

EE 3113

INTRODUCTION INTO RF

CIRCUIT DESIGN

Lecture Notes for A-term 1999

LECTURE 7

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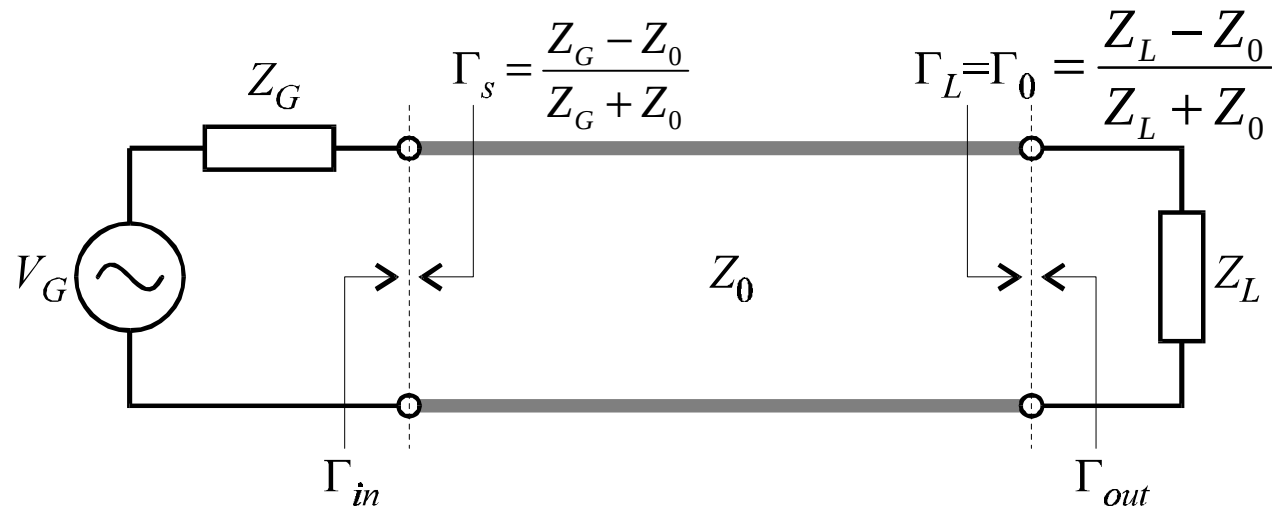
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Sourced and Loaded Transmission Lines

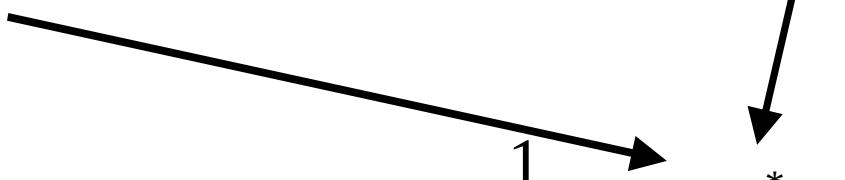
- Lossless transmission line with source



$$V_{in} = V_{in}^+ (1 + \Gamma_{in}) = V_G \left(\frac{Z_{in}}{Z_{in} + Z_G} \right)$$

Voltage at the beginning of the transmission line is composed of an **incident** and **reflected** component!

Power considerations

$$V_{in} = V_{in}^+ (1 + \Gamma_{in}) \quad I_{in} = \frac{V_{in}^+}{Z_0} (1 - \Gamma_{in})$$

$$P_{in} = \frac{1}{2} \operatorname{Re}\{V_{in} I_{in}^*\}$$

$$P_{in} = \frac{1}{2} \frac{|V_{in}^+|^2}{Z_0} (1 - |\Gamma_{in}|^2)$$

$$P_{in} = \frac{1}{8} \frac{|V_G|^2}{Z_0} \frac{|1 - \Gamma_S|^2}{|1 - \Gamma_S \Gamma_{in}|^2} (1 - |\Gamma_{in}|^2)$$

Two special cases:

Load and source
matched line

$$\Gamma_0 = \Gamma_s = 0 \quad \rightarrow \quad P_{in} = \frac{1}{8} \frac{|V_G|^2}{Z_0}$$

Mismatch at source,
but match at load

$$\Gamma_0 = 0 \quad \rightarrow \quad P_{in} = \frac{1}{8} \frac{|V_G|^2}{Z_0} |1 - \Gamma_s|^2$$

How to measure power?

$$P[dBm] = 10 \log \frac{P[W]}{1mW}$$

Return and insertion losses

Return loss: $RL = -10\log\left(\frac{P_r}{P_i}\right) = -10\log|\Gamma_{in}|^2 = -20\log|\Gamma_{in}| \quad [\text{dB}]$

Insertion loss: $IL = -10\log\left(\frac{P_t}{P_i}\right) = -10\log\left(\frac{P_i - P_r}{P_i}\right) = -10\log(1 - |\Gamma_{in}|^2) \quad [\text{dB}]$

