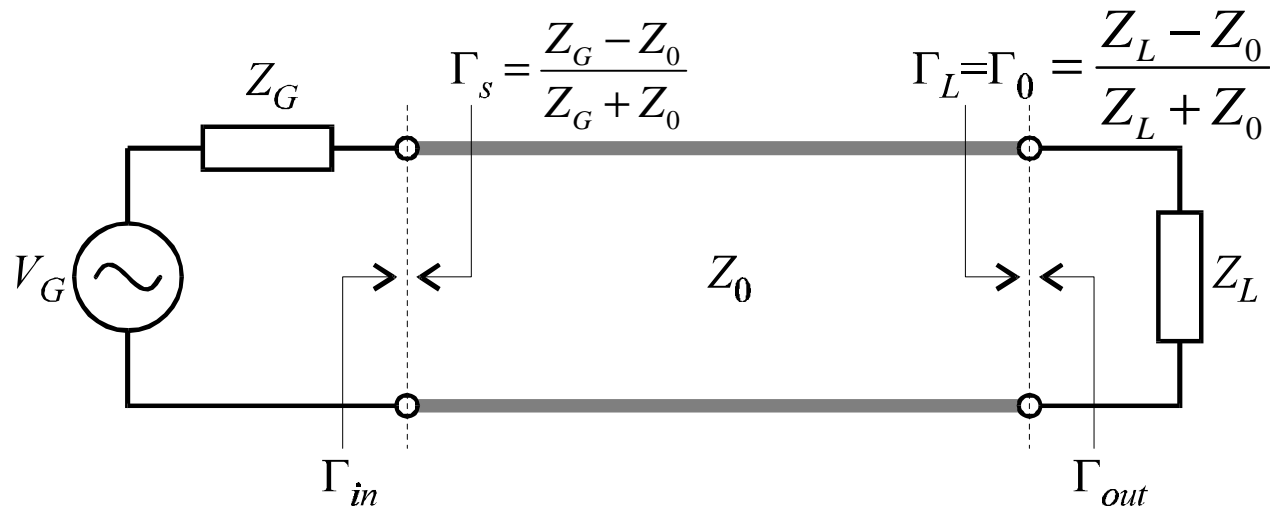# Sourced and Loaded Transmission Lines
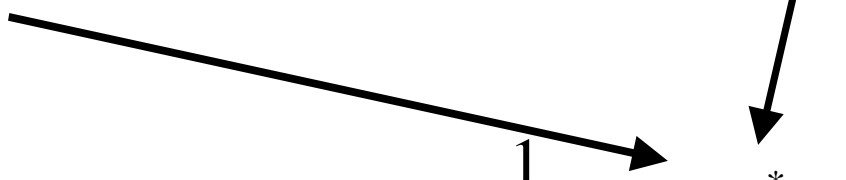
- Lossless transmission line with source

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

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

Power considerations

$$V_{in} = V_{in}^{+}(1 + \Gamma_{in})$$

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

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

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

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

<u>Two special cases:</u>

Load and source
matched line

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

Mismatch at source,
but match at load

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

How to measure power? $P[dBm] = 10 \log \frac{P[W]}{1mW}$

Return and insertion losses

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

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

No reflection		Full reflection

$\tilde{A}$

0 ⟵————————————⟶ 1

∞ dB ⟵———— RL ————⟶ 0 dB

1 ⟵———— SWR ————⟶ ∞