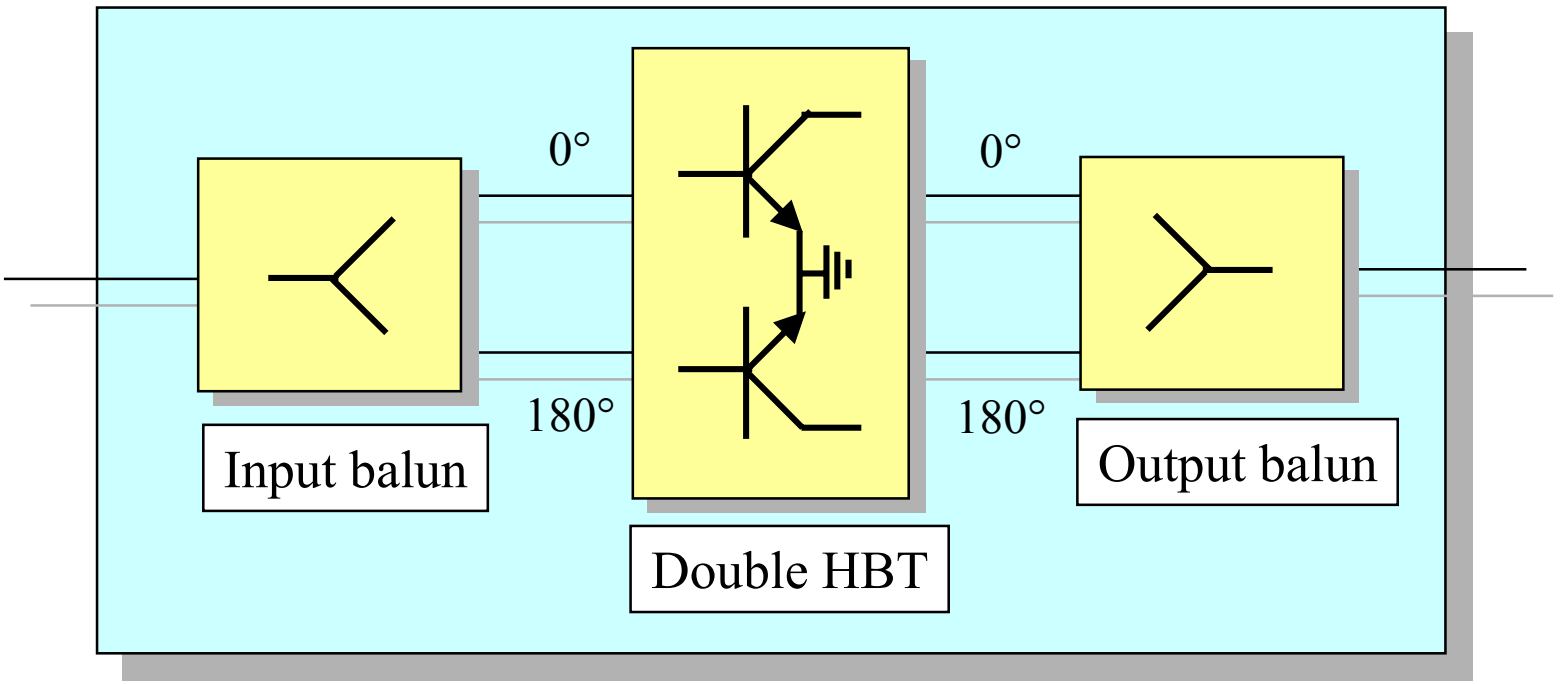


Outline

- ☑ Introduction
- ☑ Concepts of Balun structures
- ☑ Balun structure on LTCC
- ☑ Push-pull amplifier with Baluns on LTCC
- ☑ Conclusion

Introduction

GSM push-pull power amplifier



Working frequencies: 900 and 1800 MHz

Impedance transformation output: 2 × 4 Ω bal. to 32 Ω unbal.

Concepts of Balun structures

Lumped elements (SMD components):

- small space requirement
- ideal: very good calculable
- real: parasitic effects
- small bandwidth

Distributed elements:

- reproduction of lumped elements with line elements
- missing models, synthesis with field simulation complex
- large parasitic effects
- small bandwidth

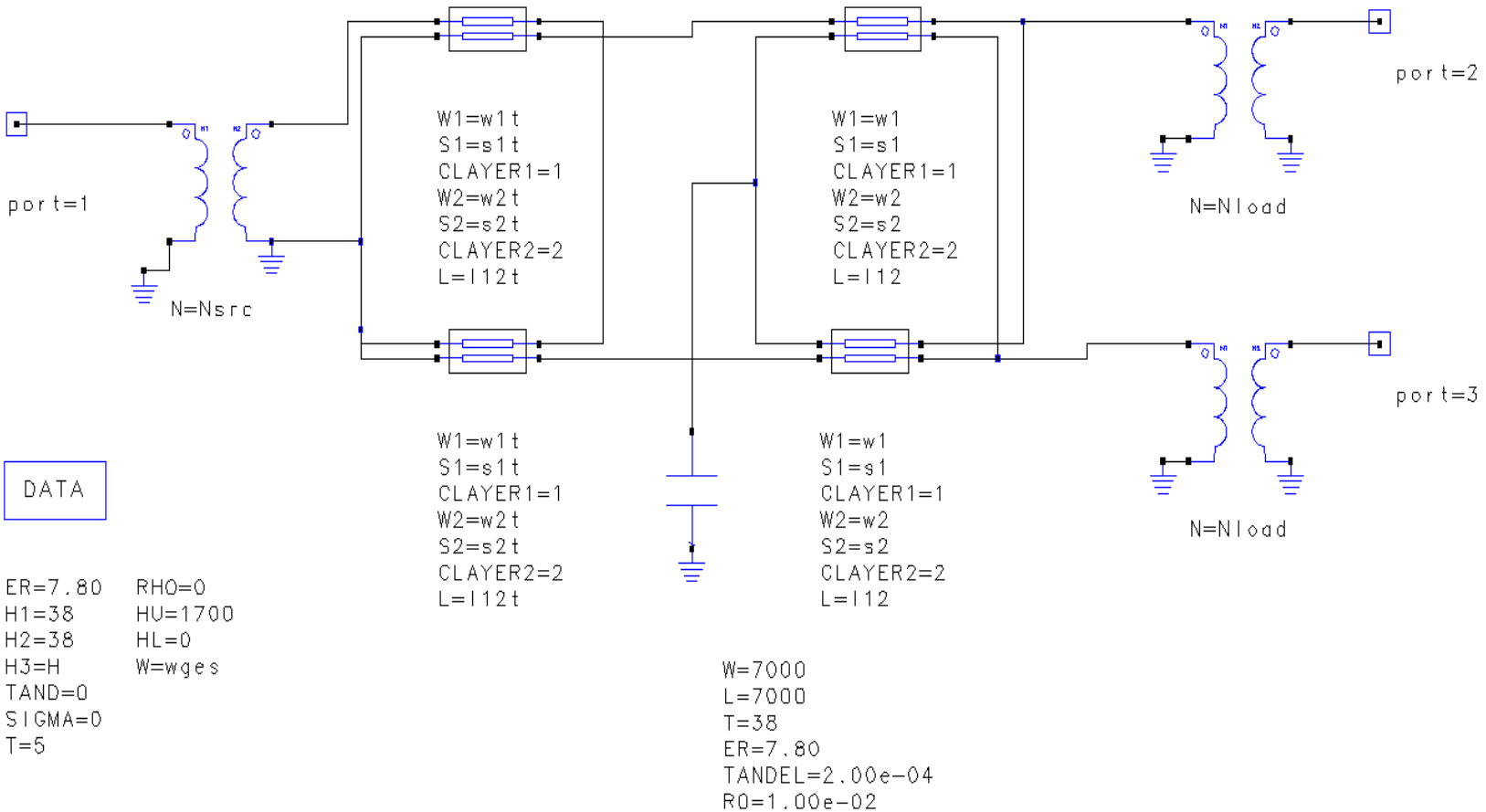
Concepts of Balun structures

Line elements:

- synthesis based on coupled lines is simple (Series IV Libra)
- larger space requirement (λ/4 approx. 25 mm@1.4 GHz on MSL)
- field simulation necessary
- large bandwidth possible

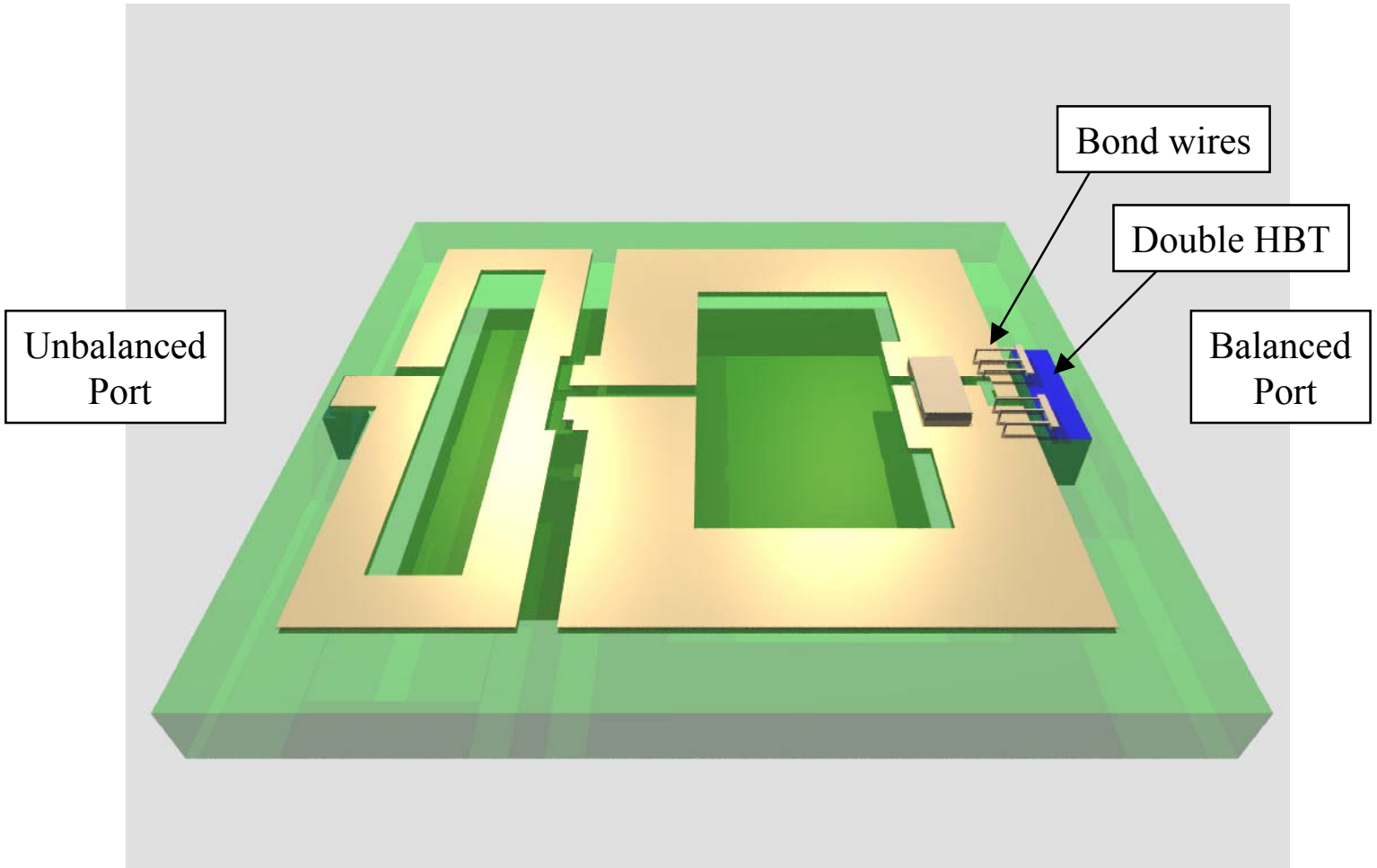
→ **Fits best the needed bandwidth specifications**
Multilayer substrate required for coupled lines
Choice: LTCC

Guanella transformer



Simulation environment (HP Series IV Libra)

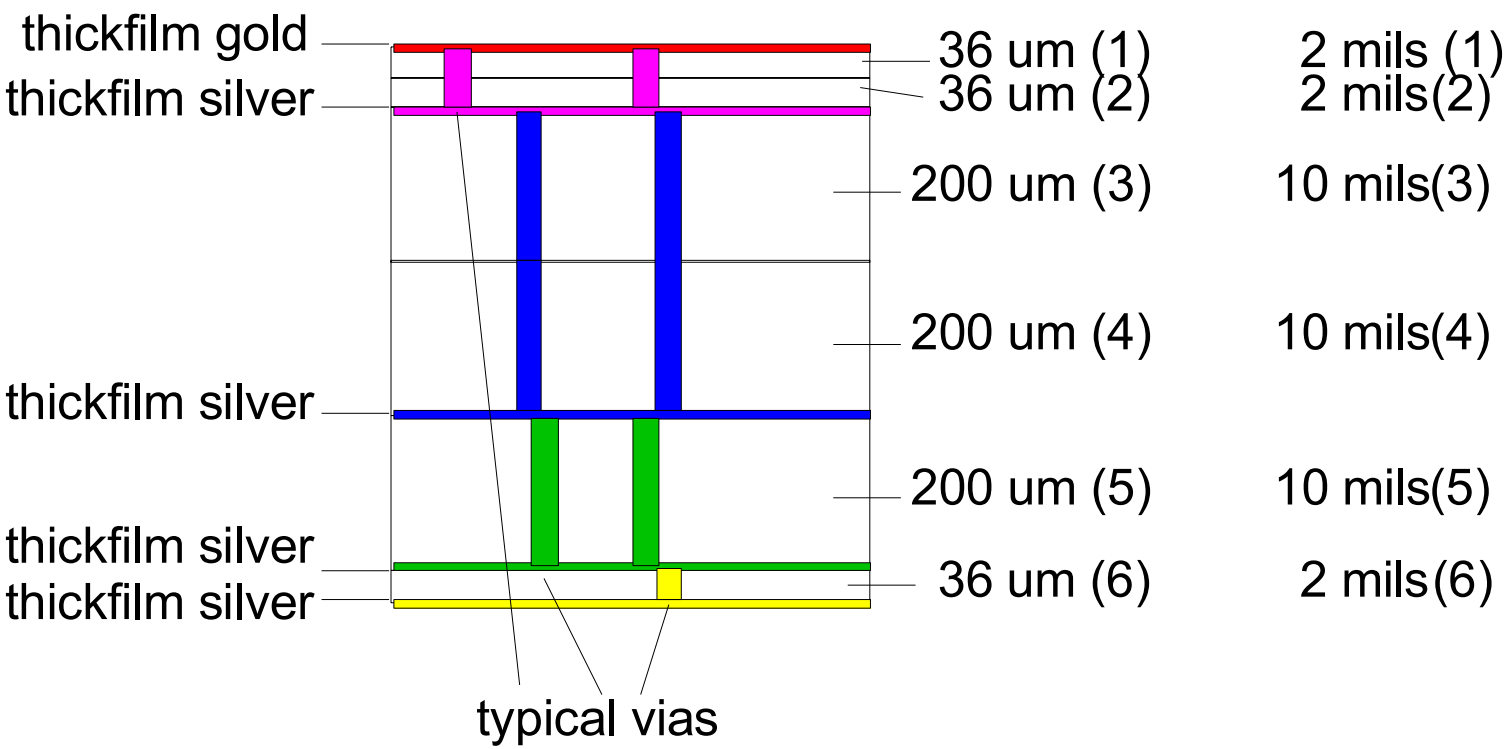
Balun structure on LTCC



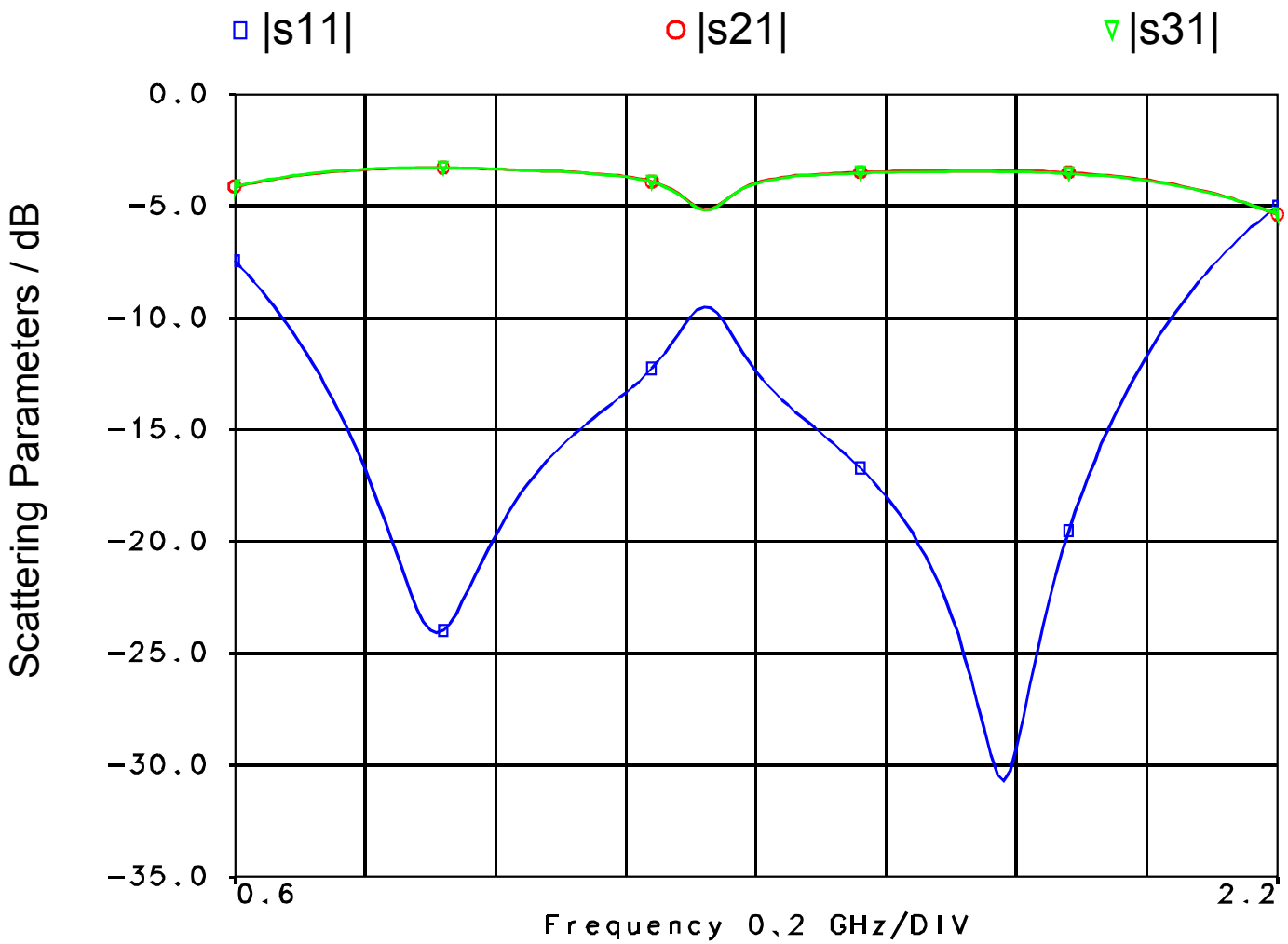
Simulation environment (IMST EMPIRE)

LTCC layer settings

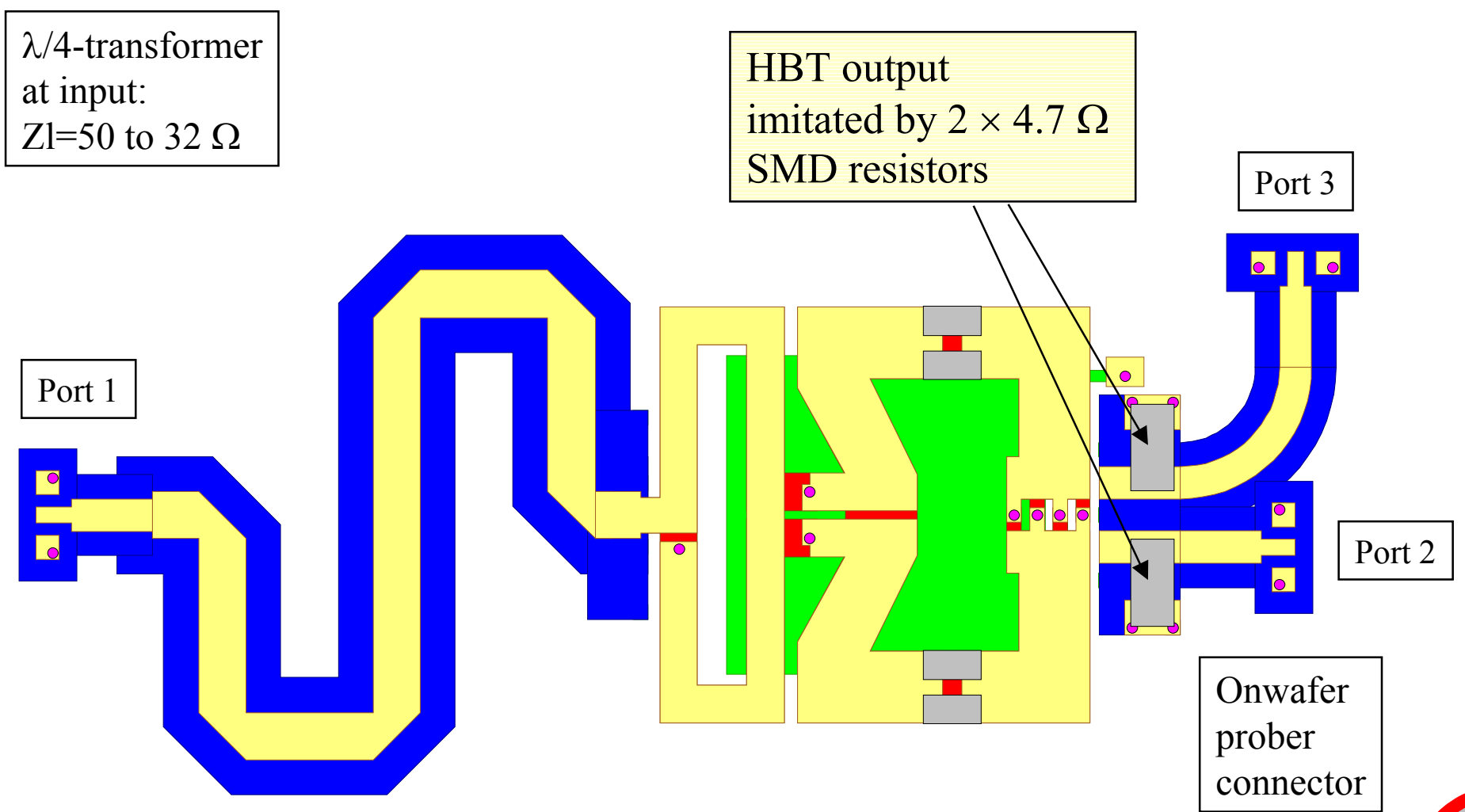
Tapes: DuPont 951
mixed metal



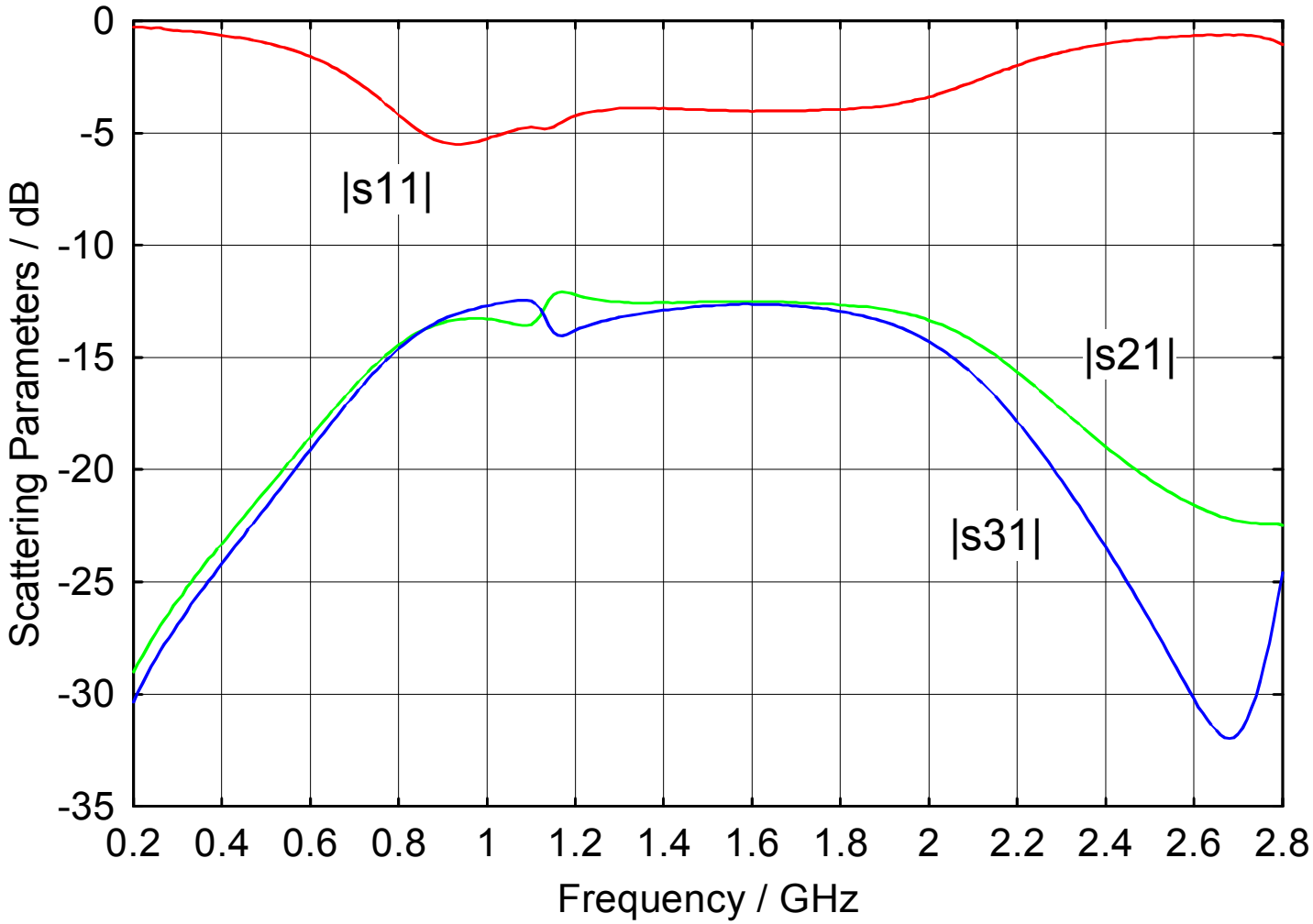
Simulation results



Measurement environment

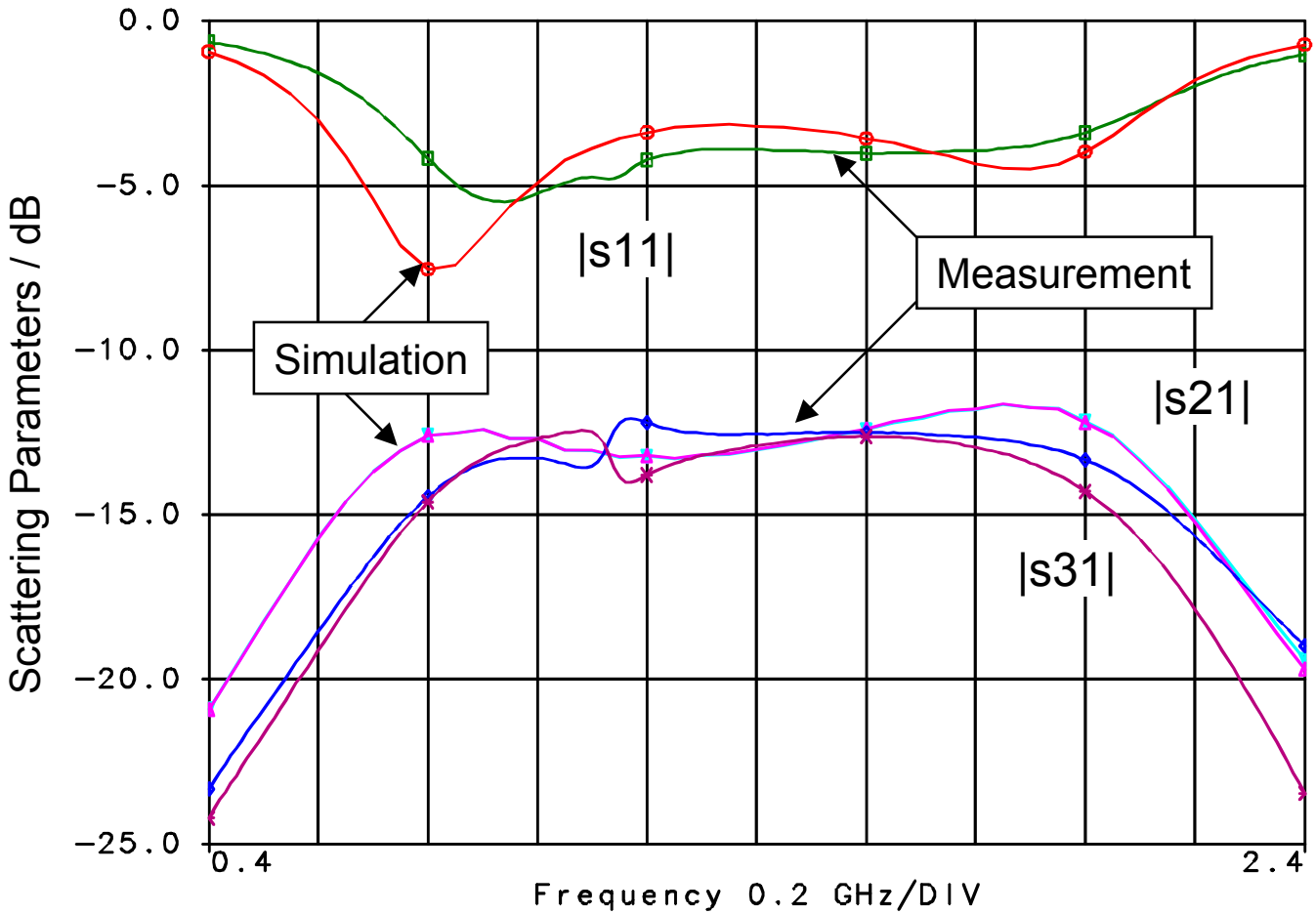


Measurement results



Problem:
SMD resistors include a very high imaginary part

Comparison: Balun results

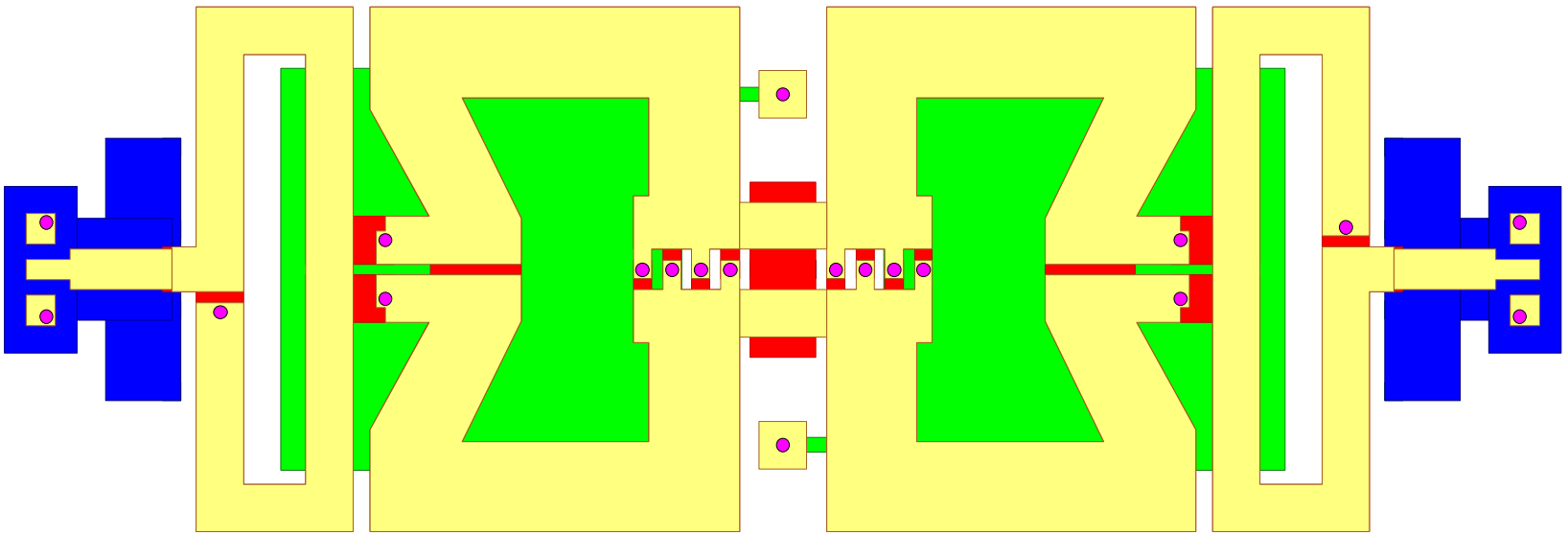


Comparison of simulation and measurement:

measured SMD resistors included in Libra simulation as s2p-files

Back to back-setup

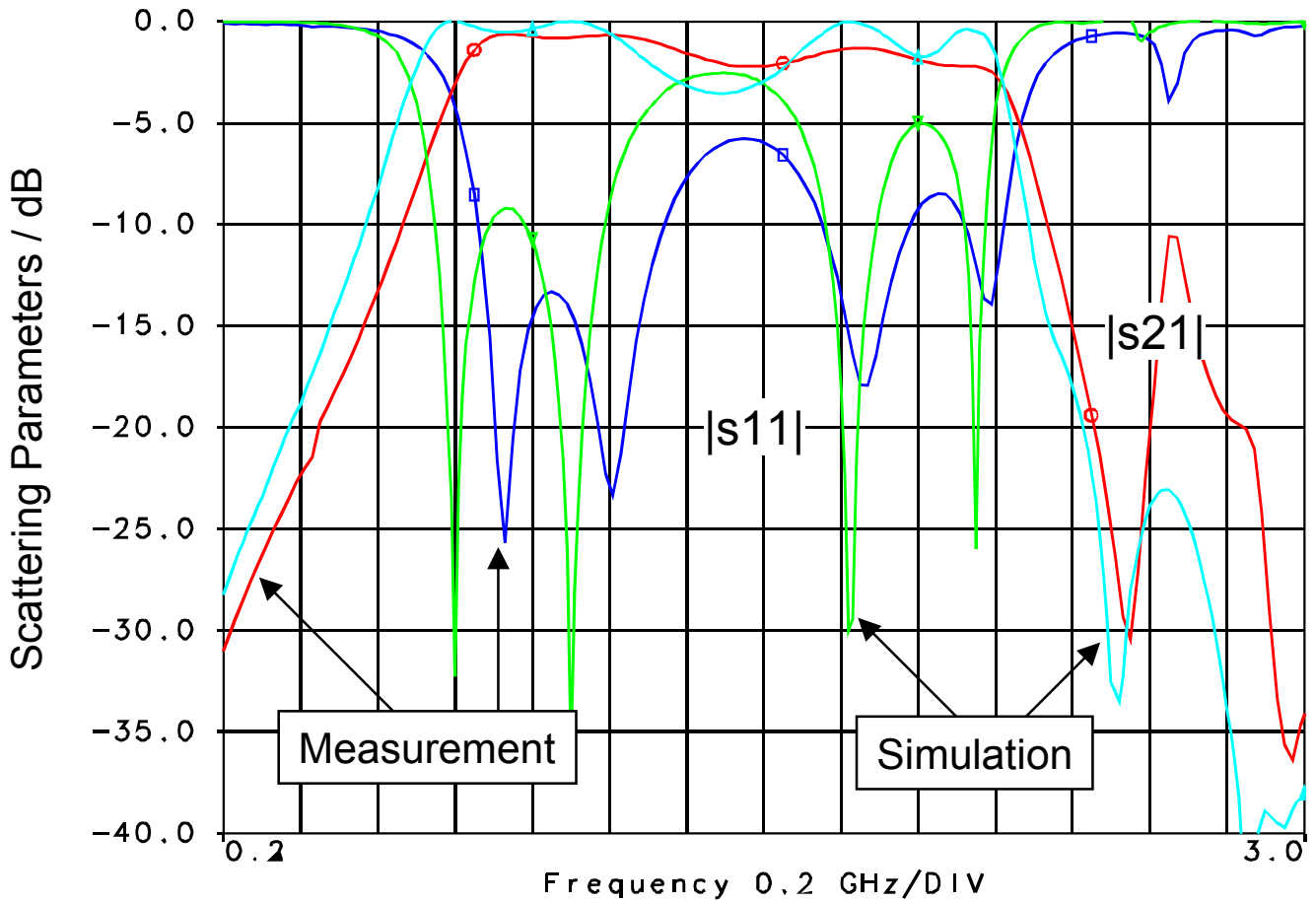
Two Balun structures back to back
to measure the loss in transmission



Back to back: results

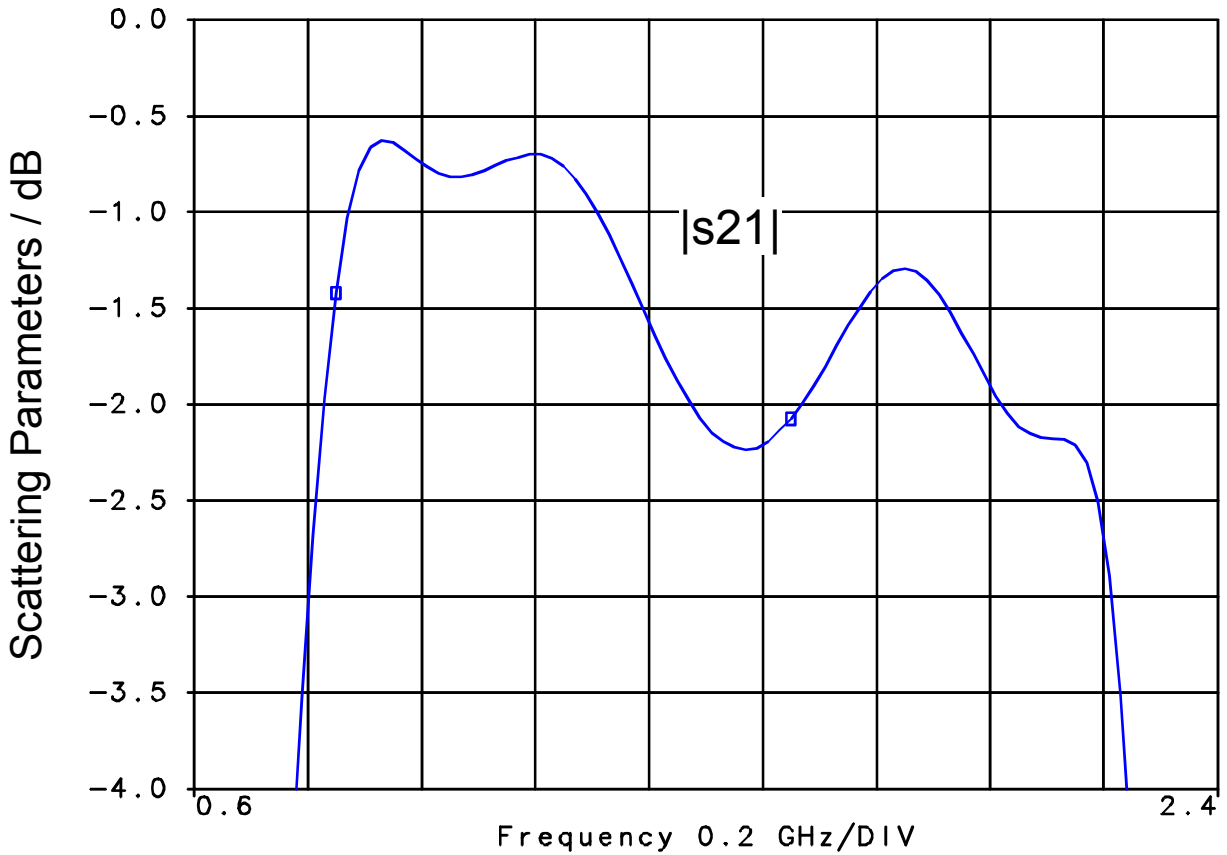
Comparison of simulation and measurement:

simulation without loss by EMPIRE

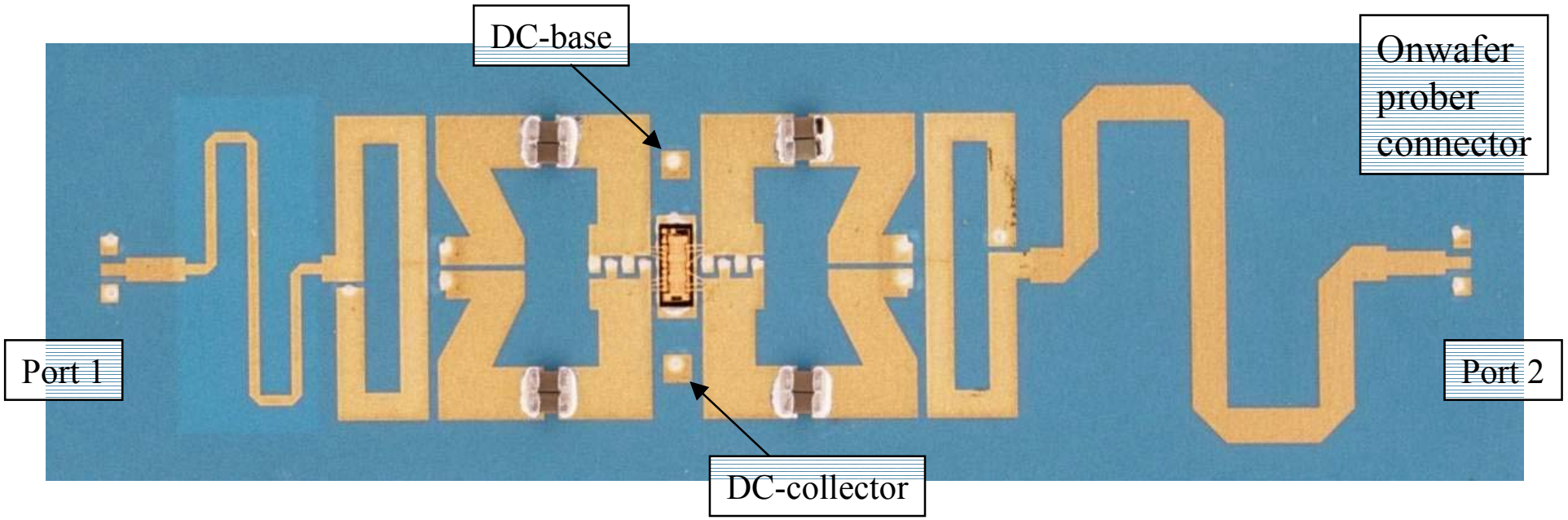


Back to back: results

measured loss in transmission of the back to back-setup



Amplifier on LTCC



Matching line at input

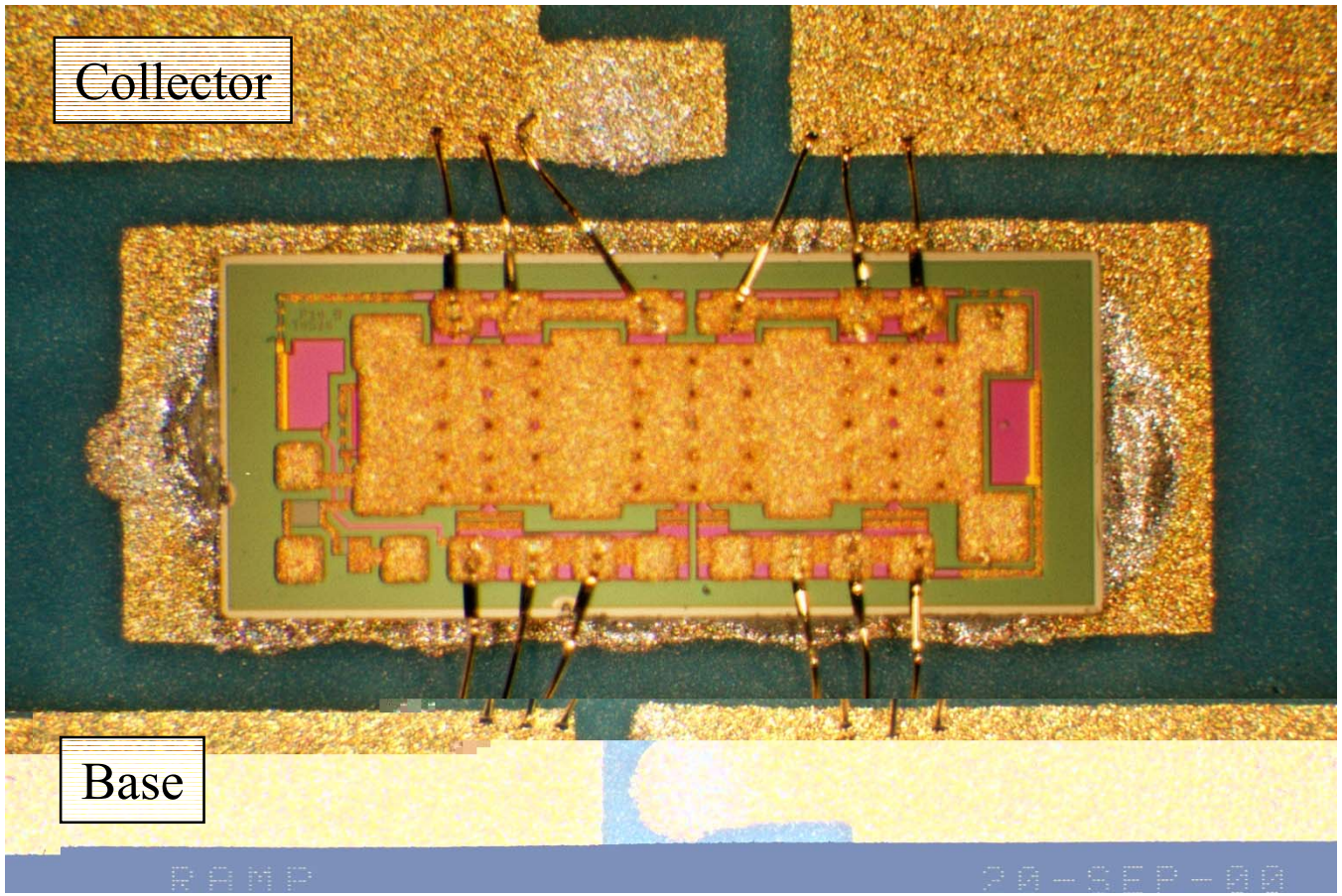
Input balun

Double HBT

Output balun

λ/4-transformator at output: Zl=32 to 50 Ω

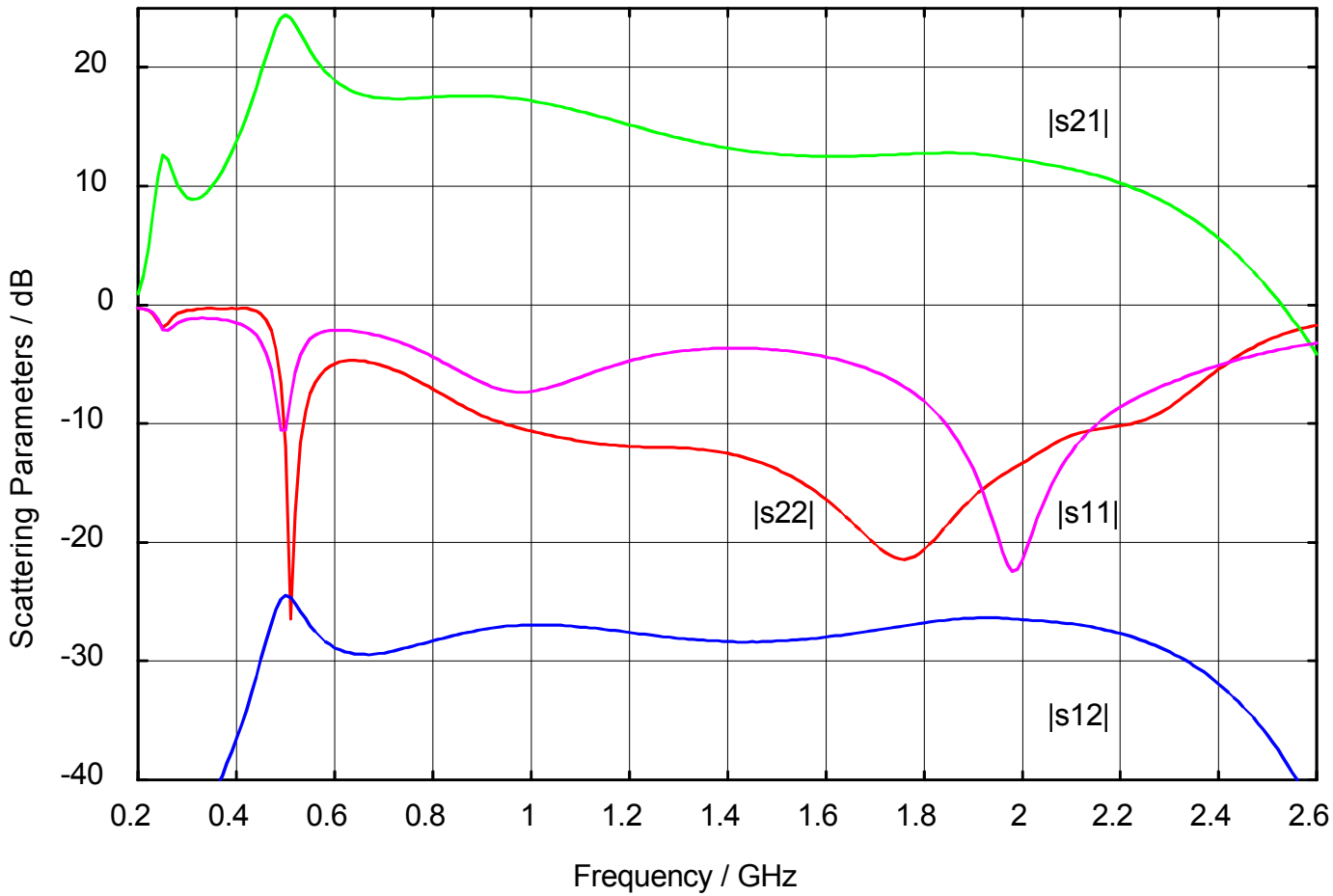
Chip connection



HBT-Chip from infineon

Measurement: small signal

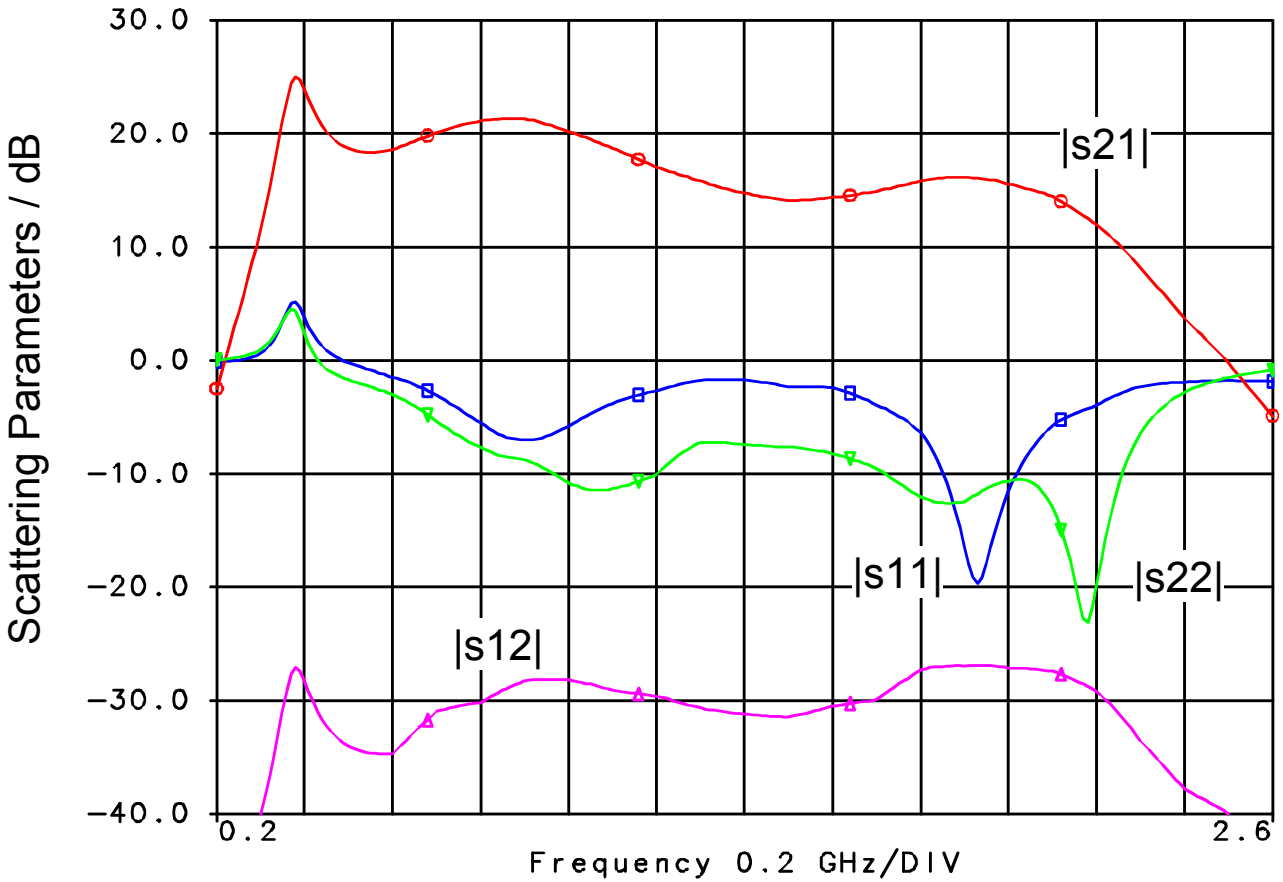
Trafo-Balun-HBT(AP 7mA/3,5V DUT; Ic=0,50A)-Balun-Trafo: Pin < -5dbm



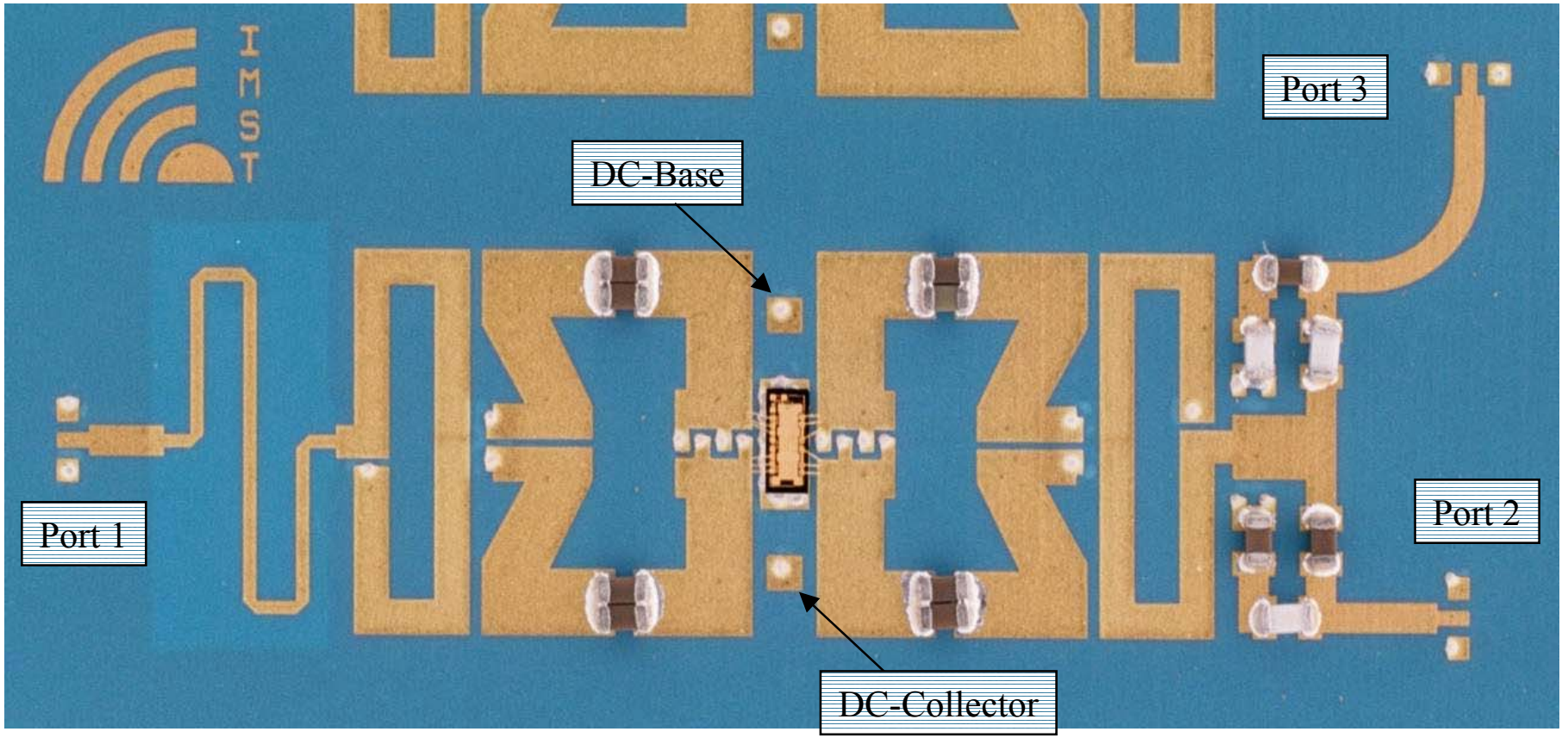
Simulation: small signal

Simulation with
s2p-file of the HBTs:

Resonance below
the used frequency band
similar to the
measurement



Amplifier with Diplexer



Matching line at input

Input balun

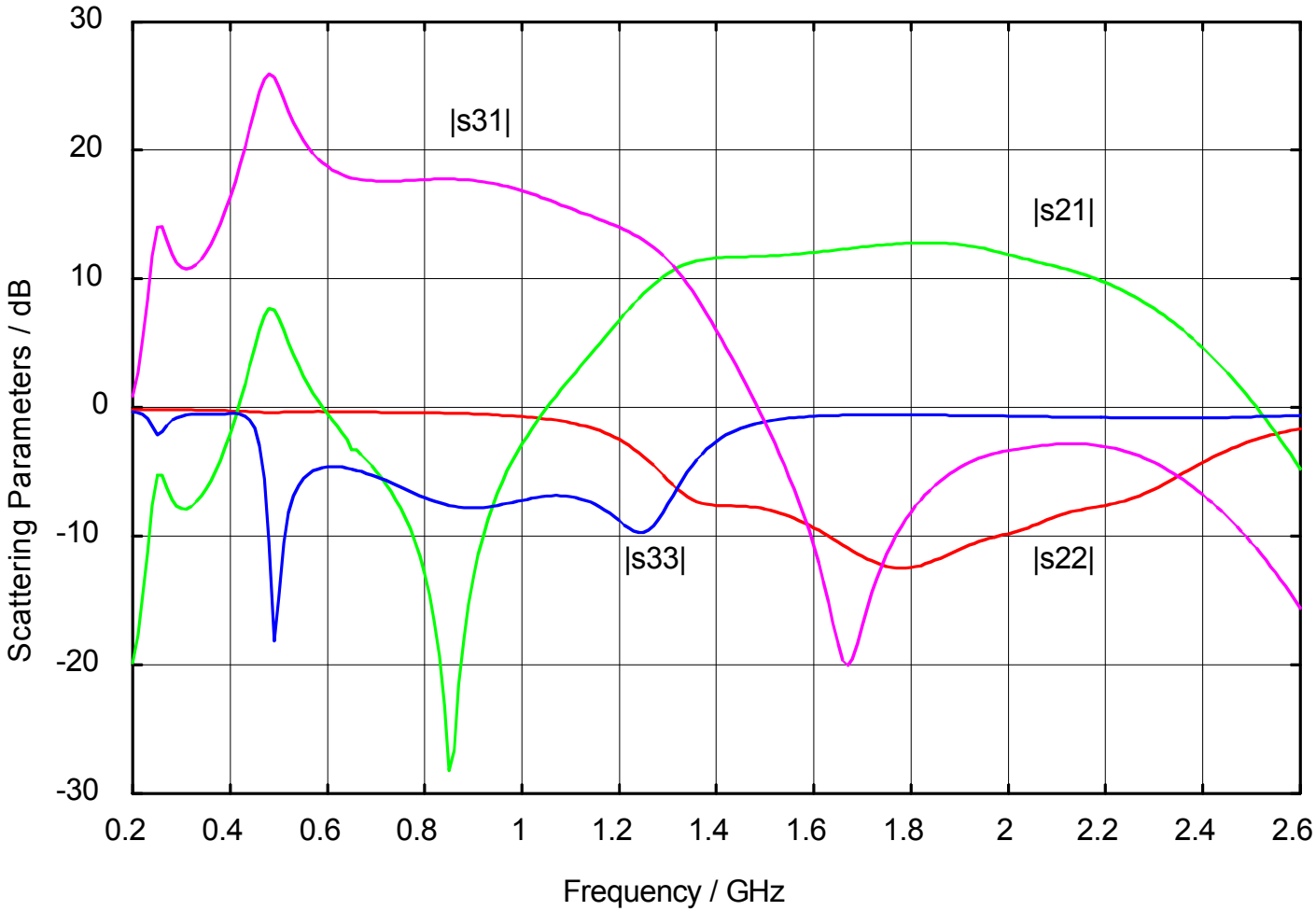
HBT Chip

Output balun

Diplexer

Amplifier with Diplexer

Trafo-Balun-HBT(AP 7mA/3,5V DUT; Ic=0,60)-Balun-Diplexer: Pin < -5dbm



Conclusion

- ☑ A broadband balun structure on LTCC has been presented
- ☑ LTCC offers good reproducibility and flexibility for such a structure (various layer thickness)
- ☑ Push-pull amplifier with baluns on LTCC successfully designed, fabricated and tested
- ☑ Space reduction by using inner layers for baluns is possible