microstrip solv. examples

ex.1

Design a rectangular microstrip Antenna using a substrate (Rt/duriod 5880) with dielectric Constant of 2.2, h = 0.1588 cm so as to resonate at 10 GHz

Solu:

the width $W = \frac{c}{2f_o}\sqrt{\frac{2}{\varepsilon_r+1}}$

$$= \frac{3*10^{10}}{2*10*10^9}\sqrt{\frac{2}{2.2+1}} = 1.186 \text{ cm}$$

the effective dielectric constant

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

$$= \frac{2.2+1}{2} + \frac{2.2-1}{2}\left[1+12\frac{0.1588}{1.186}\right]^{-1/2} = 1.972 \text{ cm}$$

the extended length $\Delta L = \frac{h}{\sqrt{\varepsilon_{eff}}} = \frac{0.1588}{\sqrt{1.972}} = 0.113 \text{ cm}$

the effective length $L_{eff} = L + 2\Delta L = \frac{c}{2f\sqrt{\varepsilon_{eff}}}$

$$= \frac{3*10^{10}}{2*10*10^9\sqrt{1.972}} = 1.068 \text{ cm}$$

∴ Actual length $L = L_{eff} - 2\Delta L$

$= 1.068 - 2*0.113 = 0.842 \text{ Cm}$

ex.2

A microstrip Line is used as a feed Line to a microstrip patch. The Substrate of the Line is Alumina ($\varepsilon_r \approx 10$) while the dimensions of the Line are $\frac{W}{h} = 1.2$ and $\frac{t}{h} = 0$. Determine the effictive dielectric constant and characteristic impedance of the Line

Solu: Given: $\varepsilon_r = 10$, $\frac{W}{h} = 1.2 > 1$, $\frac{t}{h} = 0$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

$$= \frac{10+1}{2} + \frac{10-1}{2}\left[1 + 12\left(\frac{1}{1.2}\right)\right]^{-1/2} = 6.857$$

When $\frac{W}{h} > 1$

$$\therefore Z_c = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{W_o}{h} + 1.393 + 0.667\ln\left(\frac{W_o}{h} + 1.444\right)\right]}$$

$$= \frac{120\pi}{\sqrt{6.857}\left[1.2 + 1.393 + 0.667\ln(1.2 + 1.444)\right]}$$

$= 44.414\ \Omega$

example 3

A microstrip transmission Line of beryllium oxide ($\varepsilon_r = 6.8$) has a width to height ratio of $w/h = 1.5$ Assuming that the thickness to height ratio is $t/h = 0$, determine

(a) ε_{eff}

(b) characteristic impedance of the Line

Solu:

$$\varepsilon_{eff} = \frac{6.8+1}{2} + \frac{6.8-1}{2}\left[1+12\left(\frac{1}{1.5}\right)\right]^{-1/2} = 4.8667$$

$\because w/h = 1.5 > 1$

$$\therefore Z_c = \frac{120\pi}{\sqrt{4.8667}\,[1.5+1.393+0.667\ln(1.5+1.444)]}$$

$= 47.296\ \Omega$

example 4

Design a rectangular microstrip Antenna so that it will resonate at 2GHZ the idealistic losses substrate (RT/Duroid 6010.2) has a dielectric Constant $\varepsilon_r = 10.2$ and height 0.05 in

Determine the physical diemensions of the patch

Solu: Req: $f_o = 2GHZ$, $\varepsilon_r = 10.2$, $h = 0.05\,in = 0.05*2.5 = 0.125$ cm

$$W = \frac{c}{2f_o}\sqrt{\frac{2}{\varepsilon_r+1}}$$

$$= \frac{3*10^{10}}{2*2*10^9}\sqrt{\frac{2}{10.2+1}} = 3.1693\ cm$$

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-1/2}$$

$$\varepsilon_{eff} = \frac{10.2+1}{2} + \frac{10.2-1}{2}\left[1+12\,\frac{0.125}{3.1693}\right]^{-1/2}$$

$$= 9.39$$

$$\Delta L = \frac{h}{\sqrt{\varepsilon_{eff}}} = \frac{0.125}{\sqrt{9.39}} = 0.04079\,cm$$

Actual length $L = L_{eff} - 2\Delta L$

$$= \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta L$$

$$= \frac{3*10^{10}}{2*2*10^{9}\sqrt{9.39}} - (2*0.04079\,cm)$$

$$= 2.366\ cm$$

EX.5 (example on CST Program)

Design a RecTangular microstrip Antenna using a substrate (Alron Di 870 Loss free) with Dielectric Constant ($\varepsilon_r = 2.32$) and height $h = 0.4$ cm to resonate at (2.4 GHZ ⟶ 2.483 GHZ) to use it in wifi Application

ANS:

firstly choose the center frequency $f_r = 2.4415$ GHz

then calculate W&L As shown

$$W = \frac{c}{2f_o}\sqrt{\frac{2}{\varepsilon_r+1}}$$

$$= \frac{3*10^{10}}{2*2.4415*10^9}\sqrt{\frac{2}{2.32+1}} = 4.76 \text{ Cm}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

$$= \frac{2.32+1}{2} + \frac{2.32-1}{2}\left[1+12\frac{0.4}{4.76}\right]^{-1/2} = 2.126$$

$$\Delta L = \frac{h}{\sqrt{\varepsilon_{eff}}} = \frac{0.4}{\sqrt{2.126}} = 0.274 \text{ Cm}$$

$$L_{eff} = L + 2\Delta L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} = \frac{3*10^{10}}{2*2.4415*10^9\sqrt{2.126}} = 4.214 \text{ Cm}$$

$$L = L_{eff} - 2\Delta L = 4.214 - (2*0.274) = 3.67 \text{ cm}$$