Constants used:

$\varepsilon_0 := 8.854187817 \cdot 10^{-12} \cdot \frac{farad}{m}$ $\mu_0 := 4 \cdot \pi \cdot 10^{-7} \cdot \frac{newton}{amp^2}$ $c := 3.0 \cdot 10^{8} \cdot \frac{m}{sec}$

$Z_0 := \sqrt{\frac{\mu_0}{\varepsilon_0}}$ $Z_0 = 376.73\ \Omega$ $\lambda = \frac{c}{f} \cdot \sqrt{\mu_r \cdot \varepsilon_r}$

********** Microstrip Antenna Design **********

$f := 5800MHz$ $t := 0.062in$ $t = 0.157\,cm$ $Q := 40$ $\varepsilon_r := 4.5$

$\lambda_0 := \frac{c}{f}$ $\lambda_0 = 5.172\,cm$ $\frac{t}{\lambda_0} = 3.045\,\%$ should be <1%

a) find the a and b dimensions

select b dimension

$a_{approx} := \frac{\lambda_0}{2} \cdot \frac{1}{\sqrt{\varepsilon_r}}$ $a_{approx} = 1.219\,cm$

let $b := \frac{2.5}{2} \cdot a_{approx}$ $b = 1.524\,cm$

determine "a" dimension

$\varepsilon_{reff} := \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \cdot \sqrt{1 + \frac{10 \cdot t}{b}}$ $\varepsilon_{reff} = 5.245$

$\Delta a := t \cdot \left[0.412 \cdot \frac{\left(\varepsilon_{reff} + 0.3\right) \cdot \left(\frac{b}{t} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right) \cdot \left(\frac{b}{t} + 0.813\right)} \right]$ $\Delta a = 0.068\,cm$

The error in ignoring Δa is: $\frac{\Delta a}{a_{approx}} = 5.608\,\%$

The center frequency resonance error is: $f \cdot \frac{\Delta a}{a_{approx}} = 325.242\,MHz$

the corrected length:

$$a := \frac{c}{2 \cdot f} \cdot \frac{1}{\sqrt{\varepsilon_{reff}}} - \Delta a \qquad a = 1.061\,cm$$

b) find the feed location:

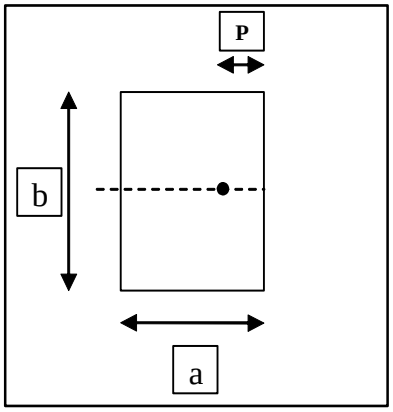
$$Z := Z_0 \cdot \sqrt{\frac{1}{\varepsilon_r}} \qquad Z = 177.592\ \Omega \qquad k := \frac{2 \cdot \pi}{\lambda_0} \cdot \sqrt{\varepsilon_r} \qquad k = 257.687\ \frac{1}{m}$$

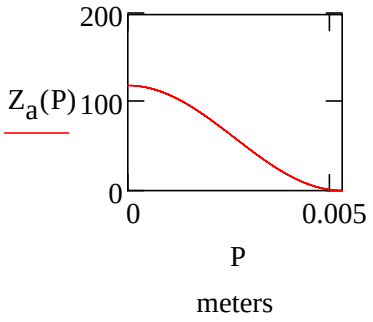
$$t = 1.575 \times 10^{-3}\ m$$

let $Z_a := 50\Omega$

$$Z_a = \frac{Q \cdot Z \cdot t}{\varepsilon_r \cdot k} \cdot \psi^2 \qquad \psi = \sqrt{\frac{2}{a \cdot b}} \cos\left(\frac{\pi \cdot P}{a}\right)$$

$$Z_a(P) := \frac{Q \cdot Z \cdot t}{\varepsilon_r \cdot k} \cdot \frac{2}{a \cdot b} \cos\left(\frac{\pi \cdot P}{a}\right)^2$$





$P := .29cm$

$Z_a(P) = 50.944\ \Omega$

Note: If Za is too small or P is too small, decrease initial b width to increase the Za profile

maximum directivity :

$$\theta_{BE} := 2 \cdot \operatorname{acos}\left[\sqrt{\frac{7.03\lambda_0^{\,2}}{\left(3a^2 + t^2\right) \cdot 4\pi^2}}\right] \qquad \theta_{BE} = 68.412j\ deg$$

$$k_0 := \frac{2\pi}{\lambda_0} \qquad k_0 = 121.475\ \frac{1}{m}$$

$$\theta_{BH} := 2 \cdot \operatorname{acos}\left(\sqrt{\frac{1}{2 + k_0 \cdot b}}\right) \qquad \theta_{BH} = 118.73\ deg$$