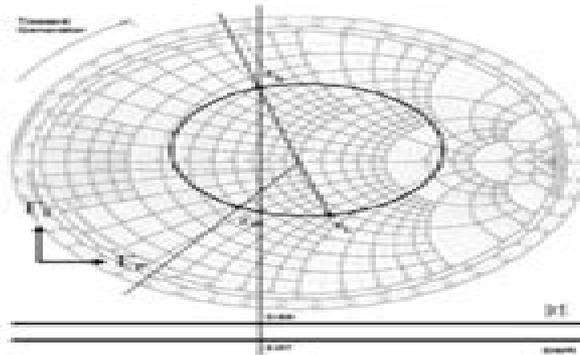


These are two families of circles as  $r_L$  and  $x_L$ . Superposition of Smith Chart and its  $180^\circ$  ( $\lambda/4$ ) rotated version is known as *Combined Impedance-Admittance Smith Chart*.



$\lambda/2$  is the complete revolution of Smith chart.  $\lambda/4$  is the half of Smith chart ( $180^\circ$ ). The images of  $Z$  is  $Y$  in Smith chart.

### 2.3. Slotted Line

This device is used to find  $Z_L$  as first  $V_{min}$ .

- Measurement of  $SWR$  on the  $l_{min}$  distance from the line.
- Calculate  $|\Gamma| = (SWR - 1)/(SWR + 1)$
- $e^{j(\theta - 2\beta l)}|_{V_{min}} = -1 \Rightarrow \theta = \pi + 2kl_{min}$
- Using  $\theta$  and  $|\Gamma|$ , write  $\Gamma = |\Gamma|e^{j\theta}$
- Calculate  $Z_L = Z_0[(1 + \Gamma)/(1 - \Gamma)]$  at  $l = 0$ .

### 2.4. Generator & Load Mismatches



$$v(x) = V_0^+ e^{-j\beta x} + V_0^- e^{+j\beta x} = V_0^+ (e^{-j\beta x} + \Gamma_L e^{j\beta x})$$

$$v(-l) = V_0^+ (e^{j\beta l} + \Gamma_L e^{-j\beta l}) = \frac{Z_{in}}{Z_0 + Z_L} V_0^+$$

$$Z_{in} = Z_0 \left. \frac{1 + \Gamma_L e^{-j2\beta l}}{1 - \Gamma_L e^{-j2\beta l}} \right|_{x=-l}$$

Then, using this

$$V_0^+ = \frac{Z_0}{Z_0 + Z_L} V_0 \frac{e^{-j\beta l}}{(1 - \Gamma_L \Gamma_L^* e^{-j2\beta l})}$$

where  $\Gamma_L = Z_L - Z_0 / Z_L + Z_0$  and  $\Gamma_L = Z_L - Z_0 / Z_L + Z_0$ .

$$P = \frac{1}{2} \text{Re}\{v_{in} I_{in}^*\} = \frac{|V_0^+|^2}{2} \frac{R_{in}}{(R_{in} + R_L)^2 + (X_{in} + X_L)^2}$$

where  $Z_{in} = R_{in} + jX_{in}$  and  $Z_L = R_L + jX_L$ . Generally  $Z_L$  is fixed and three cases are considered as

- Load Matched to Line:  $Z_L = Z_0$ ,  $\Gamma_L = 0$ ,  $SWR = 1$ . Then  $Z_{in} = Z_0$ .

$$P = \frac{|V_0^+|^2}{2} \frac{Z_0}{(Z_0 + R_L)^2 + X_L^2}$$

- Generator Matched to Line:  $Z_{in} = Z_L$ ,  $\Gamma_L = 0$ .

$$P = \frac{|V_0^+|^2}{2} \frac{R_L}{4(R_L^2 + X_L^2)}$$

- Conjugate Matching:  $Z_{in} = Z_L^*$

$$\left. \frac{\partial P}{\partial R_{in}} = 0 \Rightarrow \frac{\partial P}{\partial X_{in}} = 0 \right\} \Rightarrow Z_{in} = Z_L^*$$

$$P = \frac{|V_0^+|^2}{2} \frac{1}{4R_L^2}$$

Maximum power transfer  $\Gamma = \Gamma_L = \Gamma_L = 0$ . If one directly chose  $\Gamma = \Gamma_L = \Gamma_L = 0$ , it does not mean that the best efficiency due to the phase differences. The efficiency can be improved only by making  $Z_L$  as small as possible.

# Microwave Engineering Lecture Notes

**S Ashworth**



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