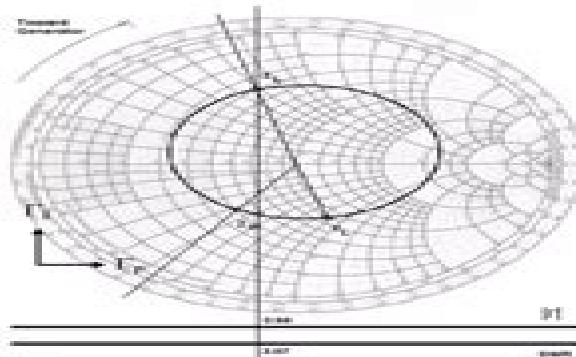


These are two families of circles as  $r_L$  and  $r_{in}$ . Superposition of Smith Chart and its  $180^\circ$  ( $\lambda/4$ ) rotated version is known as *Combined Impedance-Admittance Smith Chart*.



$\lambda/2$  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  $|\Gamma| = (SWR - 1)/(SWR + 1)$
- $e^{j(\theta - 2kl)}|_{V_{min}} = -1 \Rightarrow \theta = \pi + 2kl_{min}$
- Using  $\theta$  and  $|\Gamma|$ , write  $\Gamma = |\Gamma|e^{j\theta}$
- Calculate  $Z_L = Z_0[(1 + \Gamma)/(1 - \Gamma)]$  at  $t = 0$ .

### 2.4. Generator & Load Mismatches



$$v(x) = V_o^+ e^{-j\omega x} + V_o^- e^{+j\omega x} = V_o^+ (e^{-j\omega x} + \Gamma_o e^{j\omega x})$$

$$v(-l) = V_o^+ (e^{j\omega l} + \Gamma_o e^{-j\omega l}) = \frac{Z_{in}}{Z_{in} + Z_o} V_o$$

$$Z_{in} = Z_o \frac{1 + \Gamma_o e^{-j\omega l}}{1 - \Gamma_o e^{-j\omega l}} \Big|_{x=-l}$$

Then, using this

$$V_o^+ = \frac{Z_o}{Z_o + Z_g} V_o \frac{e^{-j\omega l}}{(1 - \Gamma_o \Gamma_g e^{-j\omega l})}$$

where  $\Gamma_g = Z_g - Z_o/Z_g + Z_o$  and  $\Gamma_o = Z_o - Z_o/Z_g + Z_o$ .

$$P = \frac{1}{2} \operatorname{Re}\{V_{in} I_{in}\} = \frac{|V_o|^2}{2} \frac{R_{in}}{(R_{in} + R_g)^2 + (X_{in} + X_g)^2}$$

where  $Z_{in} = R_{in} + jX_{in}$  and  $Z_g = R_g + jX_g$ . Generally  $Z_g$  is fixed and three cases are considered as

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

$$P = \frac{|V_o|^2}{2} \frac{Z_o}{(Z_o + R_g)^2 + X_g^2}$$

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

$$P = \frac{|V_o|^2}{2} \frac{R_g}{4(R_g^2 + X_g^2)}$$

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

$$\frac{\partial P}{\partial R_{in}} = 0 \Rightarrow \begin{cases} R_{in} = R_g \\ X_{in} = -X_g \end{cases} \Rightarrow Z_{in} = Z_g^*$$

$$P = \frac{|V_o|^2}{2} \frac{1}{4R_g^2}$$

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

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