

# APPENDIX C

## WAVE RELATIONS

### FREE SPACE

$$\beta_0 = \frac{\omega}{c} = \omega \sqrt{\mu_0 \epsilon_0} = \frac{2\pi}{\lambda_0} = \frac{2\pi f}{c} = \frac{\pi f_M}{150}$$

$$\epsilon_0 c = \sqrt{\frac{\epsilon_0}{\mu_0}} = \frac{1}{120\pi}$$

$$\mu_0 c = \sqrt{\frac{\mu_0}{\epsilon_0}} = 120\pi$$

$$\epsilon_0 \omega = \frac{\beta_0}{120\pi}$$

$$\mu_0 \omega = 120\pi \beta_0$$

$$\frac{\beta_0}{120\pi \omega \epsilon_0} = \frac{1}{120\pi c \epsilon_0} = 1$$

$$\frac{120\pi \beta_0}{\omega \mu_0} = \frac{120\pi}{\mu_0 c} = 1$$

### ANY MEDIUM

$$Z = \sqrt{\frac{\mu}{\epsilon}} \quad \text{intrinsic impedance}$$

$$\beta = \frac{\omega}{v} = \omega \sqrt{\mu \epsilon} = \frac{2\pi}{\lambda} = \frac{2\pi f}{v}$$

$$\frac{\beta}{Z\omega\varepsilon} = \frac{1}{Z\varepsilon v} = 1$$

$$\frac{Z\beta}{\omega\mu} = \frac{Z}{\mu v} = 1$$

### PLANE WAVE IN FREE SPACE

$$E = 120\pi H = \sqrt{\frac{\mu_0}{\varepsilon_0}} H = \frac{B}{\sqrt{\mu_0\varepsilon_0}} = cB = \frac{\omega}{\beta_0} B$$