Telkom University

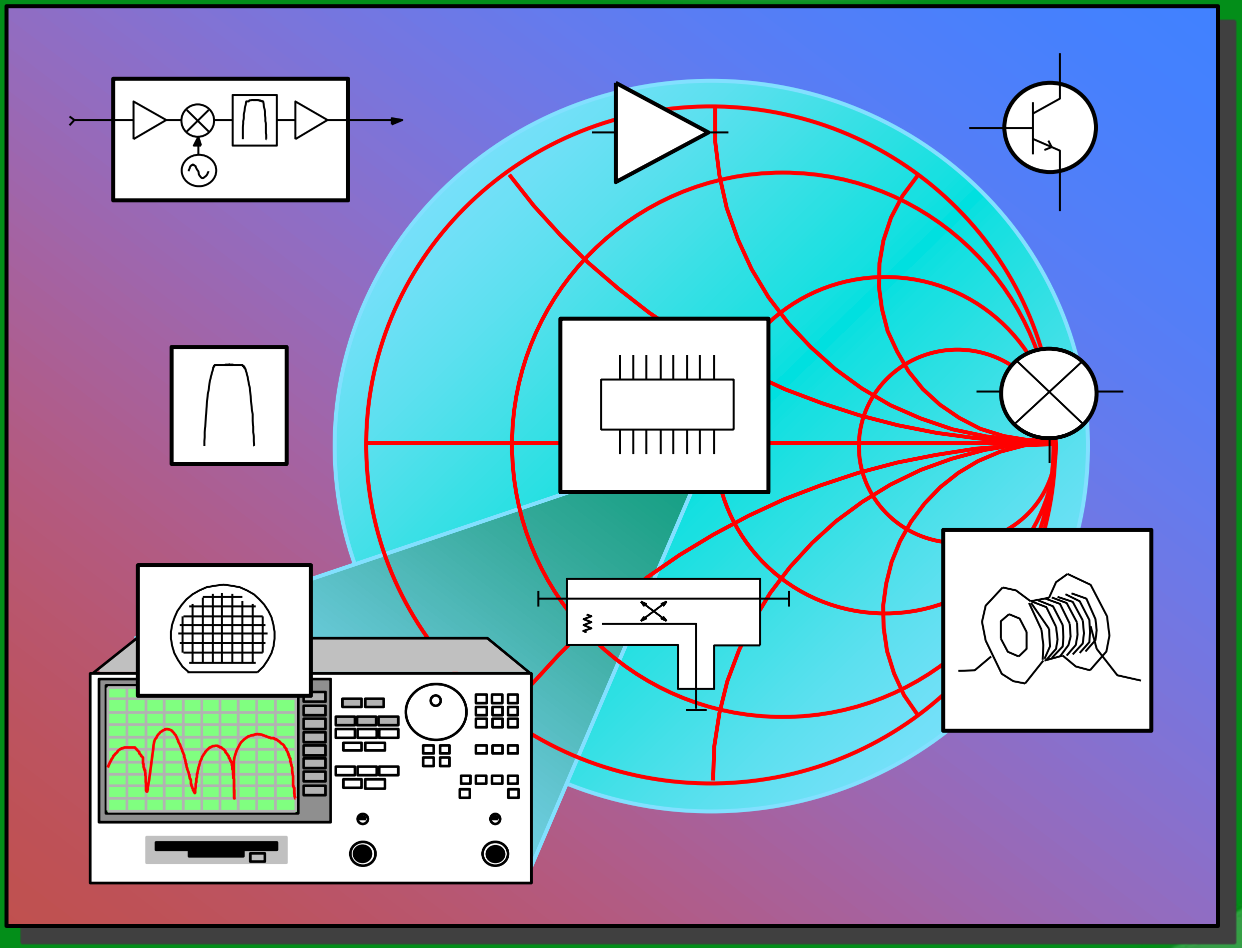
Diploma of Telecommunication Engineering

DTG 2M3 - ALAT UKUR DAN PENGUKURAN TELEKOMUNIKASI

By : Dwi Andi Nurmantris

NETWORK ANALYZER

NETWORK ANALYZER BASIC



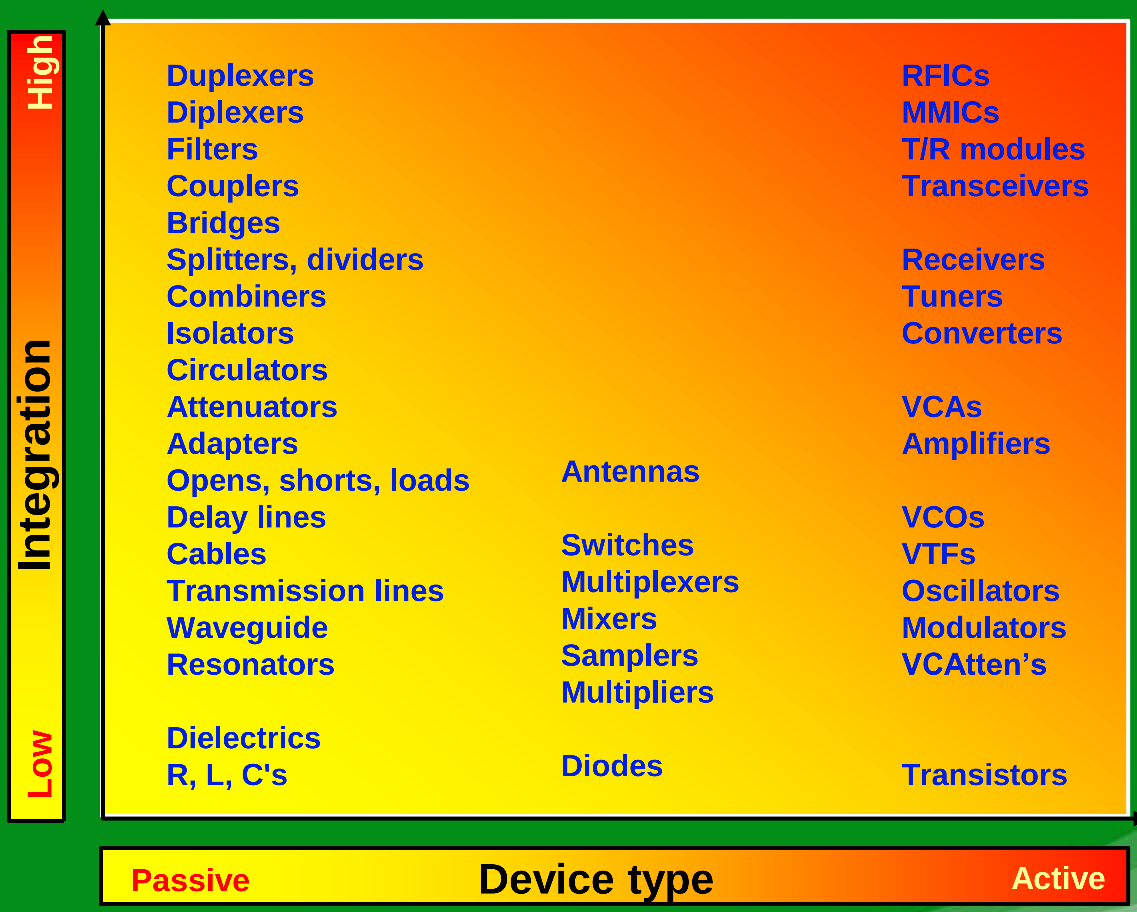
NETWORK ANALYZER BASIC

Network Analysis is NOT....

NETWORK ANALYZER BASIC

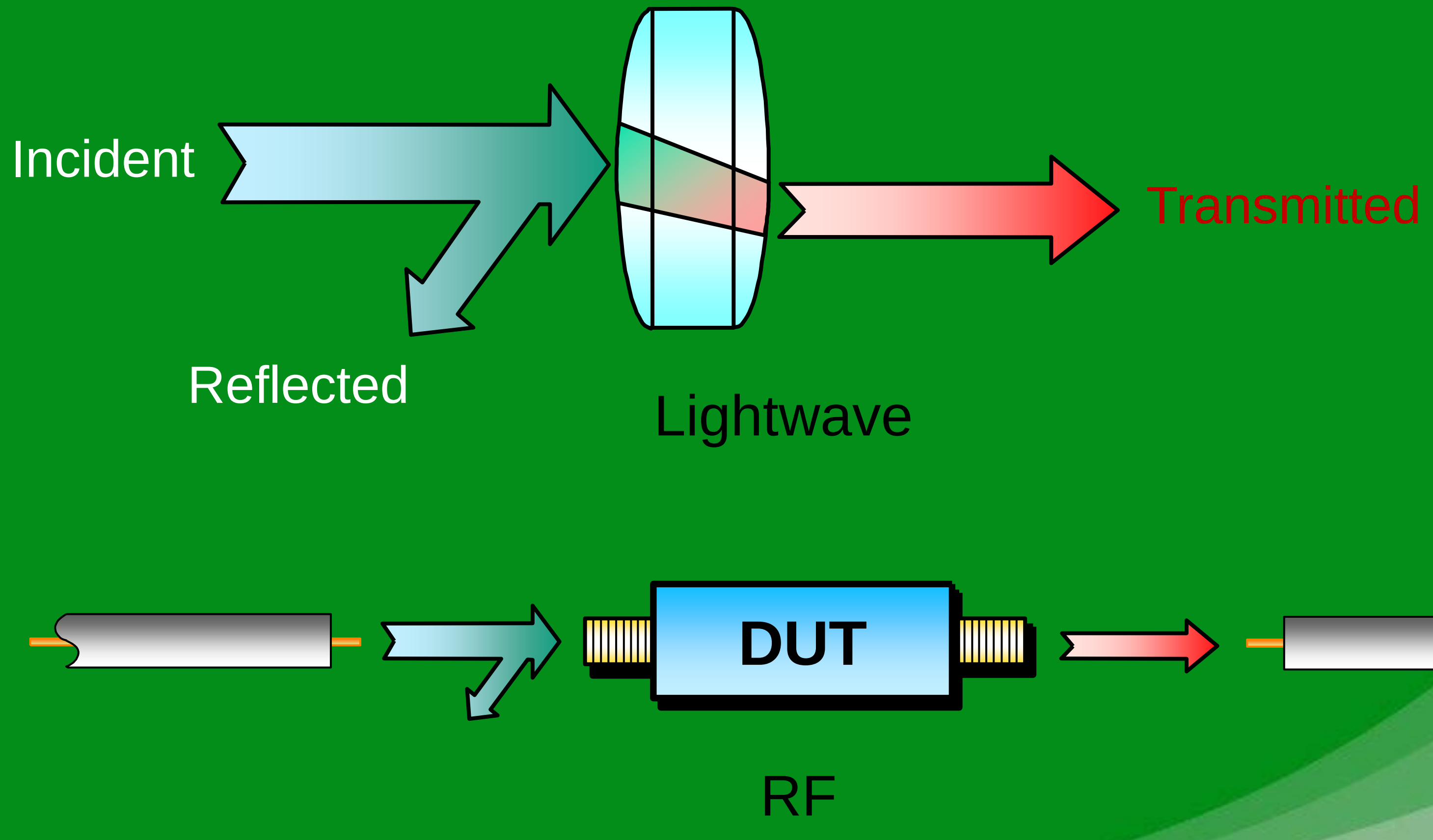
NETWORK ANALYZER BASIC

What Types of Devices are Tested?



NETWORK ANALYZER BASIC

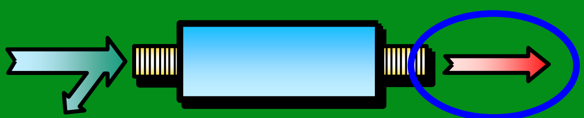
Lightwave Analogy to RF Energy



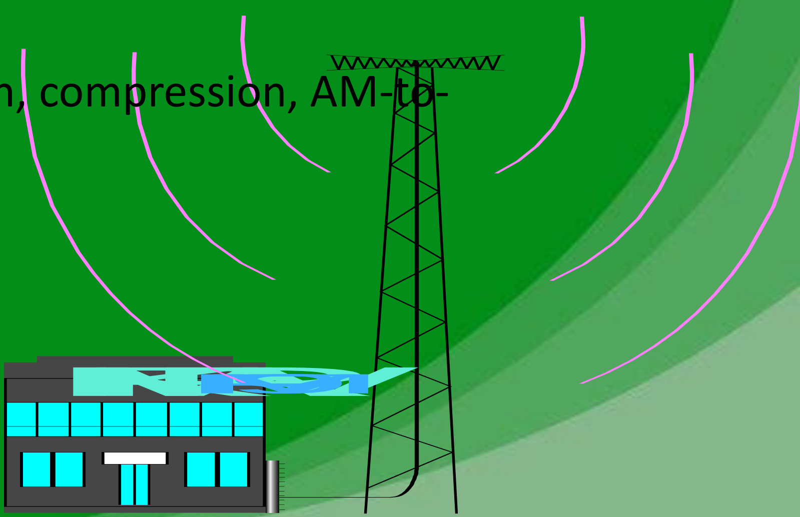
NETWORK ANALYZER BASIC

Why Do We Need to Test Components?

- Verify specifications of “building blocks” for more complex RF systems
- Ensure distortionless transmission of communications signals

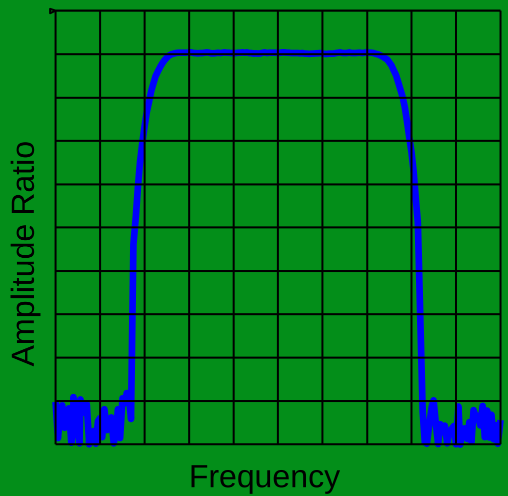


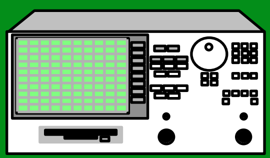
  - linear: constant amplitude, linear phase / constant group delay
  - nonlinear: harmonics, intermodulation, compression, AM-to-PM conversion
- Ensure good match when absorbing power (e.g., an antenna)



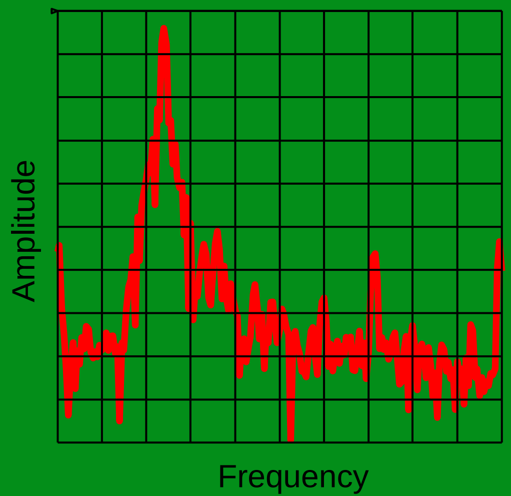
NETWORK ANALYZER BASIC

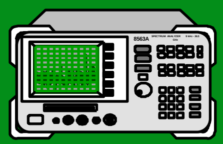
What is the Difference Between ***Network*** and ***Spectrum*** Analyzers?





Measures known signal





Measures unknown signals

Network analyzers:

- measure components, devices, circuits, sub-assemblies
- contain source and receiver
- display ratioed amplitude and phase (frequency or power sweeps)
- offer advanced error correction

Spectrum analyzers:

- measure signal amplitude characteristics carrier level, sidebands, harmonics...)
- can demodulate (& measure) complex signals
- are receivers only (single channel)
- can be used for scalar component test (*no phase*) with tracking gen. or ext. source(s)

Types of Network Analyzer

Scalar

- Magnitude only
- Lower Price
- Normalization – Less Accurate
- Measures RL, SWR, Gain/Loss

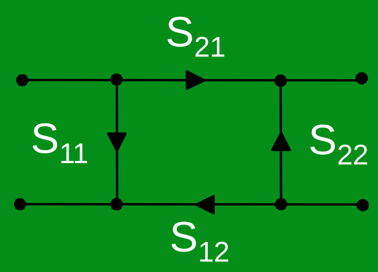
Vector

- Phase and Magnitude
- Higher Price
- Complete Error Correction – More Accurate
- Measures all

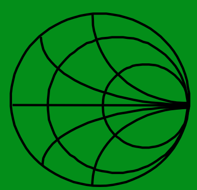
NETWORK ANALYZER BASIC

The Need for Both Magnitude and Phase

1. Complete characterization of linear networks

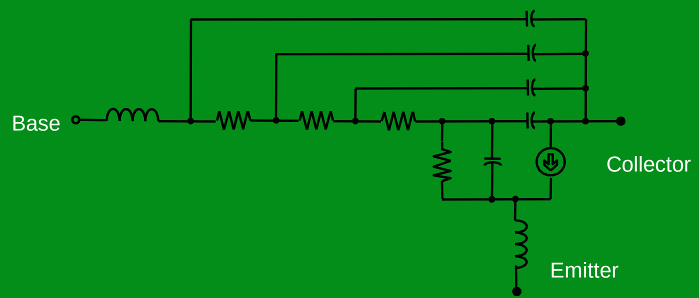


2. Complex impedance needed to design matching circuits

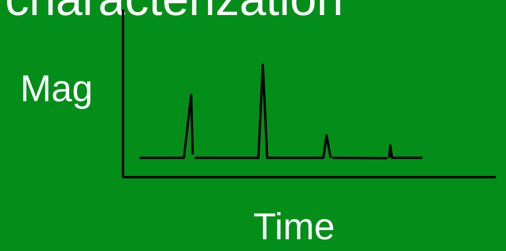


3. Complex values needed for device modeling

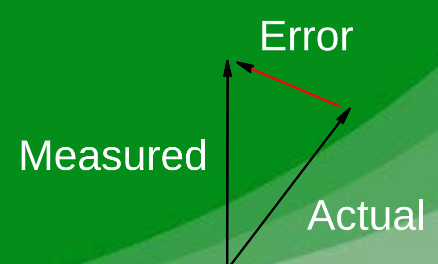
High-frequency transistor model



4. Time-domain characterization

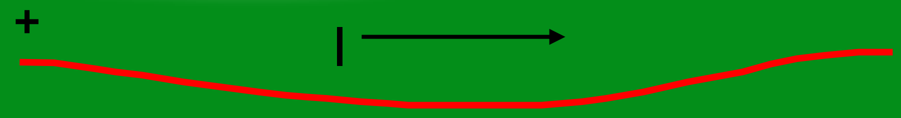


5. Vector-error correction



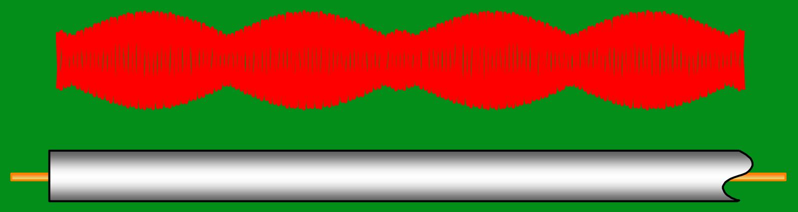
NETWORK ANALYZER BASIC

Low Freq Vs High Freq



Low frequencies

- wavelengths >> wire length
- current (I) travels down wires easily for efficient power transmission
- measured voltage and current not dependent on position along wire

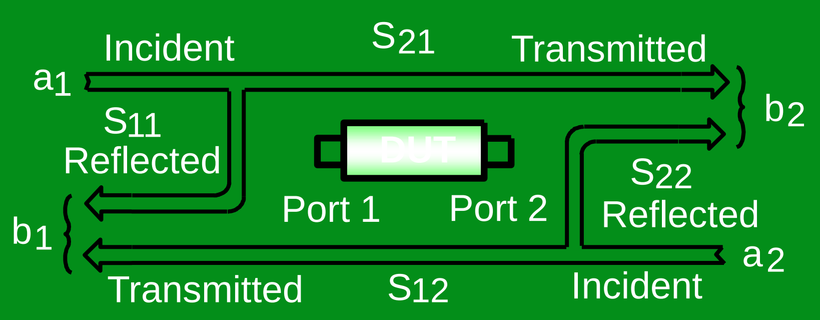


High frequencies

- wavelength » or << length of transmission medium
- need transmission lines for efficient power transmission
- matching to characteristic impedance (Zo) is very important for low reflection and maximum power transfer
- measured envelope voltage dependent on position along line

Why Use S-Parameters?

- relatively easy to **obtain** at high frequencies
  - hard to measure total voltage & current at the device ports at high frequency
  - measure voltage traveling waves with a vector network analyzer
  - don't need shorts/opens which can cause active devices to oscillate or self-destruct
- relate to **familiar** measurements (gain, loss, reflection coefficient ...)
- can **cascade** S-parameters of multiple devices to predict system performance
- can **compute** H, Y, or Z parameters from S-parameters if desired
- can easily import and use S-parameter files in our **electronic-simulation** tools

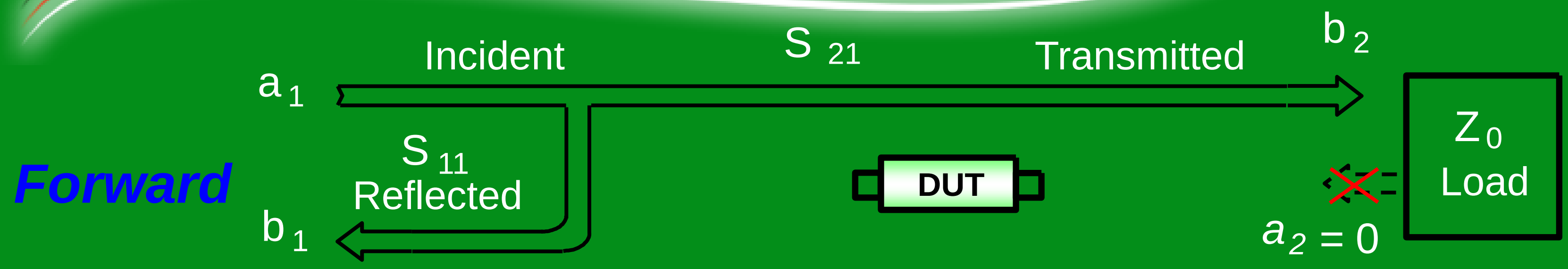


$$b_1 = S_{11} a_1 + S_{12} a_2$$

$$b_2 = S_{21} a_1 + S_{22} a_2$$

NETWORK ANALYZER BASIC

Measuring S-Parameters

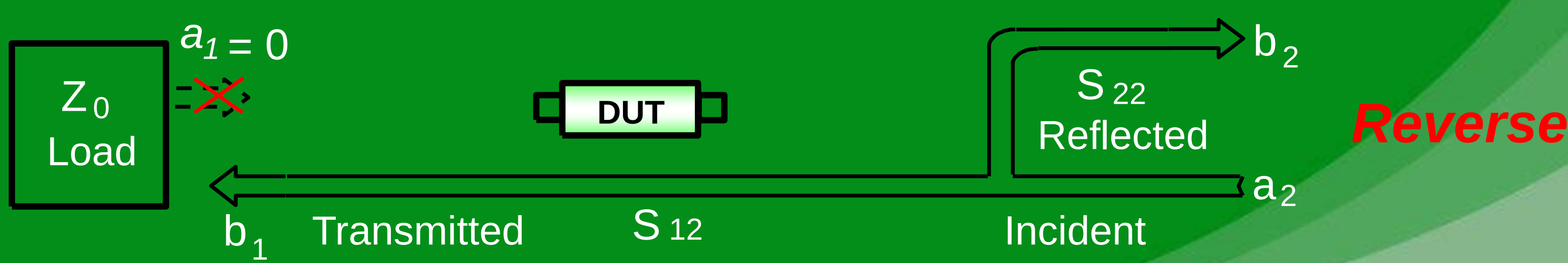


$$S_{11} = \frac{\text{Reflected}}{\text{Incident}} = \frac{b_1}{a_1}\bigg|_{a_2 = 0}$$

$$S_{21} = \frac{\text{Transmitted}}{\text{Incident}} = \frac{b_2}{a_1}\bigg|_{a_2 = 0}$$

$$S_{22} = \frac{\text{Reflected}}{\text{Incident}} = \frac{b_2}{a_2}\bigg|_{a_1 = 0}$$

$$S_{12} = \frac{\text{Transmitted}}{\text{Incident}} = \frac{b_1}{a_2}\bigg|_{a_1 = 0}$$



Equating S-Parameters with Common Measurement Terms

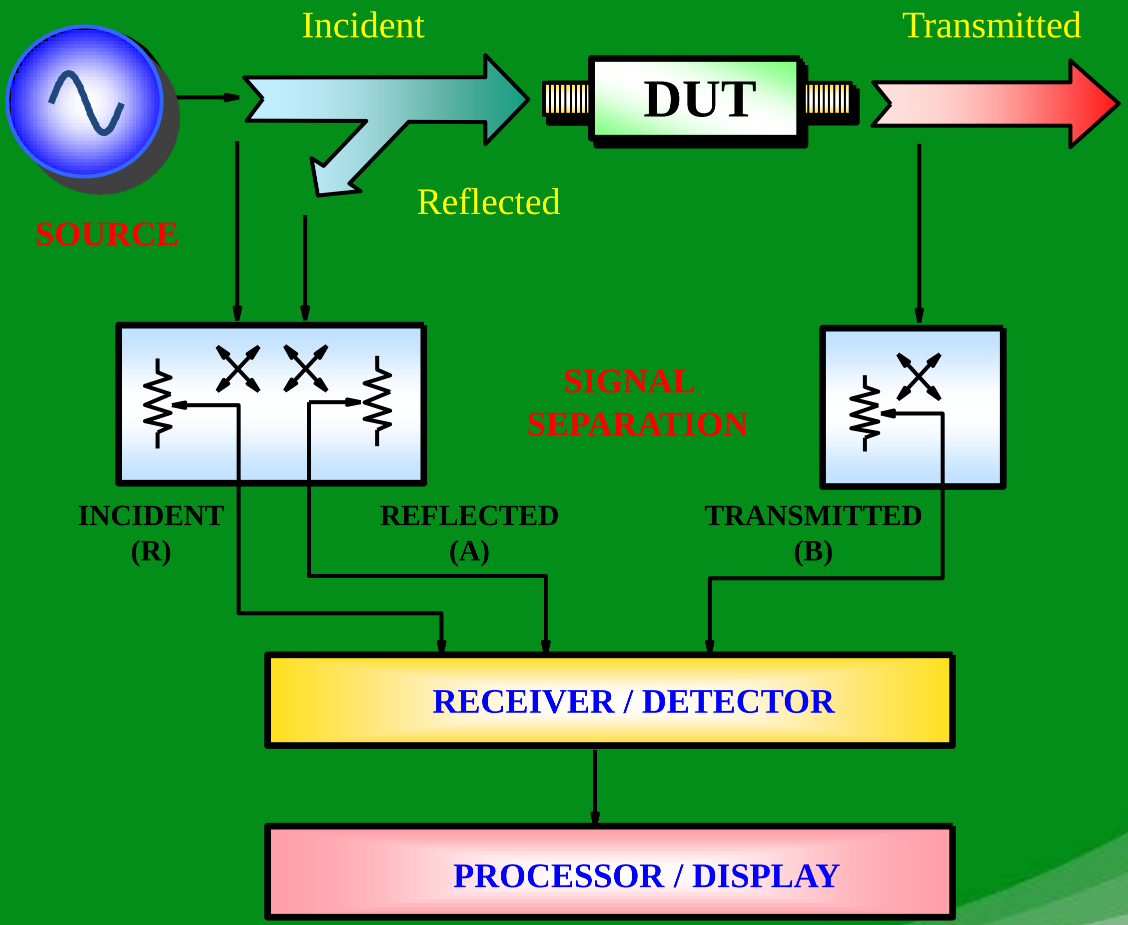
S11 = forward reflection coefficient *(input match)*
S22 = reverse reflection coefficient *(output match)*
S21 = forward transmission coefficient *(gain or loss)*
S12 = reverse transmission coefficient *(isolation)*

Remember, S-parameters are inherently complex, linear quantities. They are expressed as real and imaginary or magnitude and phase pairs

However, we often express them in a log magnitude format

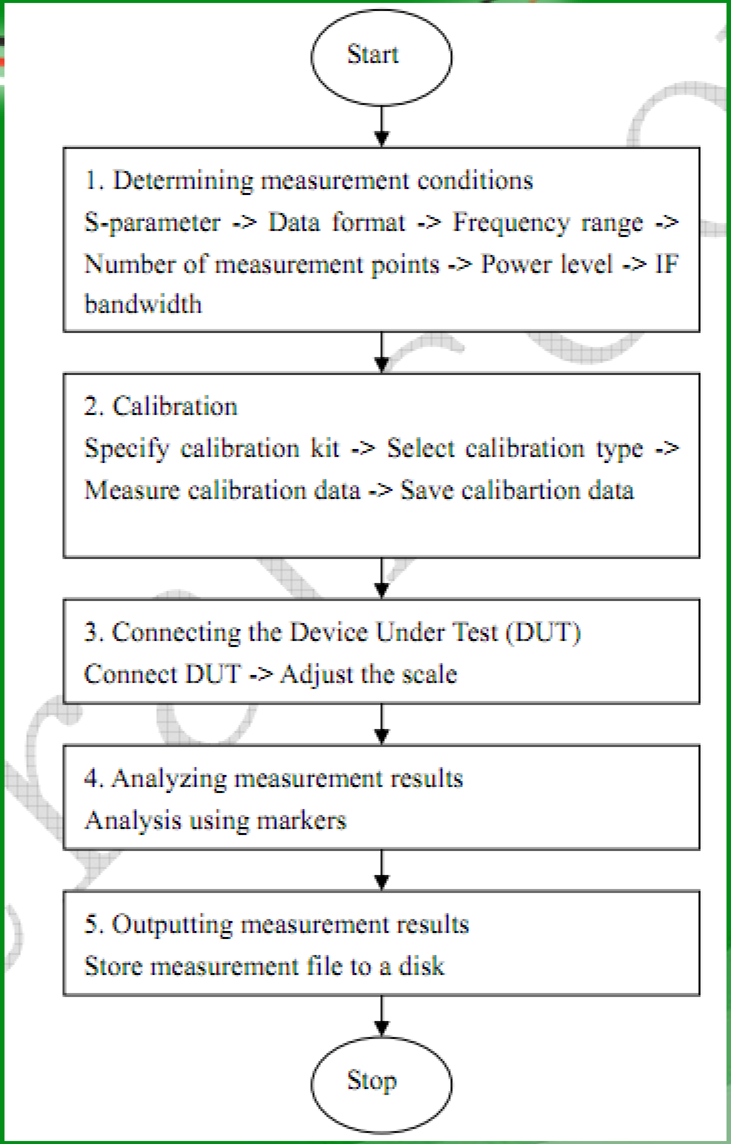
NETWORK ANALYZER BASIC

Network Analyzer Hardware -
Generalized Network Analyzer Block Diagram



NETWORK ANALYZER BASIC

Basic Measurement Procedure



LETS TRY!!

thanks for your a