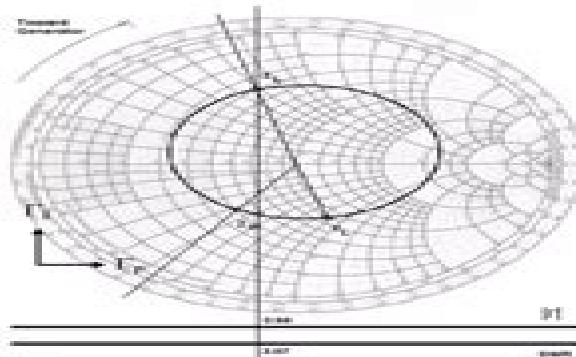


These are two families of circles as  $r_L$  and  $r_{in}$ . Superposition of Smith Chart and its  $180^\circ$  ( $\lambda/4$ ) rotated version is known as *Combined Impedance-Admittance Smith Chart*.



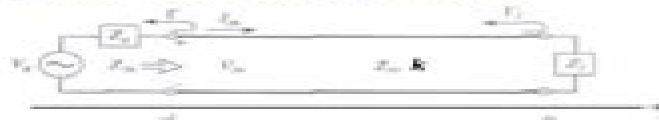
$\lambda/2$  is the complete revolution of Smith chart.  $\lambda/4$  is the half of Smith chart ( $180^\circ$ ). The images of  $Z$  is  $Y$  in Smith chart.

### 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



$$v(x) = V_0^+ e^{-j\beta x} + V_0^- e^{+j\beta x} = V_0^+ (e^{-j\beta x} + \Gamma_1 e^{j\beta x})$$

$$v(-l) = V_0^+ (e^{j\beta l} + \Gamma_1 e^{-j\beta l}) = \frac{Z_{in}}{Z_{in} + Z_g} V_0$$

$$Z_{in} = Z_0 \frac{1 + \Gamma_1 e^{-j2\beta l}}{1 - \Gamma_1 e^{-j2\beta l}} \Big|_{x=-l}$$

Then, using this

$$V_0^+ = \frac{Z_0}{Z_0 + Z_g} V_0 \frac{e^{-j\beta l}}{(1 - \Gamma_1 \Gamma_g e^{-j2\beta l})}$$

where  $\Gamma_g = Z_g - Z_0/Z_g + Z_0$  and  $\Gamma_1 = Z_1 - Z_0/Z_1 + Z_0$ .

$$P = \frac{1}{2} \operatorname{Re}\{V_{in} I_{in}\} = \frac{|V_0|^2}{2} \frac{R_{in}}{(R_{in} + R_g)^2 + (X_{in} + X_g)^2}$$

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:  $Z_L = Z_0$ ,  $\Gamma_L = 0$ ,  $SWR = 1$ . Then  $Z_{in} = Z_0$ .

$$P = \frac{|V_0|^2}{2} \frac{Z_0}{(Z_0 + R_g)^2 + X_g^2}$$

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

$$P = \frac{|V_0|^2}{2} \frac{R_g}{4(R_g^2 + X_g^2)}$$

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

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

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

Maximum power transfer:  $\Gamma = \Gamma_g = \Gamma_1 = 0$ . If one directly chose  $\Gamma = \Gamma_g = \Gamma_1 = 0$ , 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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**D Kirk**

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1. Understanding the eBook Microwave Engineering Lecture Notes Ppt
  - The Rise of Digital Reading Microwave Engineering Lecture Notes Ppt
  - Advantages of eBooks Over Traditional Books
2. Identifying Microwave Engineering Lecture Notes Ppt
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Microwave Engineering Lecture Notes Ppt
  - User-Friendly Interface
4. Exploring eBook Recommendations from Microwave Engineering Lecture Notes Ppt
  - Personalized Recommendations
  - Microwave Engineering Lecture Notes Ppt User Reviews and Ratings
  - Microwave Engineering Lecture Notes Ppt and Bestseller Lists
5. Accessing Microwave Engineering Lecture Notes Ppt Free and Paid eBooks
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  - Microwave Engineering Lecture Notes Ppt eBook Subscription Services
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- Microwave Engineering Lecture Notes Ppt Compatibility with Devices
- Microwave Engineering Lecture Notes Ppt Enhanced eBook Features

7. Enhancing Your Reading Experience

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- Highlighting and Note-Taking Microwave Engineering Lecture Notes Ppt
- Interactive Elements Microwave Engineering Lecture Notes Ppt

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- Joining Online Reading Communities
- Participating in Virtual Book Clubs
- Following Authors and Publishers Microwave Engineering Lecture Notes Ppt

9. Balancing eBooks and Physical Books Microwave Engineering Lecture Notes Ppt

- Benefits of a Digital Library
- Creating a Diverse Reading Collection Microwave Engineering Lecture Notes Ppt

10. Overcoming Reading Challenges

- Dealing with Digital Eye Strain
- Minimizing Distractions
- Managing Screen Time

11. Cultivating a Reading Routine Microwave Engineering Lecture Notes Ppt

- Setting Reading Goals Microwave Engineering Lecture Notes Ppt
- Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Microwave Engineering Lecture Notes Ppt

- Fact-Checking eBook Content of Microwave Engineering Lecture Notes Ppt
- Distinguishing Credible Sources

13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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