$$z = 0$$

Medium #1:

$$\mu_o\mu_{r1}, \quad \varepsilon_{1c} = \varepsilon_o\varepsilon_{r1} - j(\varepsilon_1^{''} + \frac{\sigma_1}{\omega})$$

$$\mathbf{a}_{ni} = \mathbf{a}_z$$

$$\mathbf{E}_i(z) = \mathbf{a}_x E_{io} e^{-jk_{1c}z}$$

$$\mathbf{H}_i(z) = \frac{1}{\eta_{1c}}\mathbf{a}_z \times \mathbf{E}_i(z) = \mathbf{a}_y \frac{E_{io}}{\eta_{1c}} e^{-jk_{1c}z}$$

$$k_{1c} = \omega\sqrt{\mu_o\mu_{r1}\varepsilon_{1c}}, \quad \eta_{1c} = \sqrt{\frac{\mu_o\mu_{r1}}{\varepsilon_{1c}}}$$

Incident

$$\mathbf{a}_{nr} = -\mathbf{a}_z$$

$$\mathbf{E}_r(z) = \mathbf{a}_x E_{ro} e^{+jk_{1c}z}$$

$$\mathbf{H}_r(z) = \frac{1}{\eta_{1c}}(-\mathbf{a}_z) \times \mathbf{E}_r(z) = -\mathbf{a}_y \frac{E_{ro}}{\eta_{1c}} e^{+jk_{1c}z}$$

$$k_{1c} = \omega\sqrt{\mu_o\mu_{r1}\varepsilon_{1c}}, \quad \eta_{1c} = \sqrt{\frac{\mu_o\mu_{r1}}{\varepsilon_{1c}}}$$

Reflected

Medium #2:

$$\mu_o\mu_{r2}, \quad \varepsilon_{2c} = \varepsilon_o\varepsilon_{r2} - j(\varepsilon_2^{''} + \frac{\sigma_2}{\omega})$$

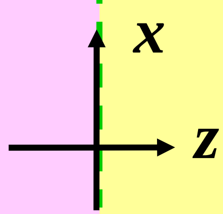
Trans
-mitted

$$\mathbf{a}_{nt} = \mathbf{a}_z$$

$$\mathbf{E}_t(z) = \mathbf{a}_x E_{to} e^{-jk_{2c}z}$$

$$\mathbf{H}_t(z) = \frac{1}{\eta_{2c}}\mathbf{a}_z \times \mathbf{E}_r(z) = \mathbf{a}_y \frac{E_{to}}{\eta_{2c}} e^{-jk_{2c}z}$$

$$k_{2c} = \omega\sqrt{\mu_o\mu_{r2}\varepsilon_{2c}}, \quad \eta_{2c} = \sqrt{\frac{\mu_o\mu_{r2}}{\varepsilon_{2c}}}$$



x

z

Medium #1:

$\mu_o \mu_{r1}, \quad \varepsilon_{1c} = \varepsilon_o \varepsilon_{r1} - j(\varepsilon_1^{''} + \frac{\sigma_1}{\omega})$

Medium #2:

$\mu_o \mu_{r2}, \quad \varepsilon_{2c} = \varepsilon_o \varepsilon_{r2} - j(\varepsilon_2^{''} + \frac{\sigma_2}{\omega})$

$$\boxed{\begin{aligned} \mathbf{E}_1 &= \mathbf{E}_i(z) + \mathbf{E}_r(z) \\ \mathbf{H}_1 &= \mathbf{H}_i(z) + \mathbf{H}_r(z) \end{aligned}}$$

Incident

$\oplus$

Reflected

Transmitted

$$\boxed{\begin{aligned} \mathbf{E}_2 &= \mathbf{E}_t(z) \\ \mathbf{H}_2 &= \mathbf{H}_t(z) \end{aligned}}$$

$\mathbf{a}_n = \mathbf{a}_z$

$z = 0$

$$\boxed{\begin{aligned} z = 0: &\quad \mathbf{E}_{1t}(z) = \mathbf{E}_{2t}(z) \\ z = 0: &\quad \mathbf{a}_n \times [\mathbf{H}_1(z) - \mathbf{H}_2(z)] = 0 \end{aligned}}$$

Medium #1:

$$\mu_o\mu_{r1},\ \ \varepsilon_{1c} = \varepsilon_o\varepsilon_{r1} - j(\varepsilon_1'' + \frac{\sigma_1}{\omega})$$

Medium #2:

$$\mu_o\mu_{r2},\ \ \varepsilon_{2c} = \varepsilon_o\varepsilon_{r2} - j(\varepsilon_2'' + \frac{\sigma_2}{\omega})$$

Incident Amplitude: E_{io}

Incident

Trans
-mitted

Transmitted Amplitude: E_{to}

$$\tau = \frac{E_{to}}{E_{io}} = \frac{2\eta_{2c}}{\eta_{2c} + \eta_{1c}}$$

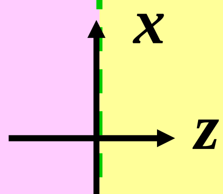
“Transmission coefficient”

Reflect
-ed

Reflected Amplitude: E_{ro}

$$\Gamma = \frac{E_{ro}}{E_{io}} = \frac{\eta_{2c} - \eta_{1c}}{\eta_{2c} + \eta_{1c}}$$

“Reflection coefficient”

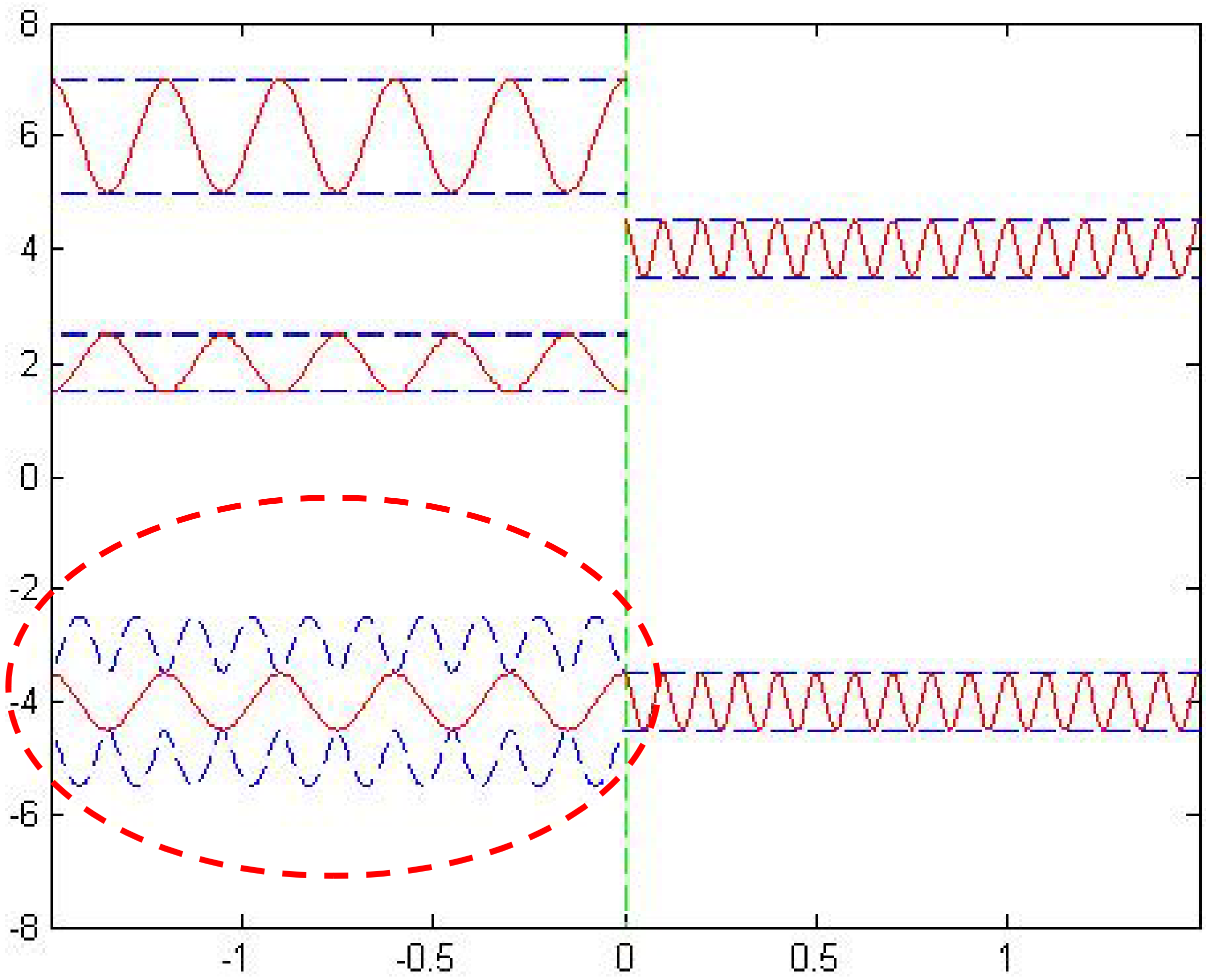


Medium #1: lossless

$\mu_o \mu_{r1}, \quad \varepsilon_{1c} = \varepsilon_o \varepsilon_{r1}$

Medium #2: Lossless

$\mu_o \mu_{r2}, \quad \varepsilon_{2c} = \varepsilon_o \varepsilon_{r2}$



Medium #1: lossless

$$\mu_o\mu_{r1},\quad \varepsilon_{1c} = \varepsilon_o\varepsilon_{r1}$$

$$\beta_1 = Re(k_1) = \omega\sqrt{\mu_o\mu_{r1}\varepsilon_o\varepsilon_{r1}}$$

$$\mathbf{a}_{ni} = \mathbf{a}_z$$

$$\mathbf{E}_i(z) = \mathbf{a}_x E_{io} e^{-jk_{1c}z}$$

$$\mathbf{H}_i(z) = \frac{1}{\eta_{1c}}\mathbf{a}_z \times \mathbf{E}_i(z) = \mathbf{a}_y \frac{E_{io}}{\eta_{1c}} e^{-jk_{1c}z}$$

$$k_{1c} = \omega\sqrt{\mu_o\mu_r\varepsilon_o\varepsilon_{r1}},\quad \eta_{1c} = \sqrt{\frac{\mu_o\mu_{r1}}{\varepsilon_o\varepsilon_{r1}}}$$

$$\mathbf{a}_{nr} = -\mathbf{a}_z$$

$$\mathbf{E}_r(z) = \mathbf{a}_x E_{ro} e^{+jk_{1c}z}$$

$$\mathbf{H}_r(z) = \frac{1}{\eta_{1c}}\mathbf{a}_z \times \mathbf{E}_r(z) = -\mathbf{a}_y \frac{E_{ro}}{\eta_{1c}} e^{+jk_{1c}z}$$

$$k_{1c} = \omega\sqrt{\mu_o\mu_{r1}\varepsilon_o\varepsilon_{r1}},\quad \eta_{1c} = \sqrt{\frac{\mu_o\mu_{r1}}{\varepsilon_o\varepsilon_{r1}}}$$

$$\mathbf{E}_1 = \mathbf{E}_i(z) + \mathbf{E}_r(z) = \mathbf{E}_i(z)(1+\Gamma e^{+j2k_1z})$$

$$\mathbf{H}_1 = \mathbf{H}_i(z) + \mathbf{H}_r(z) = \mathbf{H}_i(z)(1-\Gamma e^{+j2k_1z})$$

$$\Rightarrow |\mathbf{E}_1| = |E_{io}||1+\Gamma e^{+j2k_1z}| = |E_{io}||1+\Gamma e^{+j2\frac{2\pi}{\lambda_1}z}|$$

$$\Rightarrow |\mathbf{H}_1| = |\frac{E_{io}}{\eta_1}||1-\Gamma e^{+j2k_1z}| = |\frac{E_{io}}{\eta_1}||1-\Gamma e^{+j2\frac{2\pi}{\lambda_1}z}|$$

$\Rightarrow$ **Standing Wave Ratio (SWR)**

$$S = \frac{|\mathbf{E}|_{max}}{|\mathbf{E}|_{min}} = \frac{|\mathbf{H}|_{max}}{|\mathbf{H}|_{min}} = \frac{1+|\Gamma|}{1-|\Gamma|}$$