Parameters and measurement of two port networks

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What and why do we measure?

Measured two-port network

Incident signal — DUT — Transmitted signal

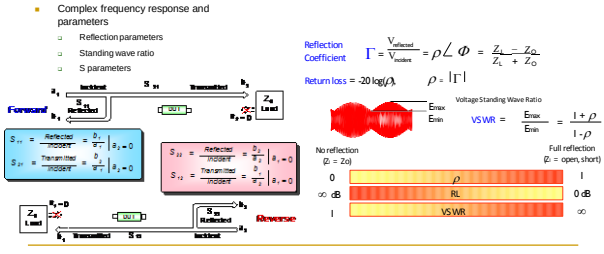
We measure transmission (transfer) characteristics of two or more port network, e.g. filter, amplifier, transmitter, receiver, antenna, etc. to identify its behavior (how signal on its input will be change on its output)

Transmission parameters are usually eked with input and output parameters (imitance, …) to describe fully the behavior of electric network (circuit) in complex electric system

The most common characteristics is frequency response and simplified derived parameters (amplification/attenuation, frequency band, phase shift/delay, …)

RF networks and parameters

- Complex frequency response and parameters
  - Reflection parameters
  - Standing wave ratio
  - S parameters



LF test methods I

- **Harmonic generator + AC voltmeter**
  - Magnitude frequency response and derived parameters (gain, bandwidth, …)
  - Time consuming step by step measurement,

Harmonic generator — DUT — AC voltmeter

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LF test methods II

- **Tracking swept harmonic generator + oscilloscope (alternatively with rectification = vobler)**
  - Frequency of generator must be controlled from oscilloscope
  - Envelope of signal in scope screen is frequency response (calibration of x=frequency axis is needed)
  - Limited to magnitude frequency response and derived parameters
  - Raw measurement with low accuracy.

Tracked generator — DUT — osciloskop

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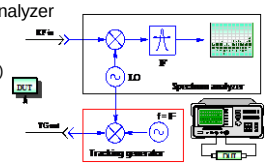
Test method III

- Spectrum analyzer with tracking generator (sinewave with frequency equal to the intermediate frequency of analyzer)
- Sometimes called scalar network analyzer
  - Limitations:
    - Single channel measurement (without phase shift measurement)
    - Only for networks without frequency transposition



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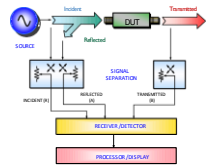
Network analyzer -NA

- Based on theory of reflection
- *Signal source* – harmonic oscillator swept in frequency (and magnitude)
- Using directional coupler incident and reflected signal can be distinguished and measured.
- Measurement:
  - Narrowband detector tuned synchronously with signal source
  - Signals are measured as vectors (magnitude and phase)



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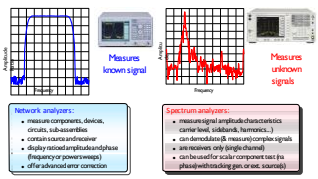
Comparison of spectrum and network analyzer



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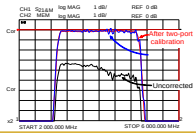
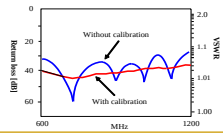
Network analyzer

- Before measuremnt a calibration must be performed errors correction of connecting cables and analog electronic in analyzer





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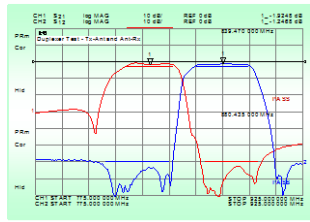
Example of results

- Measurement of s-parameters of GSM phone antenna filter



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