

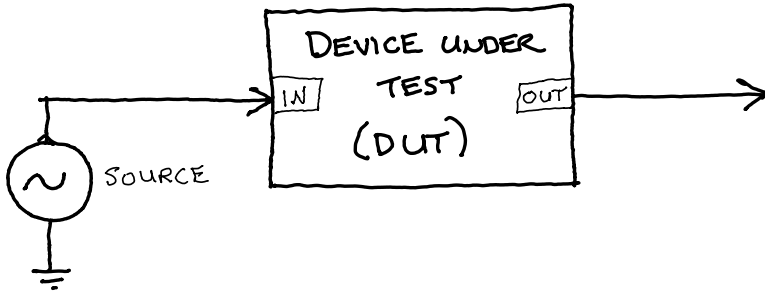
WHAT IS A VNA?

(VECTOR NETWORK ANALYZER)

- AN INSTRUMENT THAT MEASURES THE MAGNITUDE & PHASE OF THE REFLECTION & TRANSMISSION PROPERTIES OF THE PORTS OF A DEVICE VS. FREQUENCY.



LETS BREAK THIS DOWN ...



- DUT WILL AFFECT THE SIGNAL GOING THRU IT
- DUT INPUT IMPEDANCE WILL AFFECT THE APPLIED SIGNAL

REMEMBER...

- MAXIMUM POWER TRANSFER WHEN
LOAD IMPEDANCE = SOURCE IMPEDANCE

$$R_L = R_S$$

... IN A MORE GENERAL SENSE

$$R_s + jX_s = R_L - jX_L$$

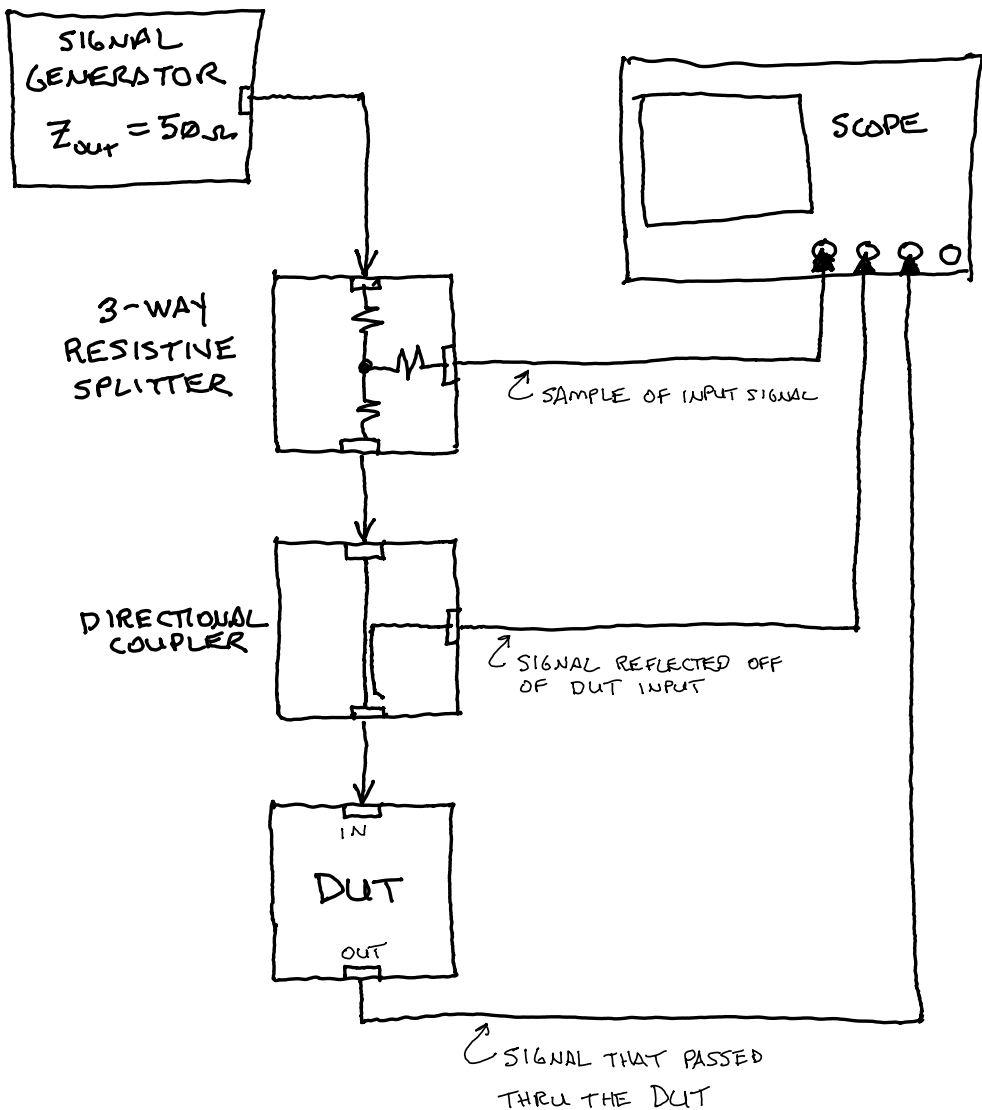
(COMPLEX CONJUGATE)

- FROM AN RF STANDPOINT, WE TALK ABOUT SIGNALS AS WAVES (WITH MAGNITUDE & PHASE)
- MOST RF CIRCUITS - SOURCE IS DESIGNED TO MATCH TRANSMISSION LINE IMPEDANCE - USUALLY 50Ω
- WHEN SOURCE & LOAD MATCH, THEN THE MAXIMUM POWER IS DELIVERED TO LOAD (ALL ABSORBED BY LOAD)
- THE DUT WILL ALTER THE MAGNITUDE & PHASE OF THE SIGNAL GOING THRU IT (TRANSMISSION)

- WE CAN MEASURE THE INPUT & OUTPUT SIGNALS AND COMPARE THEM

- WHEN SOURCE & LOAD Z DON'T MATCH, SOME POWER IS REFLECTED OFF OF LOAD BACK TO THE SOURCE (REFLECTION)

- THE "REFLECTION" FROM THE PORT CAN BE MEASURED.



- THE VNA ...

- SUPPLIES THE SIGNAL TO DUT
- MEASURES INPUT, REFLECTED AND TRANSMITTED SIGNALS VS. FREQUENCY
- MAGNITUDE & PHASE OF REFLECTED & TRANSMITTED WAVES ARE COMPARED TO THE INPUT SIGNAL
- CALIBRATIONS APPLIED ..
- FROM THE REFLECTION MEASUREMENTS ...
 - REFLECTION COEFFICIENT (Γ , ρ , S_{11} , etc.)
 - RETURN LOSS (RL)
 - INPUT IMPEDANCE ($R \pm jX$) ($G \pm jB$)
(ADMITTANCE)
 - VSWR
- FROM THE TRANSMISSION MEASUREMENTS ...
 - GAIN OR LOSS
 - TRANSMISSION COEFFICIENT (T , τ , S_{21} , etc.)
 - INSERTION PHASE
 - GROUP DELAY

- PROFESSIONAL GRADE VNAs

- TYPICALLY 2-PORT, 2-PATH (OR MORE)

- FREQ RANGE - GHz TO THz!

- 120dB DYNAMIC RANGE OR MORE

- MANY SWEEP TYPES, MEASUREMENTS, ETC.

- TYPES:

 - BENCHTOP

 - COMPACT / USB

- HOBBYIST GRADE

- LOWER DYNAMIC RANGE

- LOWER FREQUENCY RANGE

- LIMITED FEATURES

- GEARED TOWARDS SPECIFIC USES