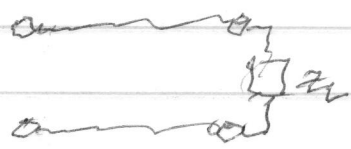


avg power delivered to load



how much power delivered to load? in the phasor world, find avg power using

$$P_{ave} = \frac{1}{2} \operatorname{Re} \{ V_L(z) I_L^*(z) \}$$

for lossless TL:

$$P_{ave} = \frac{1}{2} \operatorname{Re} \left\{ |V_0^+| e^{j\beta z} \left(e^{-j\beta z} + \Gamma_L e^{j\beta z} \right) \cdot \frac{|V_0^+|}{Z_0} e^{-j\beta z} \left(e^{j\beta z} - \Gamma_L^* e^{-j\beta z} \right) \right\}$$

at load \$z=0\$:

$$\begin{aligned} P_{ave} &= \frac{1}{2} \operatorname{Re} \left\{ \frac{|V_0^+|^2}{Z_0} (1 + \Gamma_L) (1 - \Gamma_L^*) \right\} \\ &= \frac{1}{2} \operatorname{Re} \left\{ \frac{|V_0^+|^2}{Z_0} (1 + \Gamma_L) (1 - \Gamma_L^*) \right\} \\ &= \frac{1}{2} \frac{|V_0^+|^2}{Z_0} \operatorname{Re} \{ 1 + j2\Gamma_L - |\Gamma_L|^2 \} \end{aligned}$$

$$P_{ave} = \frac{1}{2} \frac{|V_0^+|^2}{Z_0} (1 - |\Gamma_L|^2) \quad [W]$$

smith chart - R calculator

invented in 1939 by philip smith at bell labs.
used to find z_{in} , z_L , Γ_L , S , locations of the
max & min, i.e., $\{V_s\}_{max}$, $\{V_s\}_{min}$

constructing smith chart

start w/ Γ_L & normalized z_L

$$\Gamma_L = \frac{z_L - z_0}{z_L + z_0} = \text{Re}\{\Gamma_L\} + j \text{Im}\{\Gamma_L\} \\ = \Gamma_r + j \Gamma_i \quad \{ \}$$

$$z_L = \frac{z_L}{z_0} = r + jx \quad \{ \}$$

r = normalized resistance

x = " reactance

$$\Rightarrow \Gamma_L = \frac{z_L - 1}{z_L + 1} = \Gamma_r + j \Gamma_i$$

→ always normalize impedances by z_0 : z_0 , z_L , z_{in}

some algebra

→ z_L in terms of Γ_r & Γ_i

after more algebra

→ r, x in terms of Γ_r & Γ_i

then using conformal mapping:

$$\rightarrow \left(\Gamma_r - \frac{r}{1+r} \right)^2 + \left(\Gamma_i - 0 \right)^2 = \left(\frac{1}{1+r} \right)^2 \quad r \text{ circles}$$

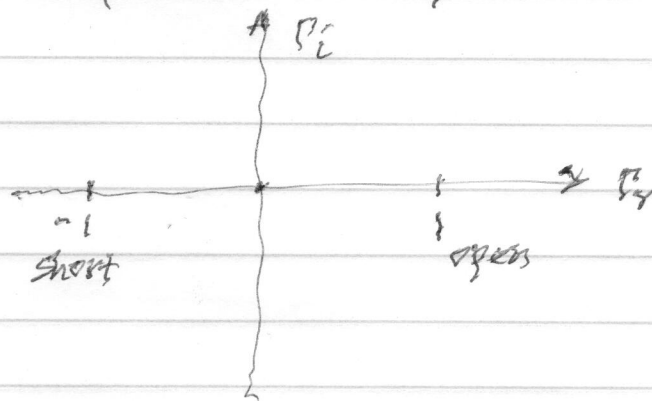
$$(\Gamma_r - 1)^2 + \left(\Gamma_i - \frac{1}{x} \right)^2 = \left(\frac{1}{x} \right)^2 \quad x \text{ circles}$$

note:

Γ_r for matched line $\Gamma_r = 0$

" " short-circ " $\Gamma_r = -1$

" " open-circ " $\Gamma_r = 1$



plot $r \in x$ circles for diff values of $r \in x$ varying from 0 to $\infty \rightarrow$ get smith chart

The Complete Smith Chart

Black Magic Design

 Γ_r, Γ_i PLANE
