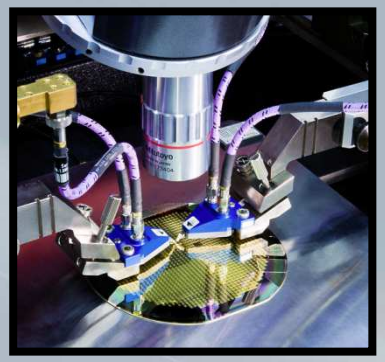
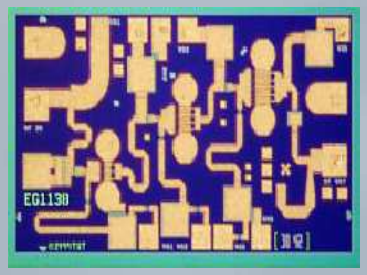
Amplifier Measurements including High Power Amplifiers







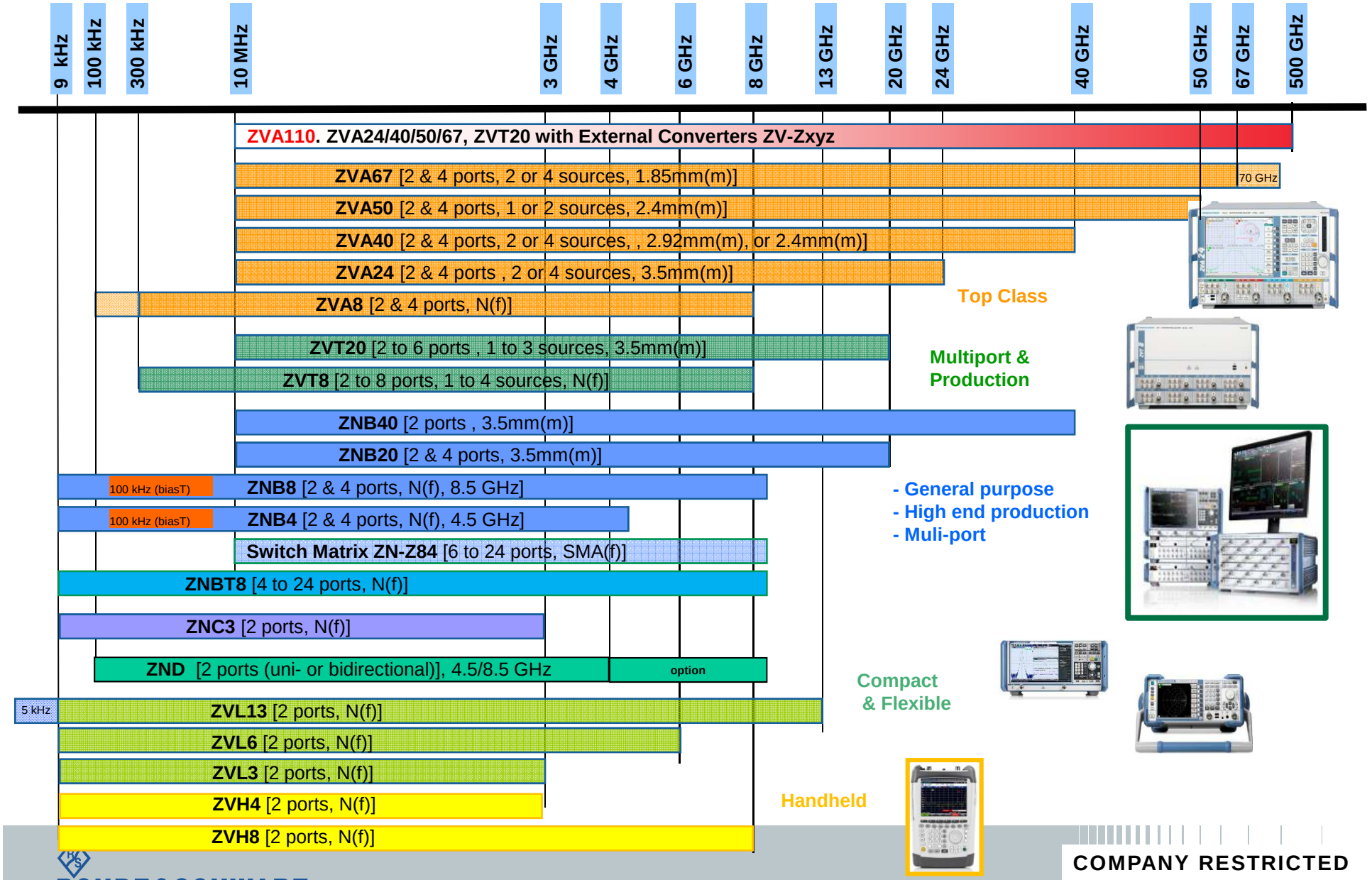
ROHDE&SCHWARZ

COMPANY RESTRICTED

Agenda

9:00 - 9:30	Welcome and visit to MPI prober station	Henkel
9:30 - 9:45	Coffee break	
9:45 - 10:30	Presentation about R&S ZVA for active component measurements	Henkel
10:30 - 11:30	Presentation CM+	Williams
11:30 - 13:00	Lunch (Casino)	
13:00 - 14:00	Presentation/Demonstration CML	Williams
1400 - 14:30	Coffee Break	
14:30 - 15:30	Presentation about Waveform Engineering	Williams
15:30 – 16:00	Final Discussion	

R&S Portfolio Network Analyzers



Amplifier Measurements
Overview

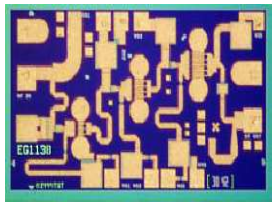


Linear Measurements

- Gain and Flatness
- Deviation from linear phase
- Group delay
- Return loss/SWR
- Stability (k and μ)
- Power added efficiency
- (True) Differential measurements

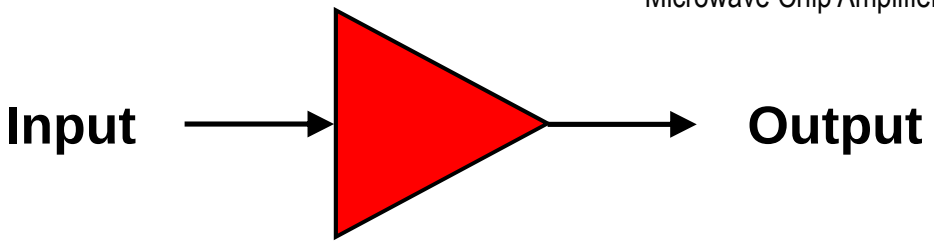
Nonlinear Measurements

- Compression
- AM/PM Conversion
- Harmonic Distortion
- Intermodulation



Microwave Chip Amplifier

- Hot S22
- Noise Figure
- Pulsed Meas.

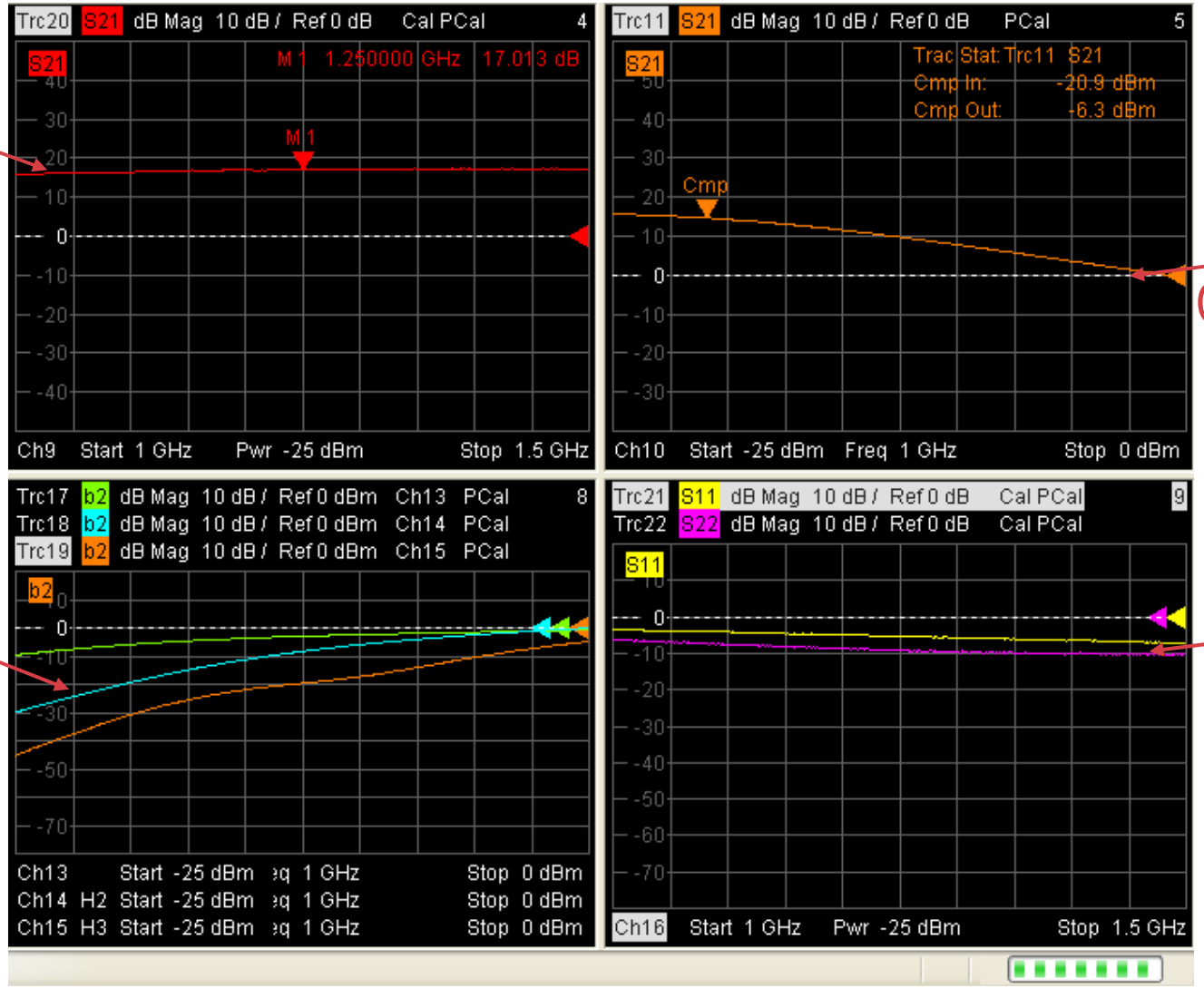


- High Power measurements

Amplifier Characterization - Examples

Gain

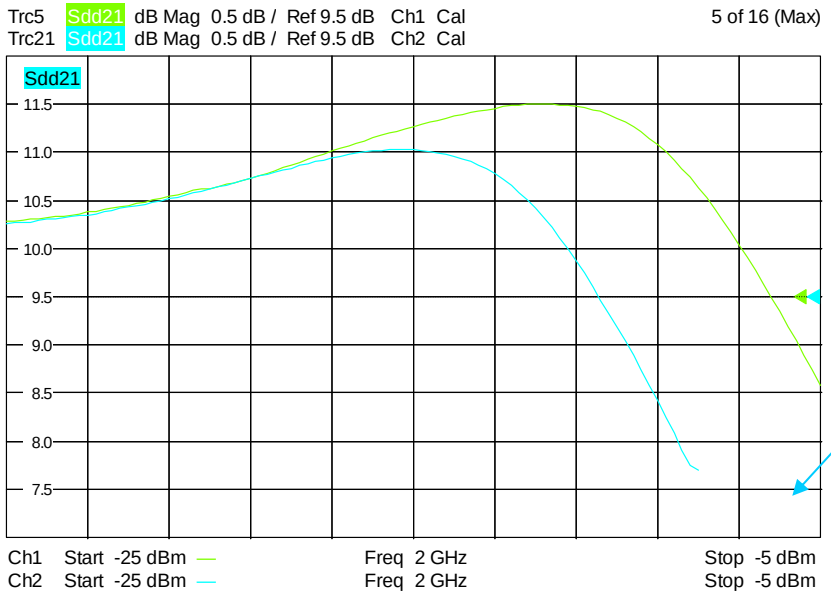
Harmonics



1dB Compression

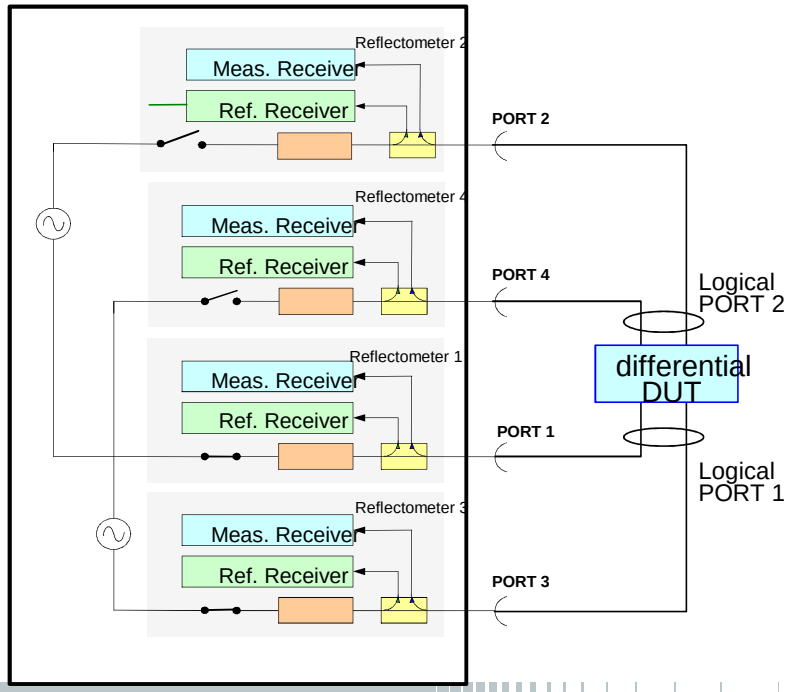
Input and Output Match

Differential measurements – Virtual and True

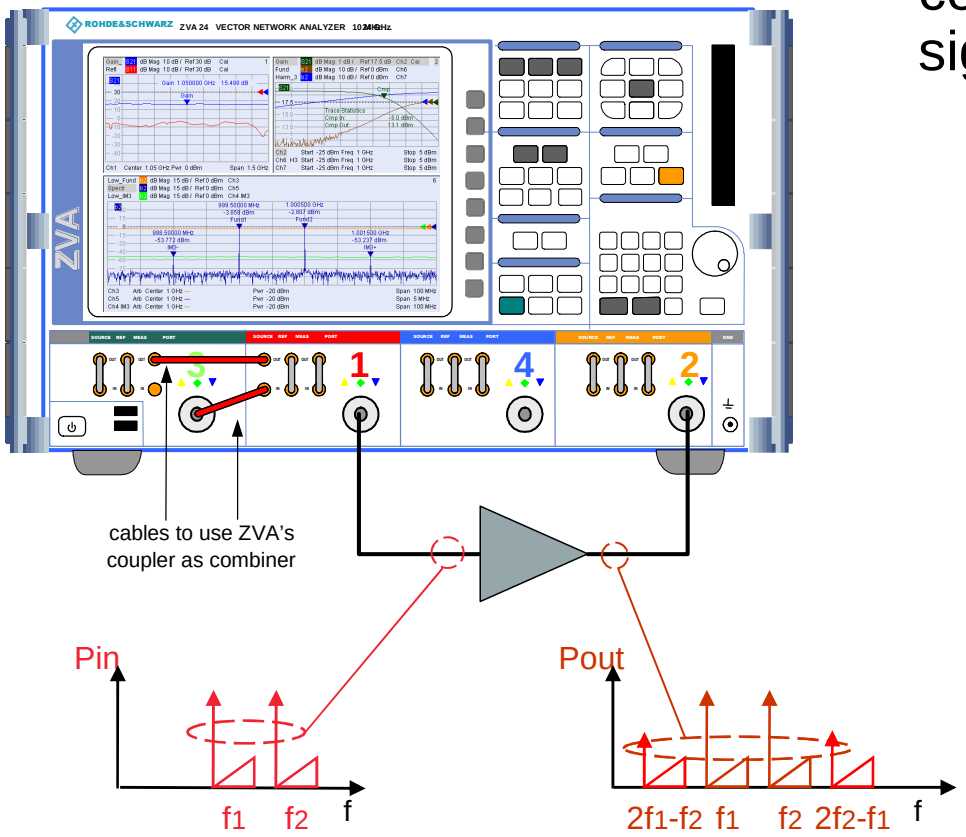


VirDi mode

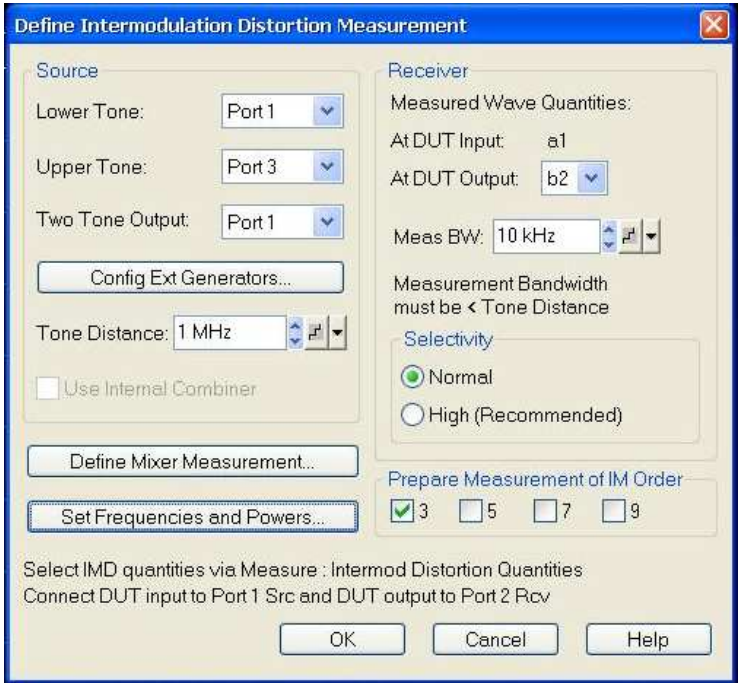
TruDi mode



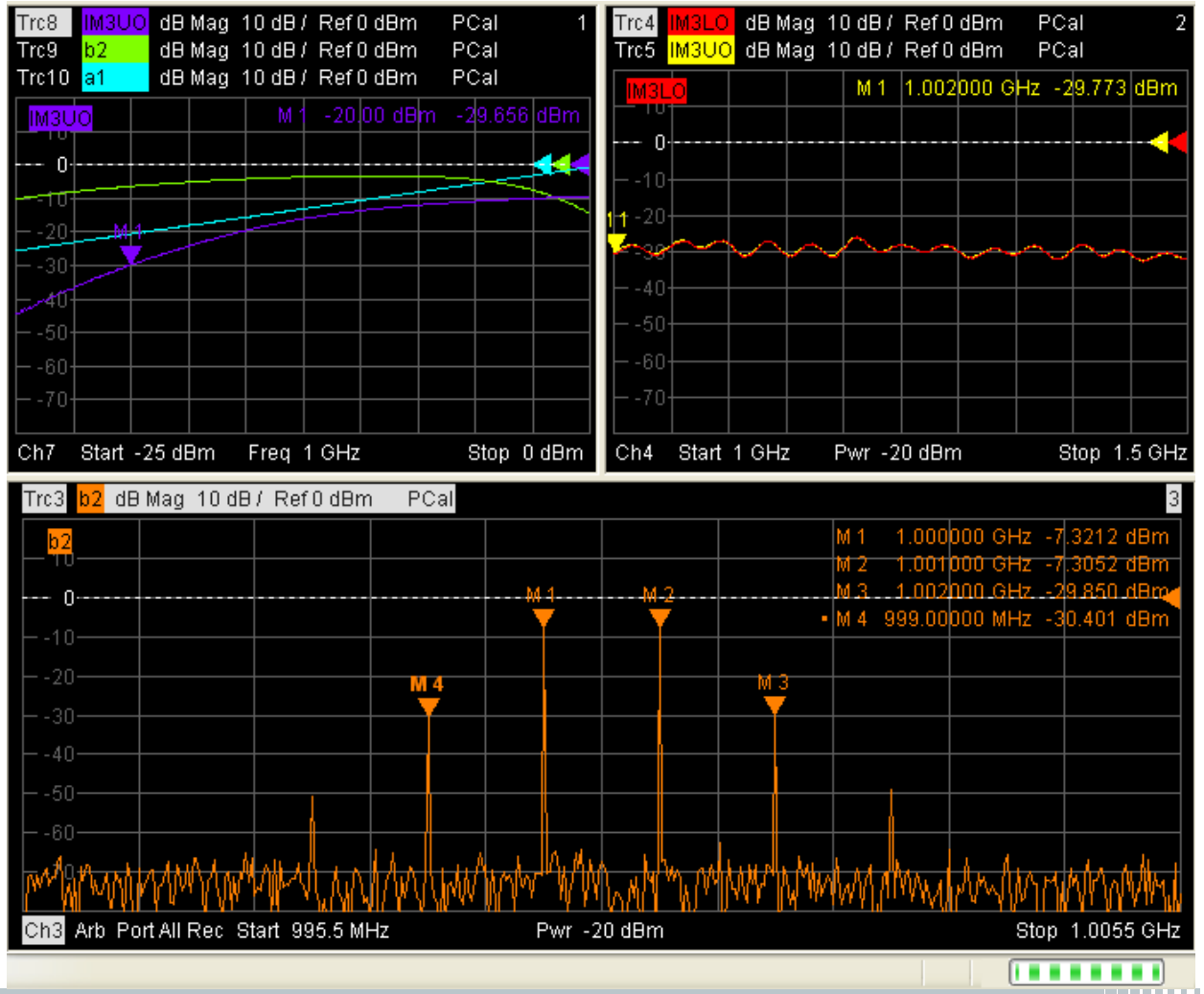
Amplifier Characterization - Intermodulation



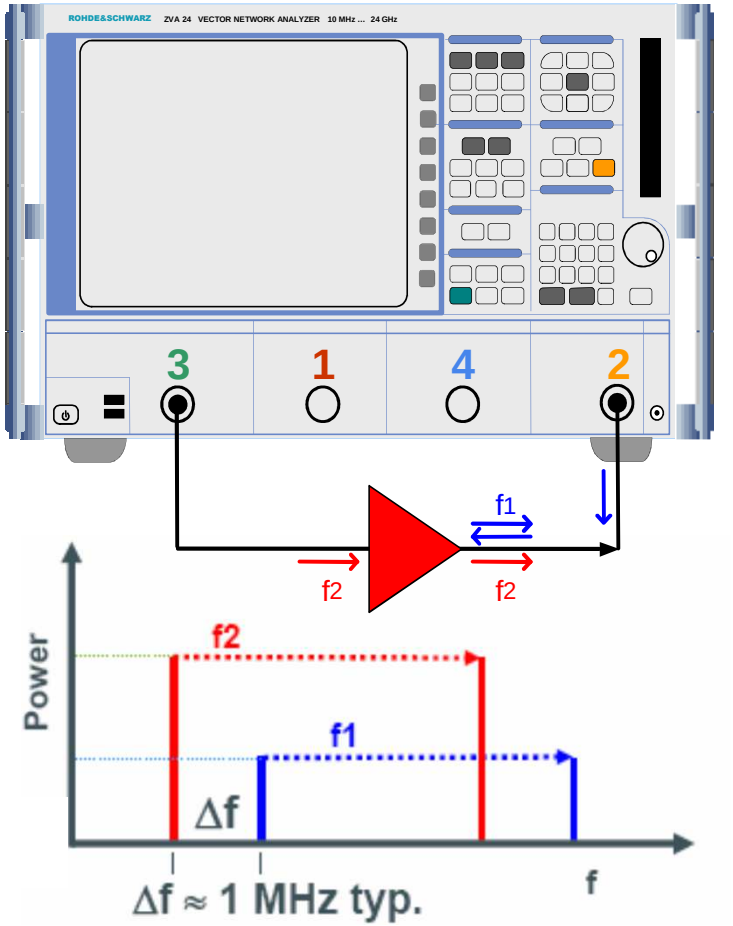
Internal coupler used as combiner to create 2-tone signal



Amplifier Characterization - Intermodulation



Amplifier Characterization – Hot S22 measurement

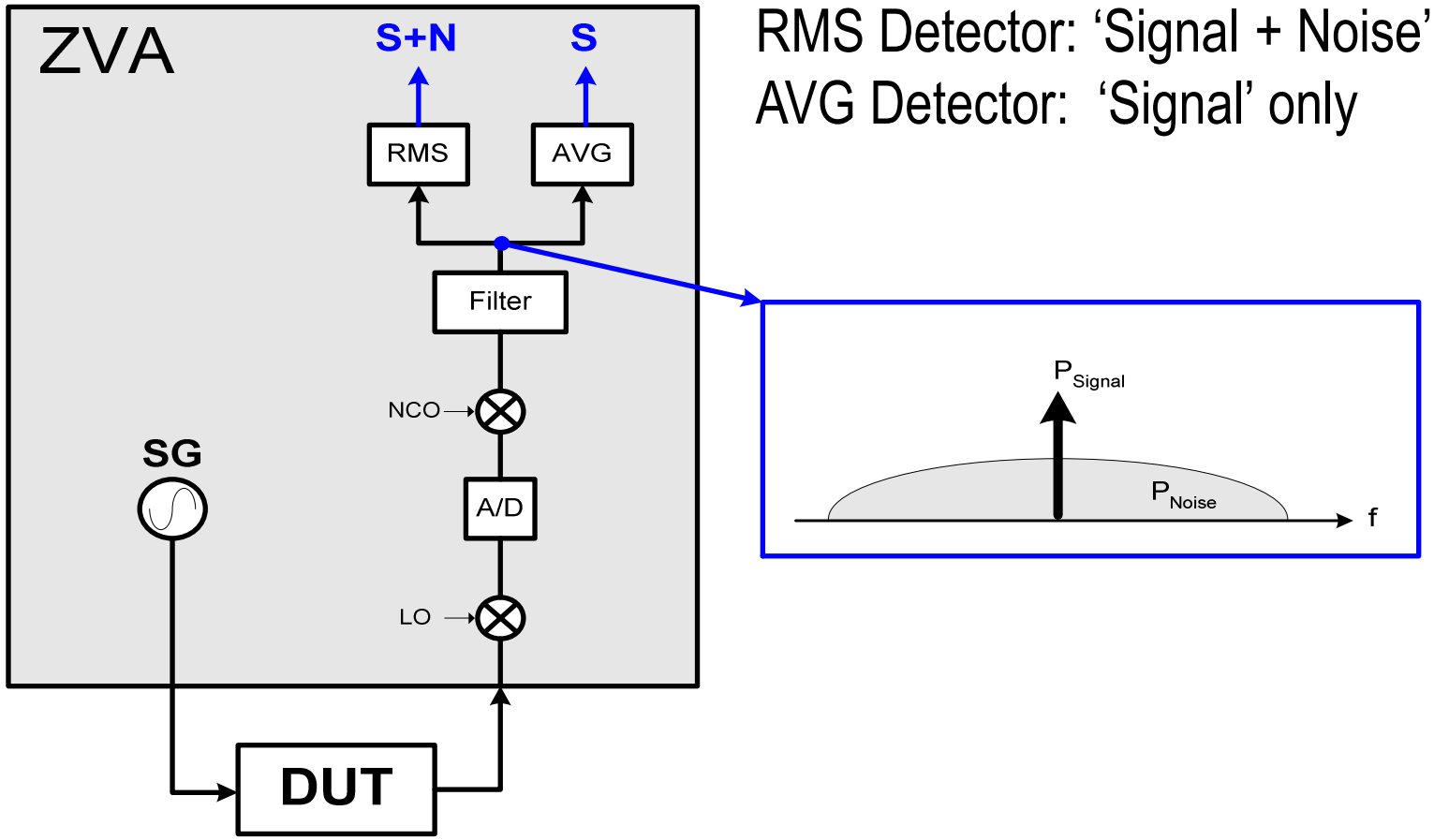


- **Driving signal from port 1**
  S_{22} Measurement signal from port 2
- **Frequency offset between signals : Selective receiver allows suppression of f2 and measurement of f1**
- **Nevertheless : Attenuators required for reduction of f2 power**
- **Consider remaining directivity**
- **Isolator may be required**

S_{22} under operating conditions

Amplifier Characterization – Noise Figure measurement

Simultaneous measurement with two detectors:
RMS und AVG



RMS Detector: 'Signal + Noise'
AVG Detector: 'Signal' only

Noise Figure and Gain Measurement results

Gain

Noise Figure

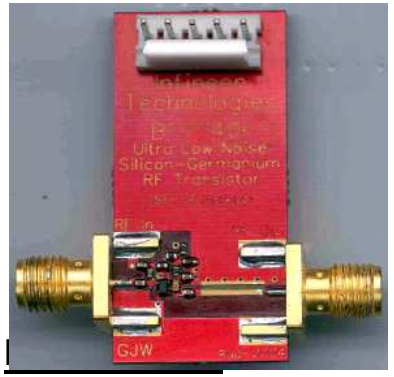


Noise Figure Measurement



Specification in brief:

DC Voltage: 3V
DC Current: 14.7mA @ 3V
Input Power: -25dBm



f [MHz]: 1475
NF [dB]: < 0.7
Gain [dB]: 19

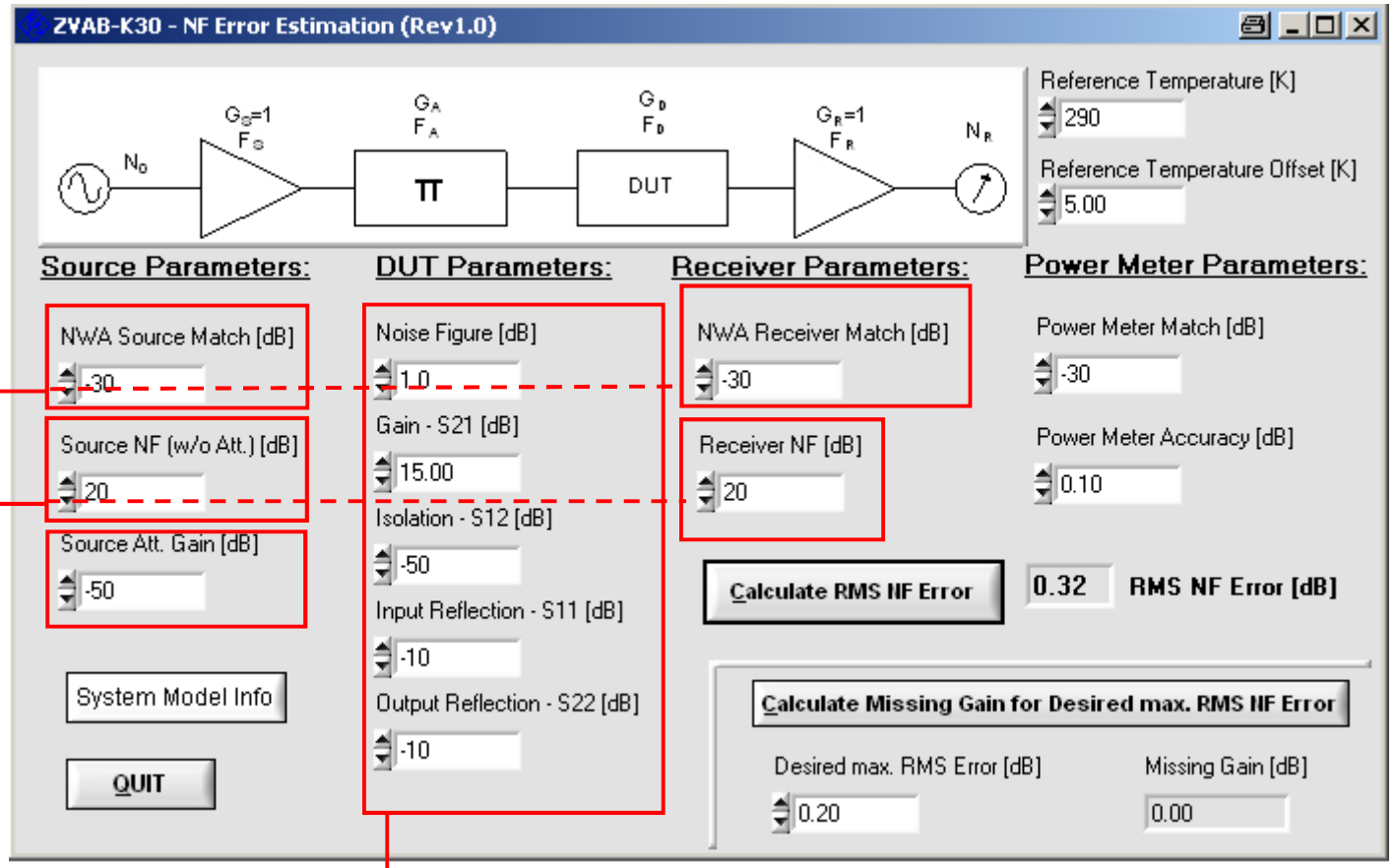
GPS-L1 Band

f [MHz]: 1575
NF [dB]: < 0.8
Gain [dB]: 19

PCS Band

f [GHz]: 1.93-1.99
NF [dB]: < 0.9
Gain [dB]: 18

Measurement uncertainty for NF



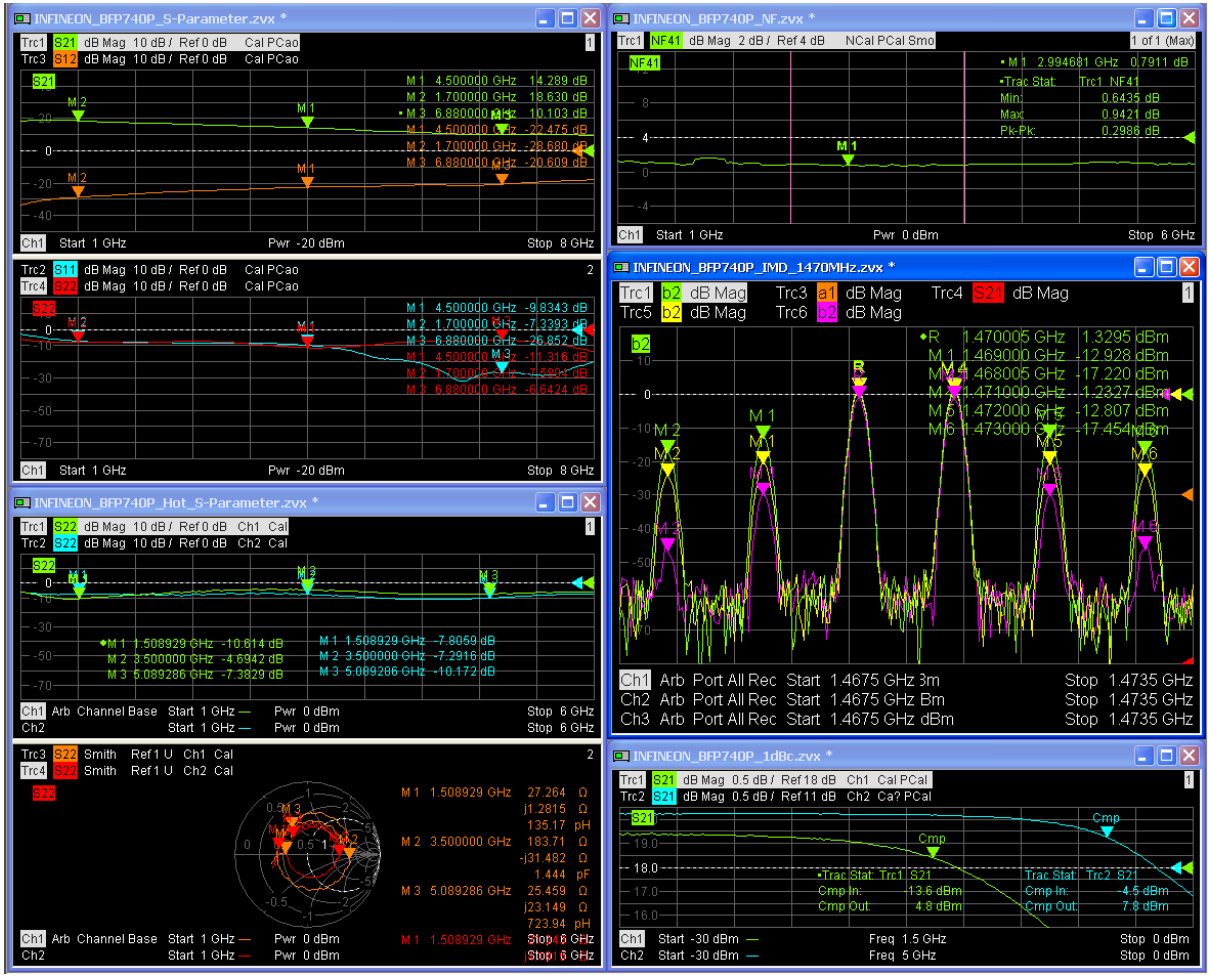
From NF Calibration

DUT Parameters

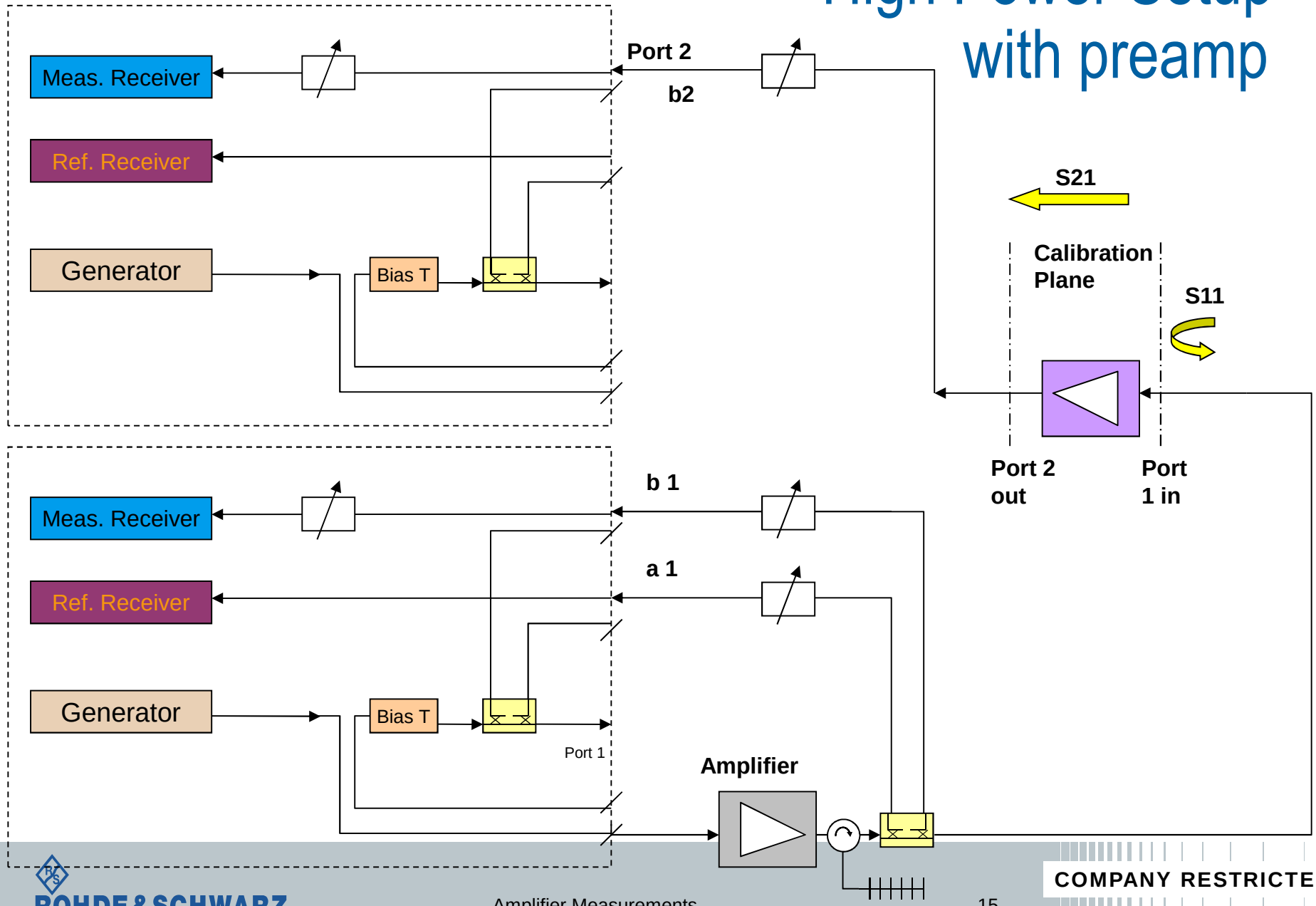
Single Connection Device Characterization

All measurements in a single connection

- No switches required
- No device reconnection
- Ideal for On-Wafer and production testing



High Power Setup with preamp

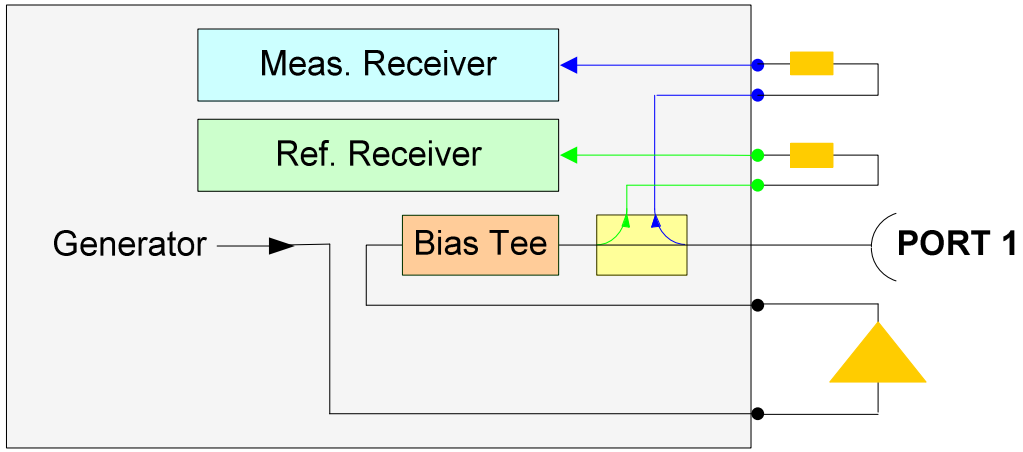


After Power Calibration

How to keep the Power constant during Measurement

Typical Application: Use of booster amplifier for high power levels

- Necessary for high power levels esp. at high frequencies
- Amplifier in the source path
- All calibrations possible
- Power change does not affect calibration



Typical problems:

- Thermal drift changes power level versus time
- Matching of DUT different to calibration state

ZVA Solution:

- Use of automatic level control (ALC)

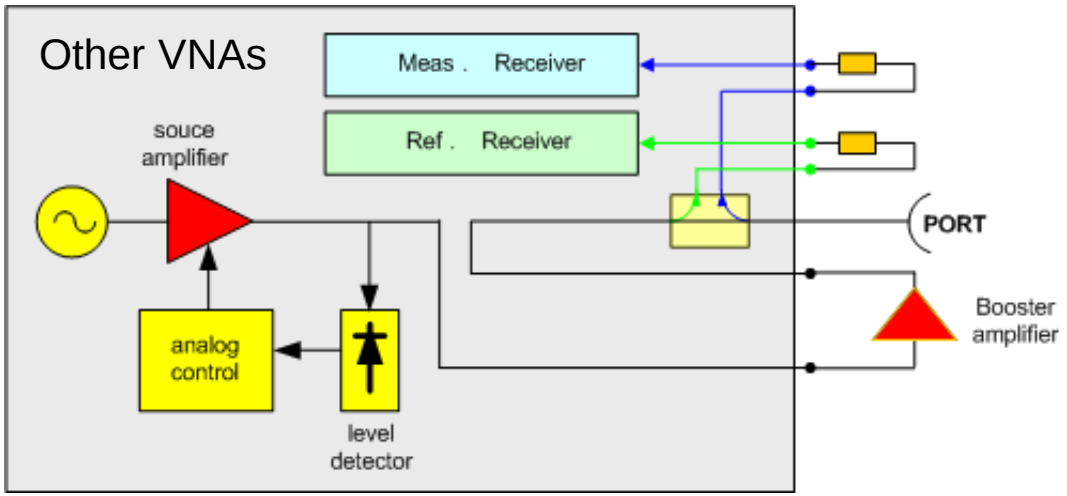
Typical Problem with other VNAs

- They use analog ALC (automatic level control)
- They use a power detector at output of source amplifier to measure Pout
- Analog control circuit controls source power

Problems :

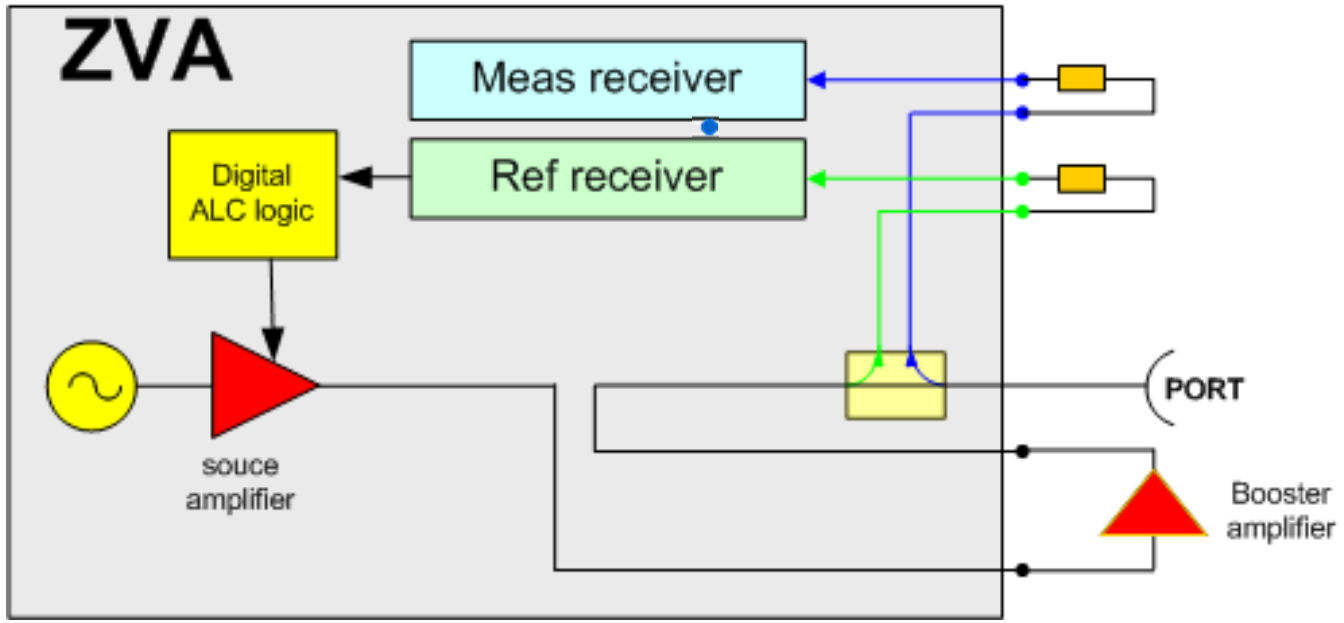
- Not possible to control the power of a booster amplifier

- Thermal drift of booster amplifier requires recalibration



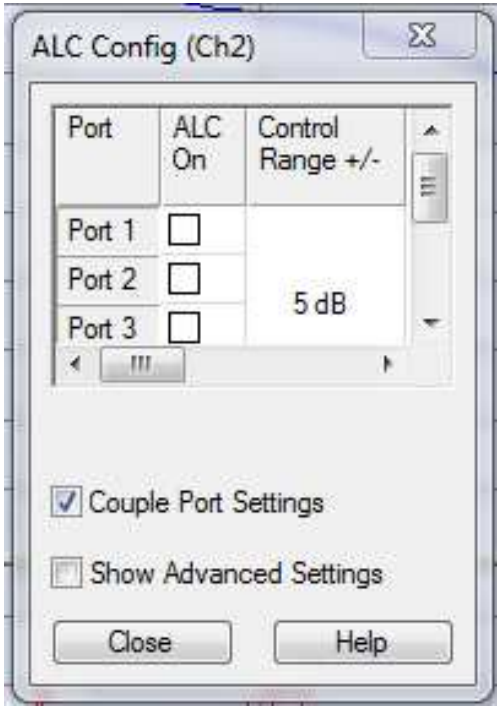
Special digital ALC in ZVA

- Additional digital path of ZVA for Automatic Level Control
- Measured reference signal is used for level control



Special digital ALC in ZVA

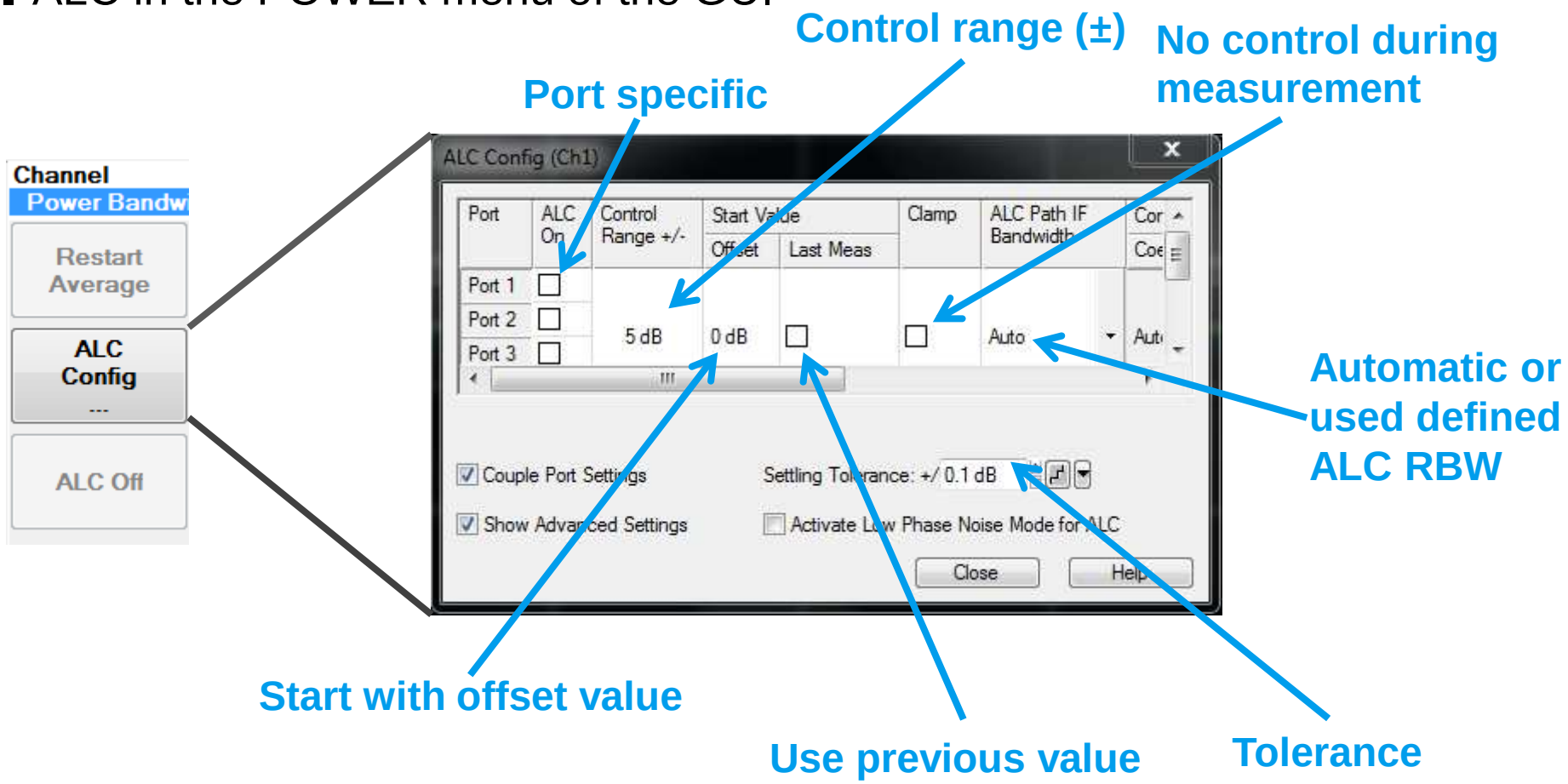
- Use of reference receiver takes booster amplifier into accout
  - No time dependence
  - No drift
  - No recalibration necessary
- Uses selective reference receiver
  - No influence of harmonics
  - High linearity
  - No influence of noise
- Access to all parameters of control logic



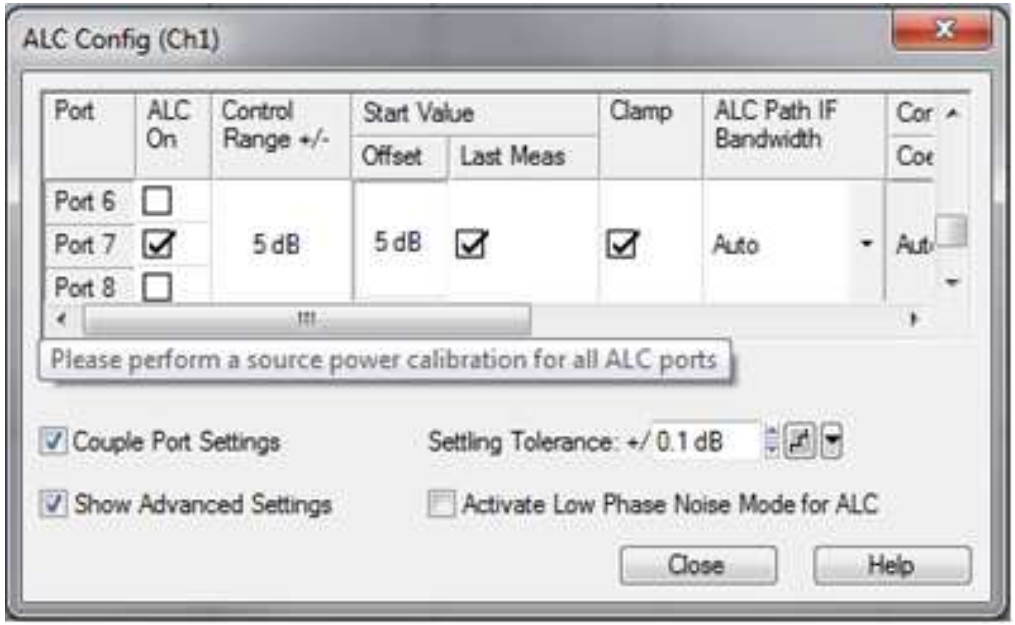
Separate activation for each port possible

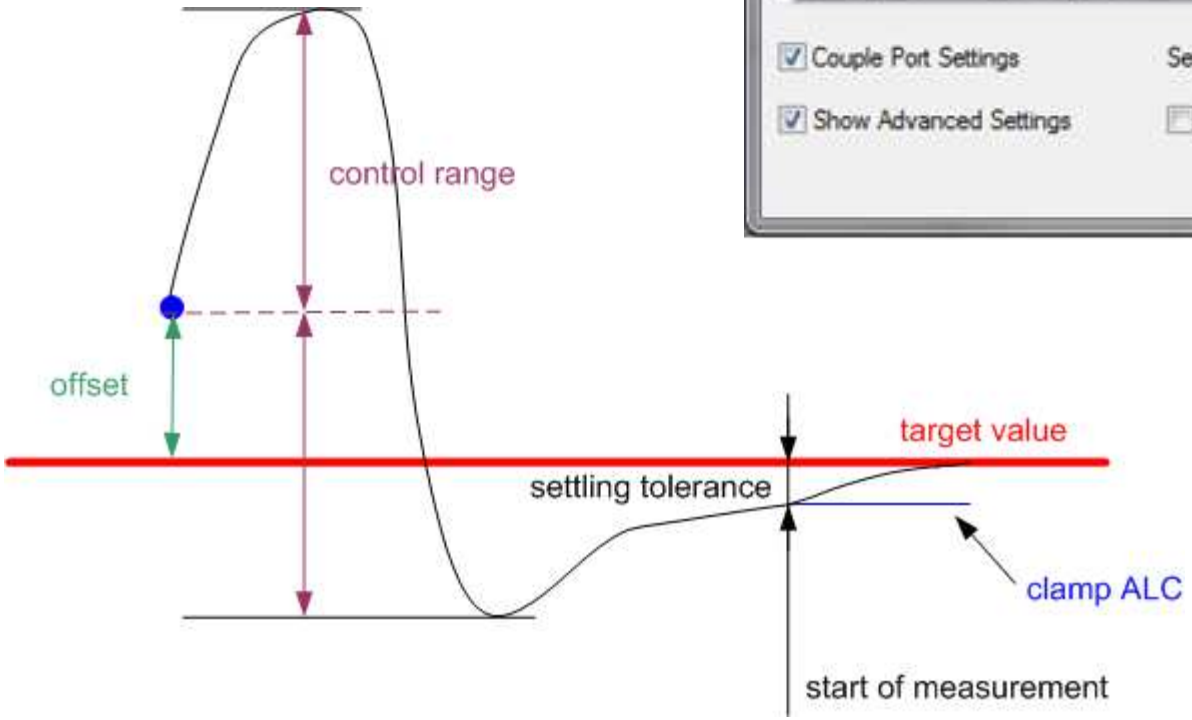
ALC Advanced Settings

- ALC in the POWER menu of the GUI

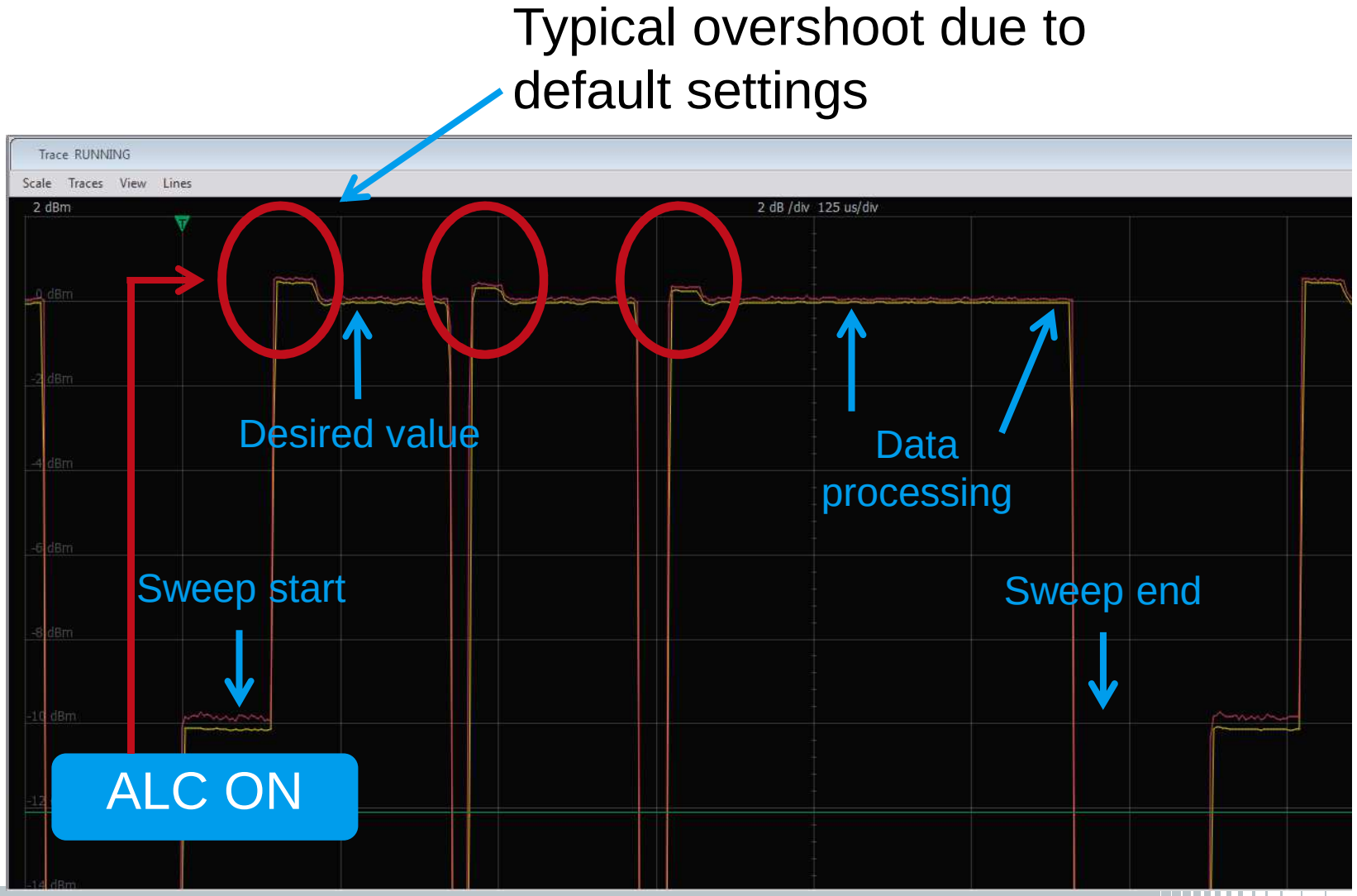


ALC Concept

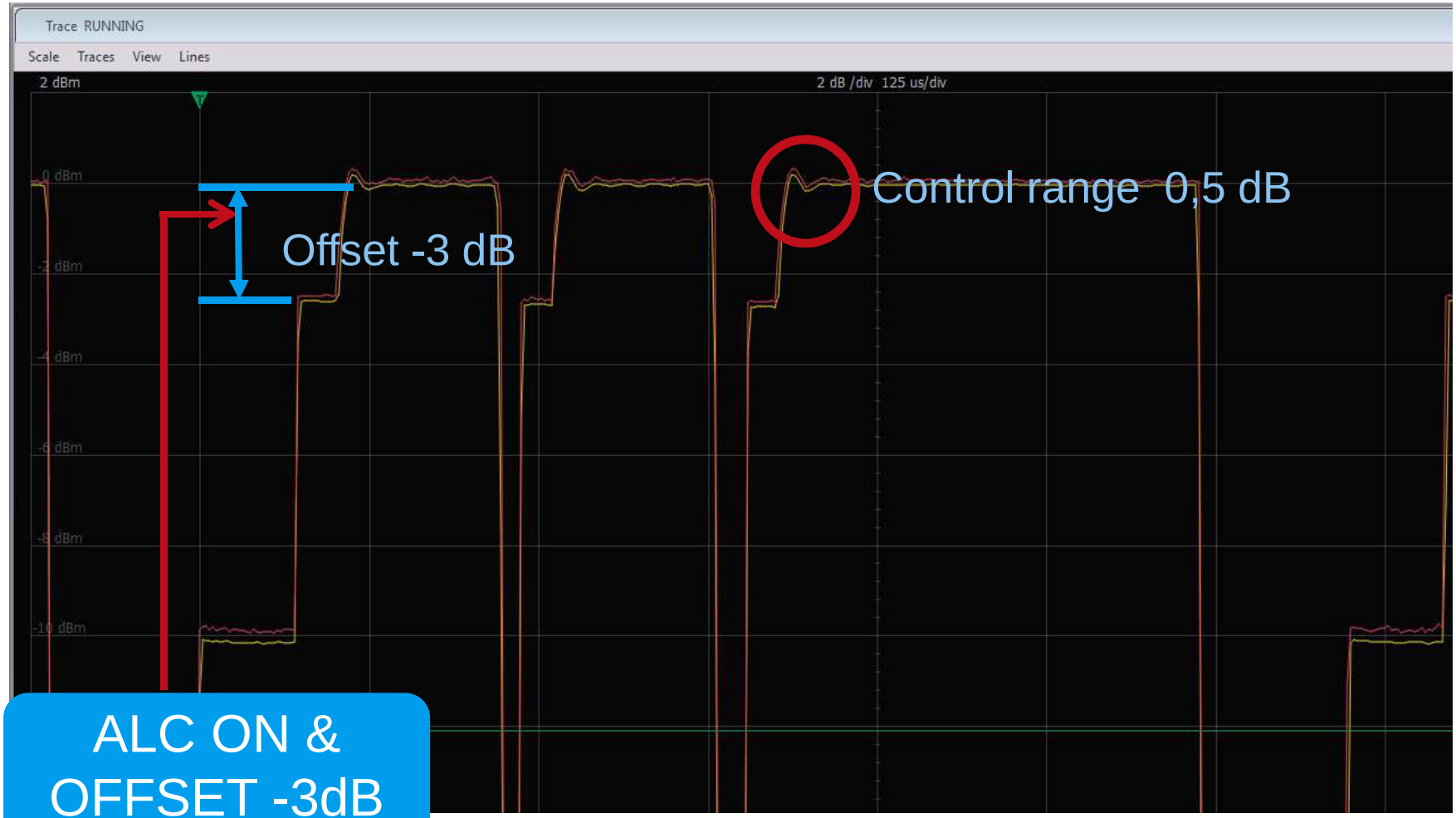

ALC Config (Ch1)
Port
ALC On
Control Range +/-
Start Value
Offset
Last Meas
Clamp
ALC Path IF Bandwidth
Port 6
Port 7
Port 8
5 dB
5 dB
Auto
Please perform a source power calibration for all ALC ports
Couple Port Settings
Settling Tolerance: +/ 0.1 dB
Show Advanced Settings
Activate Low Phase Noise Mode for ALC
Close
Help


control range
offset
target value
settling tolerance
clamp ALC
start of measurement

Example for ALC



Example for ALC with offset and control range setting



What are the Advantges of ZVAs digital ALC

- Highly selective, immune against distortion signals
- No intermodulation as with other VNA´s diode detectors
- Highly linear, as linear as the reference receiver
- Unmatched performance also for higher frequencies
- Works espcially with booster amplifiers
- Control circuit parameters as gain and delay can be modified if necessary

Thank you for your attention

1950 : World´s first Vector Network Analyzer
- made by R&S



Direct display of S-Parameters
in a complex plane

> 50 years of experience in network analysis