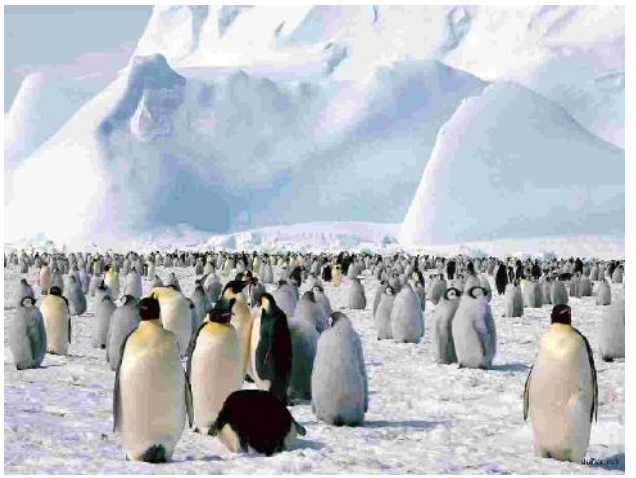
NMDG
LEADING BEYOND S-PARAMETERS

Spurious and Stability Analysis under Large-Signal Conditions

using your Vector Network Analyser



An application of ICE

June 2012

Outline

- Why combining Large-Signal and Small-Signal Measurements
- Block Diagram
- Practical Setup
- S-parameters
- Stability Criteria
- Large-Signal Measurements
- References and Acknowledgements
- Conclusions

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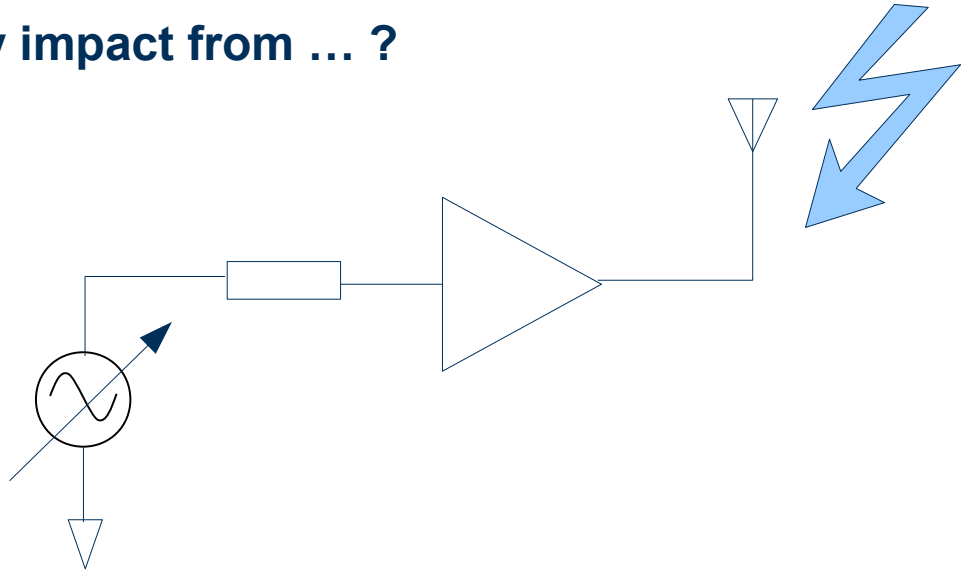
Why combining Large-Signal and Small-Signal Measurements

How to quantify impact from … ?



SPURIOUS SIGNALS

INTERFERENCE

S-parameters, usually measured under small-signal conditions, provide

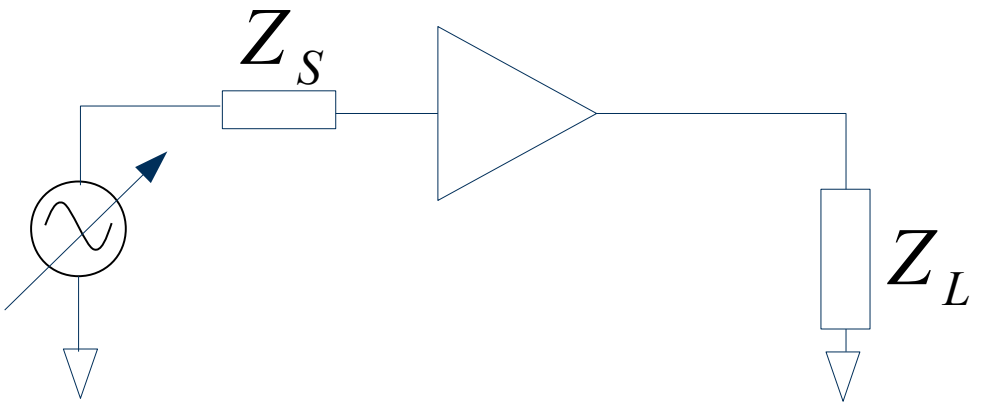
- good insight in the linear behaviour of a amplifiers
- provide insight in the stability of the amplifier

S-parameters, measured under large-signal conditions, provide

- good insight in what happens with spurious signals and interference signals

Why combining Large-Signal and Small-Signal Measurements

Under different large signal conditions … what about … ? **STABILITY**



S-parameters, usually measured under small-signal conditions, provide

- good insight in the linear behaviour of a amplifiers
- provide insight in the stability of the amplifier

S-parameters, measured under large-signal conditions, provide

- provide insight in the stability of the amplifier as conditions change

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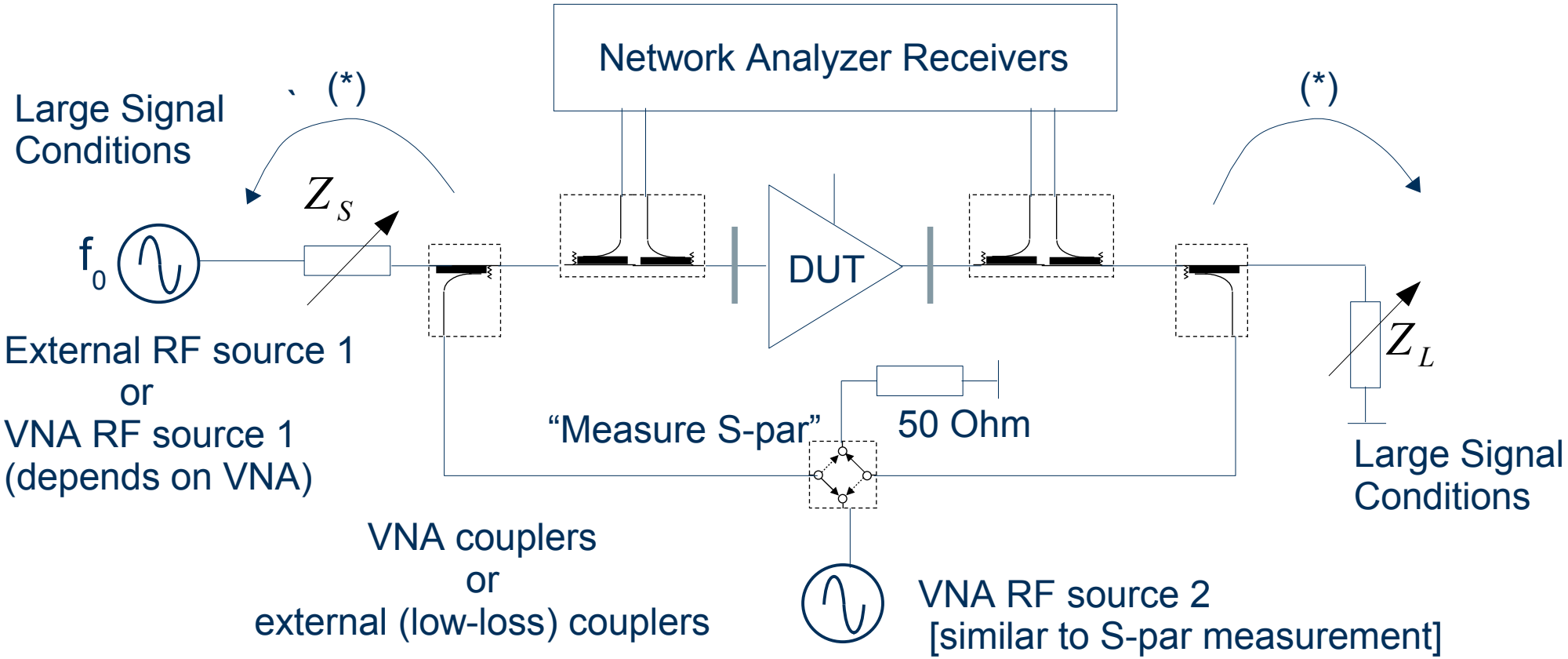
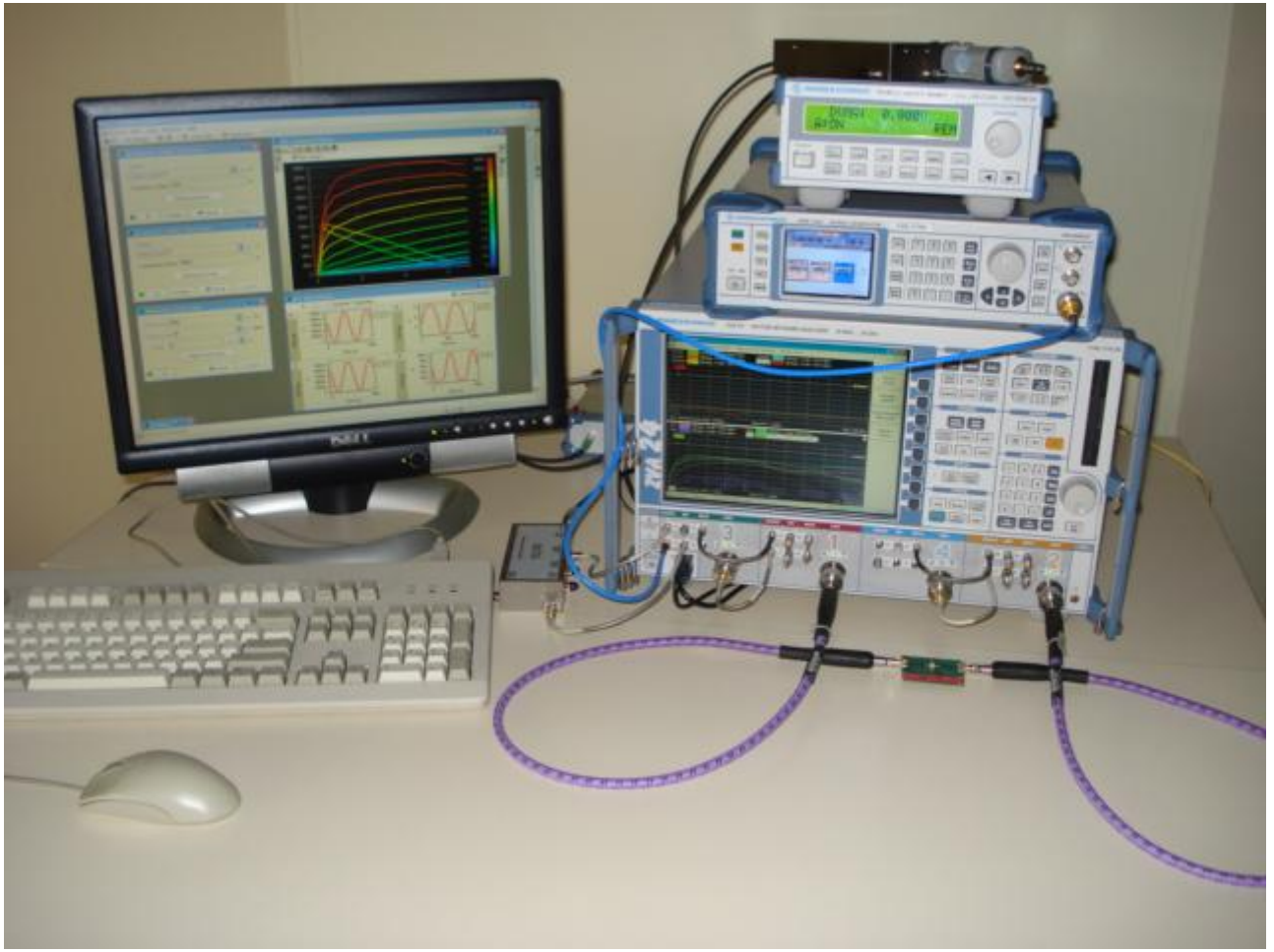
Block Diagram

Measure | at large-signal frequency grid and
at small-signal frequency grid, sweeping source 2

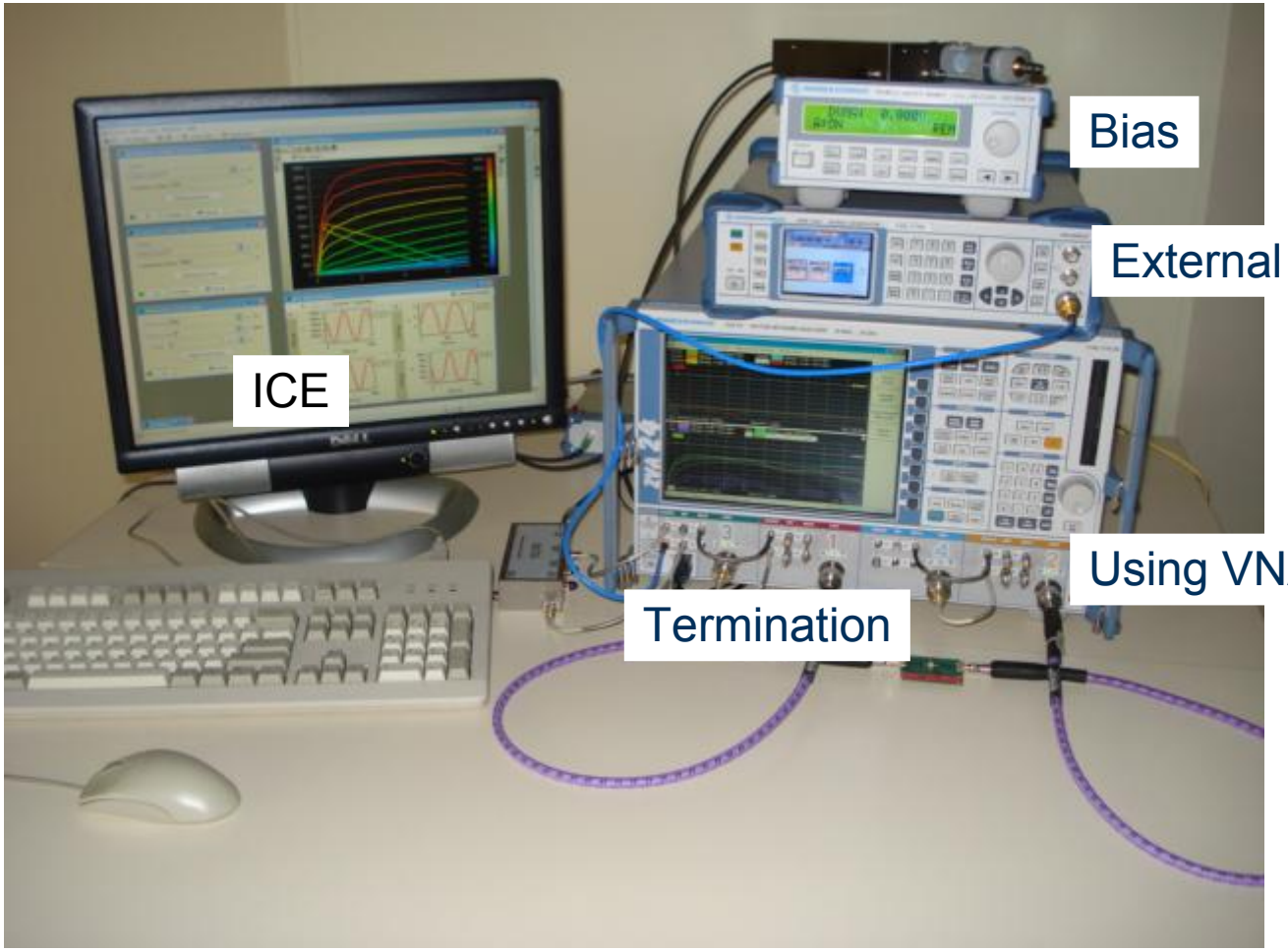


—— Absolute Calibration Planes

(*) Other configurations possible, e.g. position couplers, use of splitters, depending on power requirements



Practical Setup



FET Gate bias: -1.2 V (class A)
Drain bias: 4 V

Increasing input power and different terminations

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“Channel” capability of the ZVA 24

Using Rohde&Schwarz ZVA capability to configure different “channels”

Each channel has	his own specific hardware configuration measured data

The Rohde&Schwarz ZVA switches fast from channel to channel

ZVA24 Display

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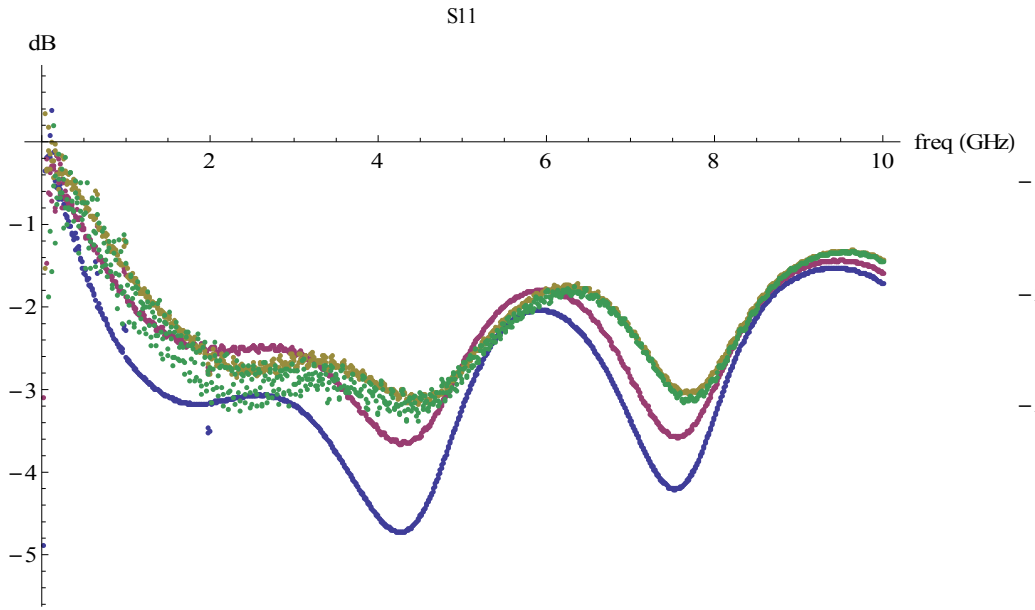
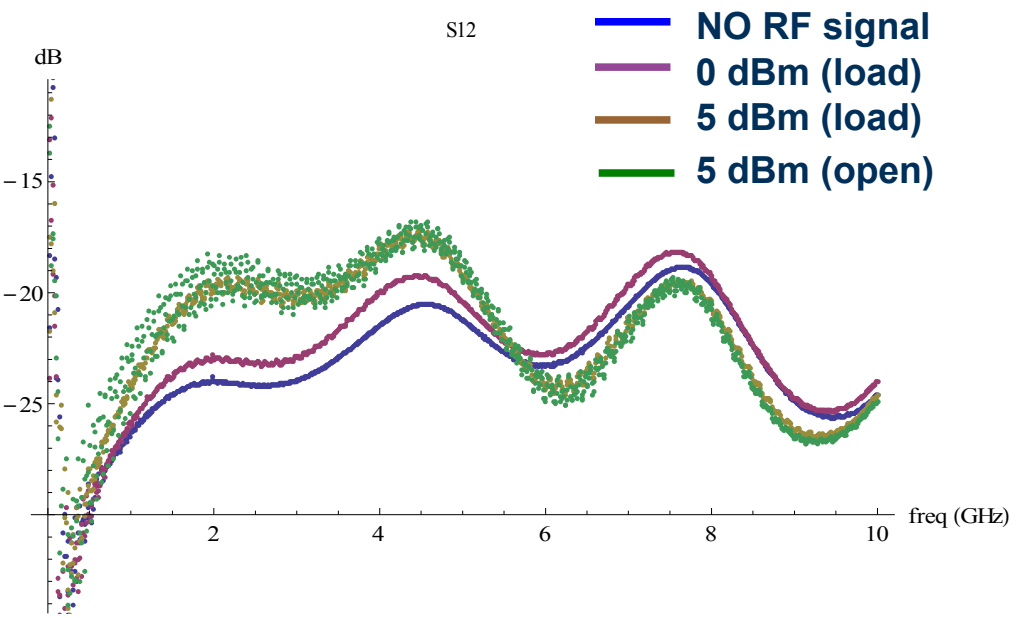
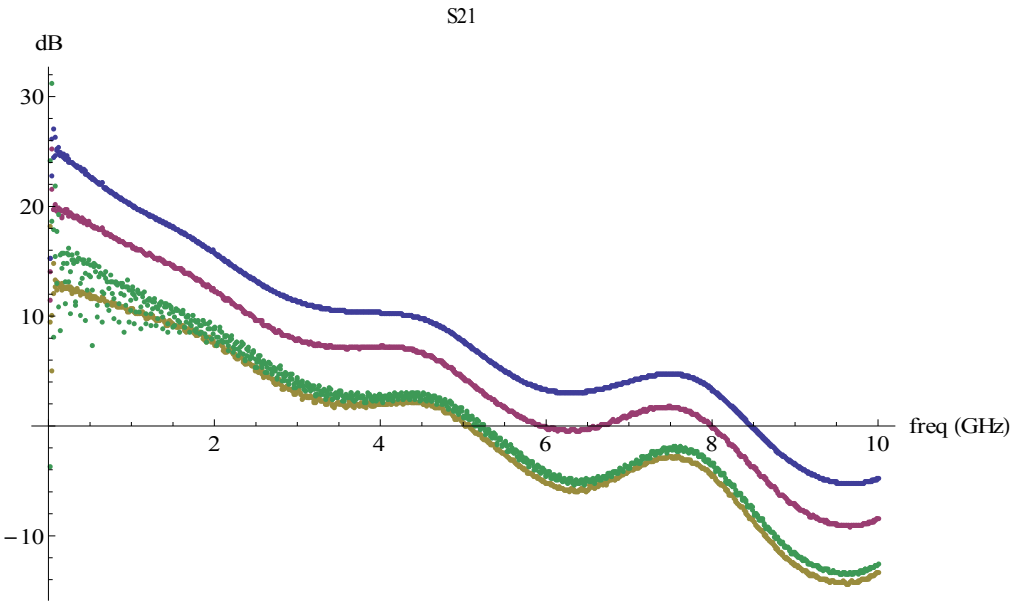
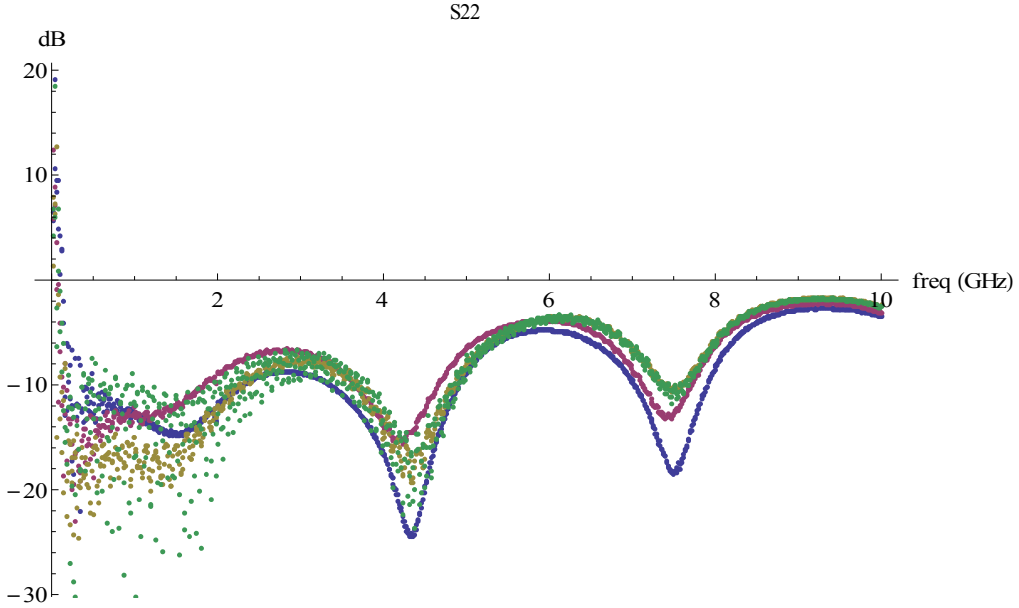
S-parameters under different large-signal conditions





NO RF signal
0 dBm (load)
5 dBm (load)
5 dBm (open)





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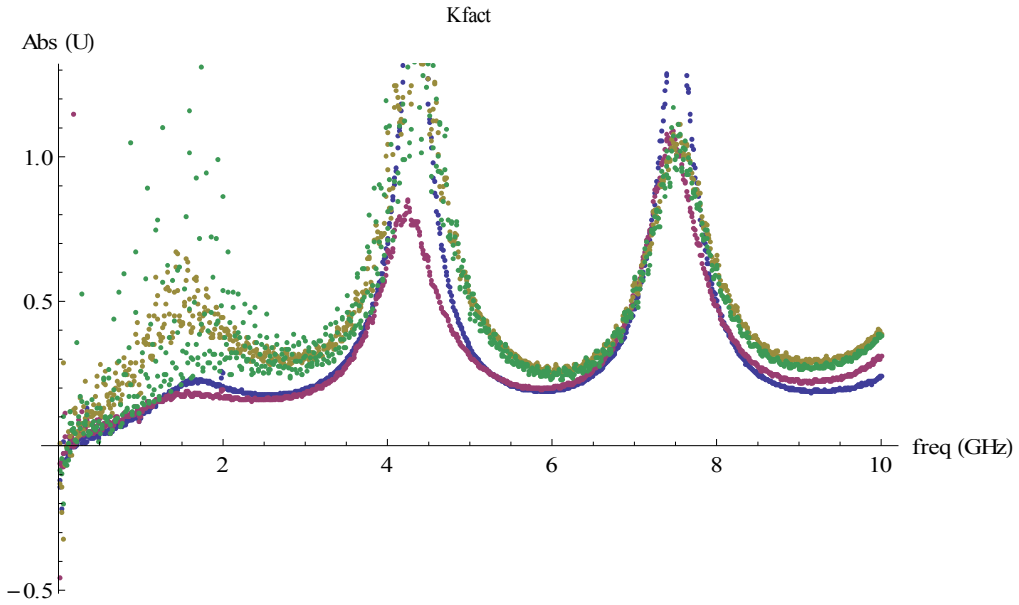
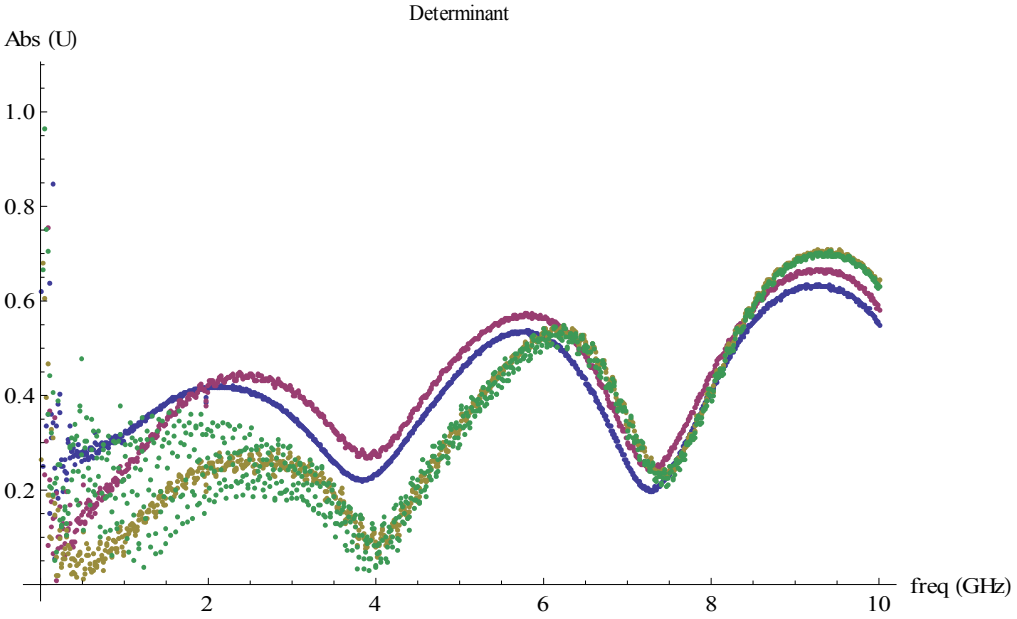
Stability K-Factor and Determinant





Stability Conditions

$$|K|>1 \text{ and } |\Delta|<1$$

- NO RF signal
- 0 dBm (load)
- 5 dBm (load)
- 5 dBm (open)

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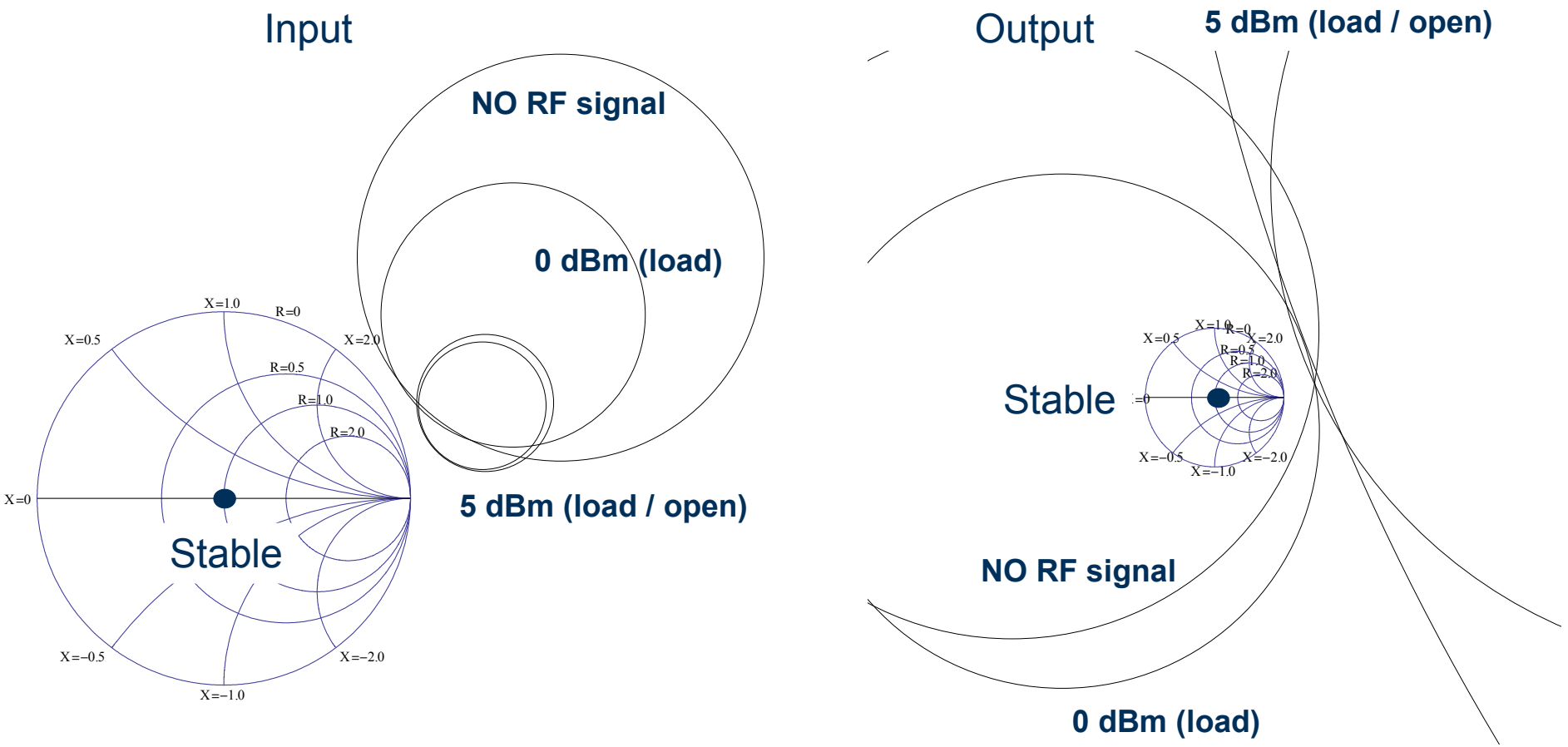
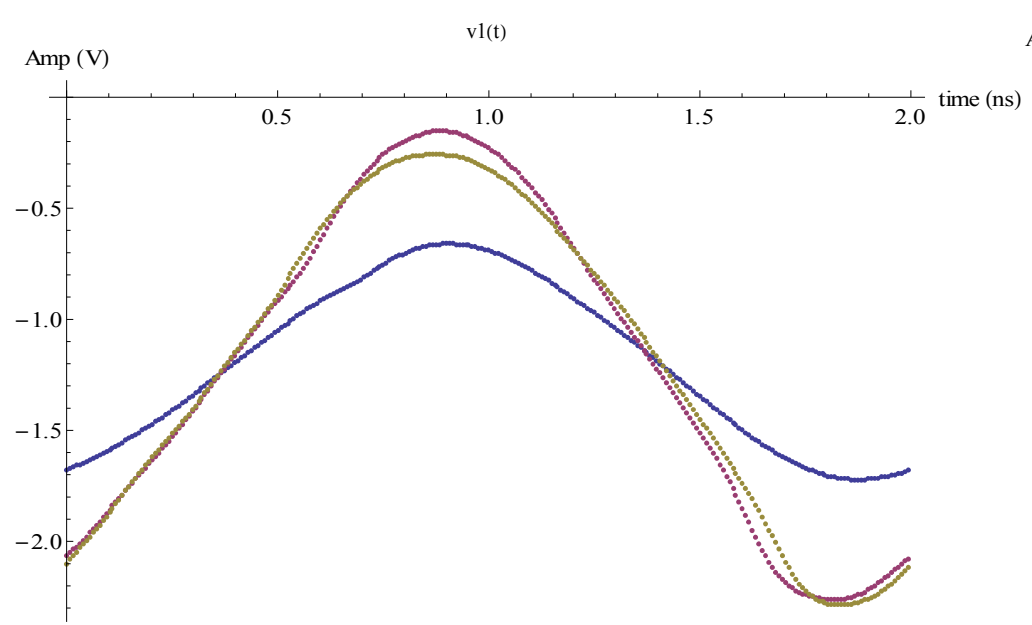
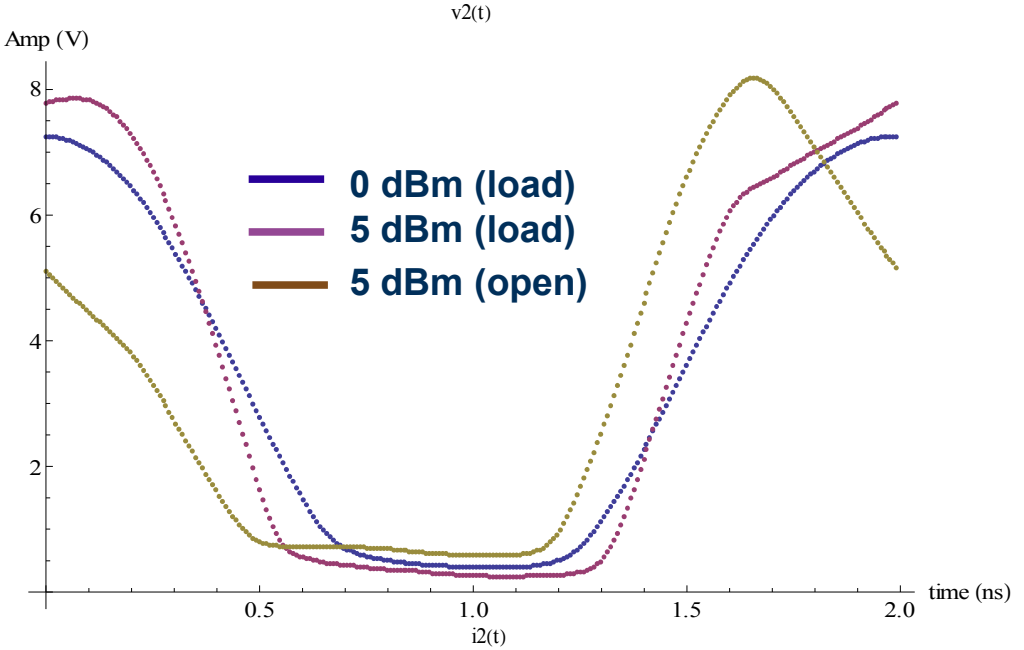
Input and Output Stability Circles

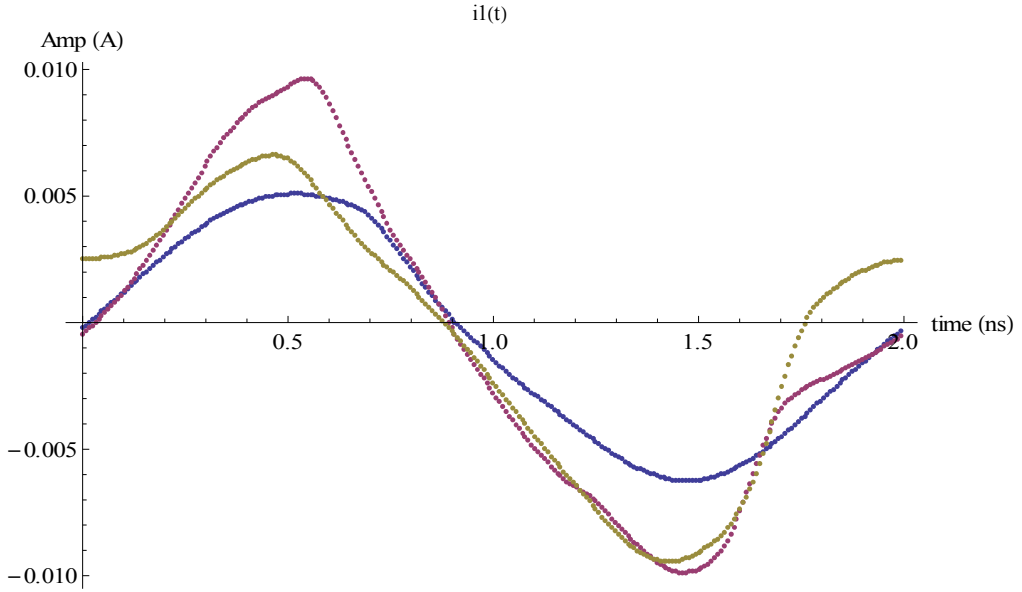


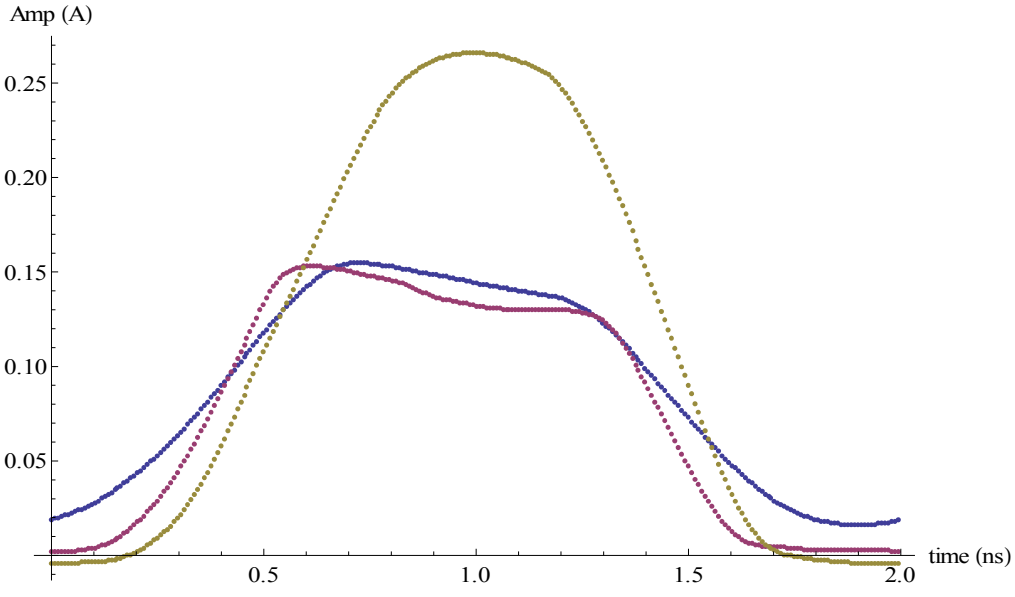
Frequency: 4.2 GHz

Large-Signal Conditions while measuring S-parameters









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References and Acknowledgements

- “A New Characterization Technique of “Four Hot S-parameters” for the Study of Nonlinear Parametric Behaviors of Microwave Devices”, T. Gasseling, D. Barataud, et alii, 2003 IEEE MTT-S Digest, p. 1663

- Thanks to Rohde & Schwarz for providing the R&S ZVA network analyzer equipment and the support around the network analyzer

- Thanks to Focus Microwaves for providing the tuners and the good cooperation

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Conclusions

- It is straightforward with a Rohde & Schwarz network analyzer to measure the small-signal behaviour while applying and measuring the large-signal conditions

- With the S-parameters it is possible to get better insight when spurious signals are applied to the component or interference signals are picked up, e.g. RF front-end picking up signals

- The S-parameters result in different stability criteria. This is evenly important as the large-signal performance, designing active circuits, like amplifiers

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