Microstrip calculations

For er = 10.2

For Z_o in ranges $\leq 44 - 2\varepsilon_r$ ie Zo <= 23.6Ω

$$\frac{W}{h} = \frac{2}{\pi}\left\{B - 1 - Ln(2B - 1) + \frac{\varepsilon_r - 1}{2\varepsilon_r}\left[Ln(B - 1) + 0.293 - \frac{0.517}{\varepsilon_r}\right]\right\}$$

$$\text{Where } B = \frac{377\pi}{2Z_o\sqrt{\varepsilon_r}}$$

$$B = \frac{377\pi}{2 * 25\sqrt{10.2}} = 7.41 \quad \text{For } Z_0 = 25\Omega$$

$$\frac{W}{h} = \frac{2}{\pi}\left\{7.41 - 1 - Ln(2 * 7.41 - 1) + \frac{10.2 - 1}{2 * 10.2}\left[Ln(7.41 - 1) + 0.293 - \frac{0.517}{10.2}\right]\right\}$$

$$\frac{W}{h} = 1.81 \quad \therefore \text{for a dielectric thickness of 0.635mm width of track} = \boxed{1.2\text{mm}}$$

For $Z_o \geq 44 - 2\varepsilon_r$ ie Zo >= 23.6Ω

$$\frac{W}{h} = \frac{8e^{n}}{e^{2n} - 2}$$

$$\text{Where } n = \sqrt{\frac{\varepsilon_r + 1}{2}.\frac{Zo}{60} + \frac{\varepsilon_r - 1}{\varepsilon_r + 1}.\left(0.226 + \frac{0.12}{\varepsilon_r}\right)}$$

For $Z_o \geq 44 - 2\varepsilon_r$ Impedance required = 50Ω

$$44 - 2\varepsilon_r = 23.6\Omega$$

$$\frac{W}{h} = \frac{8e^{2.167}}{e^{2*2.167} - 2} = 0.94$$

$$\text{Where } n = \sqrt{\frac{10.2 + 1}{2}.\frac{50}{60} + \frac{10.2 - 1}{10.2 + 1}.\left(0.226 + \frac{0.12}{10.2}\right)} = 2.167$$

Using this calculated value of W/h = 0.94 it is possible to calculate the line width required to give us a 50Ω line.

h = 0.635 therefore W = 0.635 * 0.94 = **0.59mm**

Using this calculated value of W/h = 0.94 it is possible to calculate the effective dielectric constant:-

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 10.\frac{h}{w}\right)^{-a.b}$$

$$\text{where } b = 0.564\left(\frac{\varepsilon_r - 0.9}{\varepsilon_r + 3}\right)^{0.053}$$

$$\text{and } a = 1 + \left(\frac{1}{49}\right)Ln\left[\frac{(W/h)^4 + (W/52h)^2}{(W/h)^4 + 0.432}\right] + \left(\frac{1}{18.7}\right)Ln\left(1 + (W/18.1h)^3\right)$$

$$\therefore b = 0.553 \quad \text{and} \quad a = 0.9911 \quad \therefore ab = 0.548$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 10.\frac{h}{w}\right)^{-a.b} \quad \varepsilon_{eff} = \frac{10.2 + 1}{2} + \frac{10.2 - 1}{2}\left(1 + 10 * \frac{1}{0.94}\right)^{-0.548}$$

$$\varepsilon_{eff} = 6.80$$

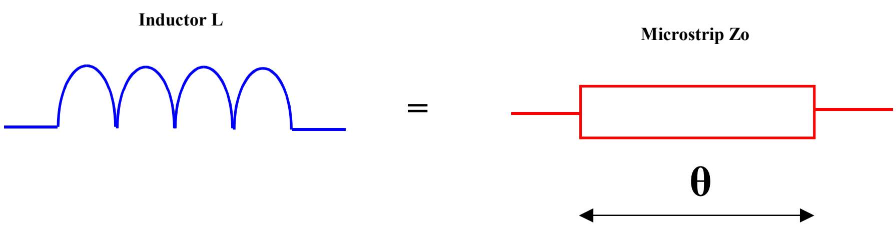
Length of transmission line can now be calculated:-

Length of 'n' degrees Transmission Line

$$\lambda_{air} = \frac{c}{f} = \frac{3E8}{5E9} = 0.06m \qquad \lambda_{microstrip} = \frac{\lambda}{\varepsilon_{eff}} = \frac{0.06}{\sqrt{6.80}} = 0.023m$$

$$\therefore Length = \frac{\text{nn degrees required}}{360} * 0.023 =$$

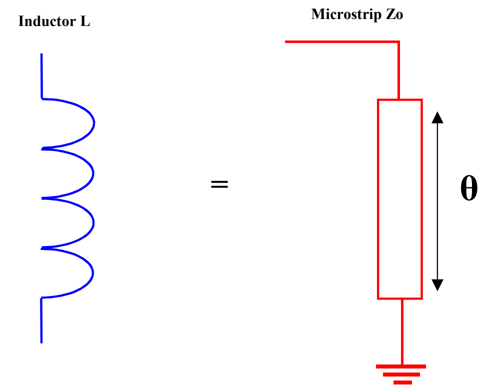
Calculation of micro-strip series inductor



$$\omega_L = Zo.\sin\theta$$

$$Where\,\theta < 90^0 \left(90^0 = \frac{\lambda_{op}}{4} \right)$$

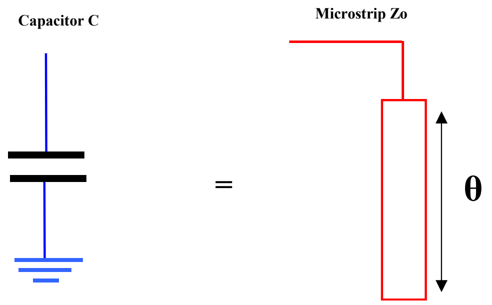
Calculation of micro-strip shunt inductor



$$\omega_L = Zo.\tan\theta$$

$$Where\,\theta < 90^0 \left(90^0 \frac{\lambda_{op}}{4} \right)$$

Calculation of micro-strip shunt capacitor



$$\omega C = \frac{\tan\theta}{Zo}$$

$$Where\,\theta < 90^0 \left(90^0 \frac{\lambda_{op}}{4} \right)$$

Series C are realised using chip capacitors, Inter-digital capacitors or gaps in tracks.