

1) Calculate the length and width of the Rectangular patch antenna operating at a frequency of 4 GHz. The Substrate is made of FR4 epoxy, with a relative Permittivity of 4.3. The height of the Substrate is assumed to be 1.6 mm.

Soln.

$$f_r = 4 \text{ GHz}$$

$$h = 1.6 \text{ mm}$$

$$\epsilon_r = 4.3$$

$$|L| = \frac{c}{2f_r \sqrt{\frac{\epsilon_r + 1}{2}}}$$
$$= \frac{3 \times 10^8}{2 \times 4 \times 10^9 \sqrt{\frac{4.3 + 1}{2}}}$$

$$|L| = 0.023 \text{ m}$$

To find the length

$$\epsilon_{r\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[\frac{1}{\sqrt{1 + 12 \left(\frac{h}{|L|} \right)}} \right]$$

$$\Sigma_{\text{reft}} = \frac{4.3+1}{2} + \frac{4.3-1}{2} \left[\frac{1}{\sqrt{1+12 \left(\frac{0.0016}{0.023} \right)}} \right] \quad \Delta L = 0.412h \left[\frac{(\Sigma_{\text{reft}} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\Sigma_{\text{reft}} - 0.258) \left(\frac{W}{h} + 0.8 \right)} \right]$$

$$\Sigma_{\text{reft}} = 3.868$$

$$L_{\text{eff}} = \frac{C}{2f_r \sqrt{\Sigma_{\text{reft}}}}$$

$$= \frac{3 \times 10^8}{2 \times 4 \times 10^9 \sqrt{3.868}}$$

$$L_{\text{eff}} = 0.019 \text{ m}$$

$$\Delta L = 0.412 \times 0.0016 \left[\frac{(3.868 + 0.3) \left(\frac{0.023}{0.0016} + 0.264 \right)}{(3.868 - 0.258) \left(\frac{0.023}{0.0016} + 0.8 \right)} \right]$$

$$\Delta L = 0.000734 \text{ m}$$

$$L = L_{\text{eff}} - 2\Delta L$$

$$= 0.019 - 2 \times 0.000734$$

$$L = 0.01753 \text{ m} \approx 17.53 \text{ mm}$$

