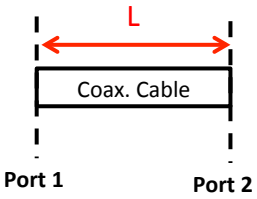
Coaxial Cable

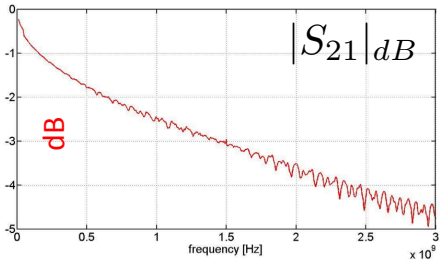


$$S_{21}(\omega) = e^{-\gamma L} = e^{-\alpha L - j\beta L} =$$
$$= e^{-\alpha' \sqrt{\omega} L - j\omega\tau}$$

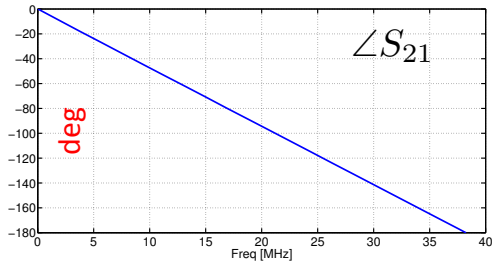
$$\beta L = \frac{\omega}{c}\sqrt{\epsilon_r} L = \omega\tau \qquad \tau = \sqrt{\epsilon_r}\frac{L}{c}$$

Electrical Delay

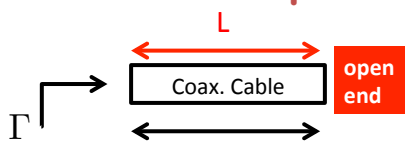
$$|S_{21}|_{dB} = -20\log_{10}(e)\sqrt{2\pi}\alpha' L\sqrt{f}$$



$$\angle S_{21} = -\tau 2\pi f$$



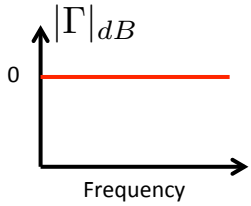
Open Coaxial Cable

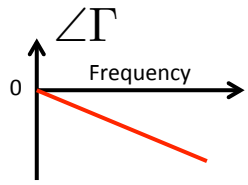


$$\tau = \sqrt{\epsilon_r}\frac{L}{c}$$

Ideal Case

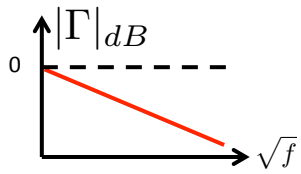
$$\Gamma = \frac{b_1}{a_1} = e^{-j2\pi f 2\tau}$$



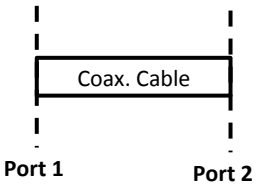


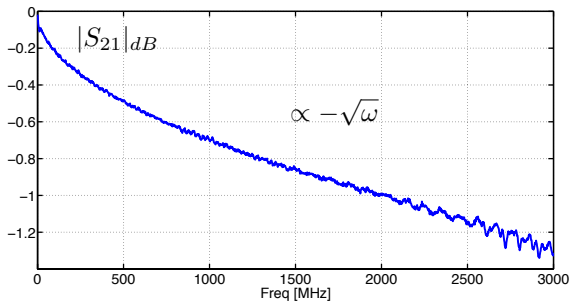
Radiation + Losses

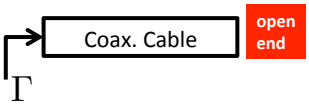
$$\Gamma \approx e^{-\alpha'\sqrt{\omega}2L} e^{-j2\pi f 2\tau}$$

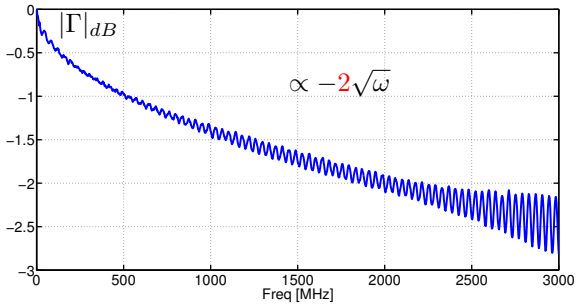


Coaxial cable: reflection and transmission

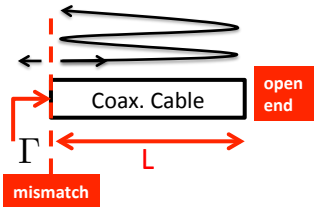








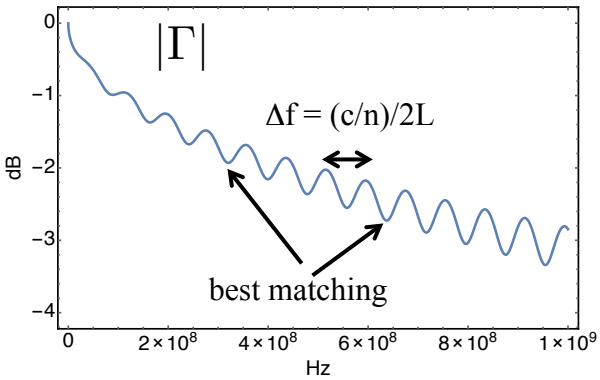
Open Coaxial Cable: source mismatch



$L = m\,\lambda/2$ $\quad \lambda_m = 2L/m$ **Standing wave**

$f_m = m\,(c/n)/\,2L$ $\quad n = \sqrt{\varepsilon_r}$

n = refraction index



$$n = c/(\Delta f\, 2\, L)$$