

In a conducting medium:

Good Conductor

Good Dielectric

Exact

$$\alpha \approx \sqrt{\pi f \mu \sigma} \quad \alpha \approx \frac{\sigma}{2} \sqrt{\frac{\mu}{\epsilon}} \quad \alpha = \omega \sqrt{\frac{\epsilon \mu}{2}} \left[\sqrt{1 + \left(\frac{\sigma}{\omega \epsilon} \right)^2} - 1 \right]^{1/2}$$

$$\beta \approx \sqrt{\pi f \mu \sigma} \quad \beta \approx \omega \sqrt{\mu \epsilon} \left(1 + \frac{1}{8} \left(\frac{\sigma}{\omega \epsilon} \right)^2 \right) \quad \beta = \omega \sqrt{\frac{\epsilon \mu}{2}} \left[\sqrt{1 + \left(\frac{\sigma}{\omega \epsilon} \right)^2} + 1 \right]^{1/2}$$

$$\eta_c \approx (1 + j) \frac{\alpha}{\sigma} \quad \eta_c \approx \sqrt{\frac{\mu}{\epsilon}} \left(1 + j \frac{\sigma}{2 \omega \epsilon} \right) \quad \eta_c = \frac{\omega \mu}{\sqrt{\alpha^2 + \beta^2}} \exp \left(\tan^{-1} (\alpha / \beta) \right)$$

$$\bar{P}_{av} = \frac{1}{2} \operatorname{Re} [\bar{E} X \bar{H}^*]$$

$$\Gamma_{\perp} = \frac{\eta_2 \cos \theta_i - \eta_1 \cos \theta_t}{\eta_2 \cos \theta_i + \eta_1 \cos \theta_t} \quad \Gamma_{\parallel} = \frac{\eta_2 \cos \theta_t - \eta_1 \cos \theta_i}{\eta_2 \cos \theta_t + \eta_1 \cos \theta_i}$$

$$T_{\perp} = \frac{2 \eta_2 \cos \theta_i}{\eta_2 \cos \theta_i + \eta_1 \cos \theta_t} \quad T_{\parallel} = \frac{2 \eta_2 \cos \theta_t}{\eta_2 \cos \theta_t + \eta_1 \cos \theta_i}$$

$$T_{\perp} = 1 + \Gamma_{\perp} \quad T_{\parallel} = \frac{\cos \theta_i}{\cos \theta_t} (1 + \Gamma_{\parallel})$$