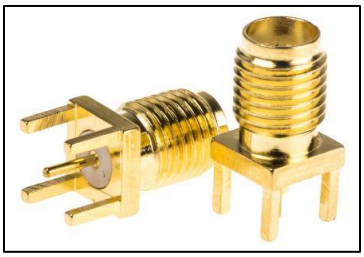
Names: _____

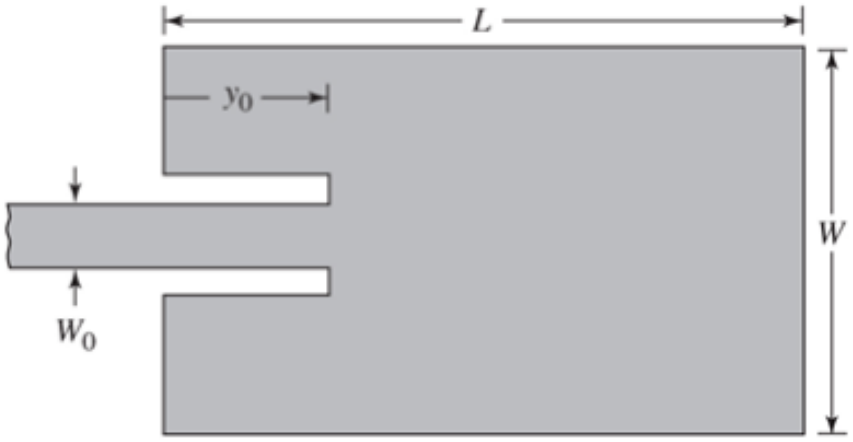
The project objective is to build a Wi-Fi (2.4 GHz) microstrip patch antenna.

Rectangular Microstrip Antenna Design

One of the most popular type of microstrip antenna is the rectangular patch. You will calculate the parameters needed for the project.

This receiving antenna will be connected to a $50\ \Omega$ transmission line. You will use a copper clad substrate FR-4 printed circuit board, which has a permittivity $\epsilon_r \cong 4.40$ and approximate height substrate of $1.55\ \text{mm}$. Consider the thickness of the antenna patch and ground to be around $t \cong 0.033\ \text{mm}$. The feed of the microstrip transmission line will be connected to an female SMA straight PCB mount, which connects to a transmission line with $50\ \Omega$ characteristic impedance, as shown in the figure.





(a) Calculate the dimensions of the rectangular patch antenna (L and W) with the parameters mentioned above.

(b) Using the new found parameters, calculate the input resistance using the admittance approach. Do not take into account mutual effects.

(c) Use at least two online rectangular patch antenna calculation websites, calculate the input impedance of the antenna with the dimensions found in part (a).

(d) Using the inset feed technique, determine the length y_0 the feed needs to be in the antenna to match $50\ \Omega$. Use the impedance found in part (b).

(e) Using the accurate formulas for the characteristic impedance of the microstrip transmission line, determine the width of the transmission line W_0 to be $50\ \Omega$.

$L =$ _____ cm $W =$ _____ cm

$y_0 =$ _____ cm $W_0 =$ _____ cm

$R_{in}(numerical) =$ _____ Ω

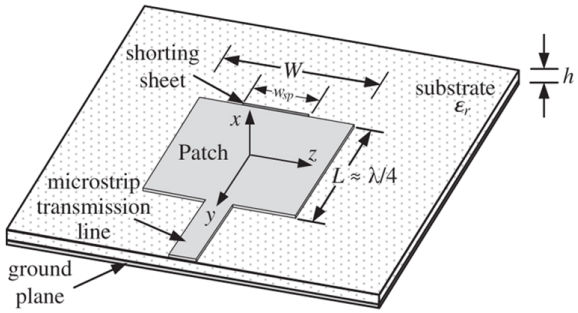
$R_{in}(website\ 1) =$ _____ Ω website: _____

$R_{in}(website\ 2) =$ _____ Ω website: _____

Miniaturization of Microstrip Antenna

In order to accommodate antennas in small spaces we need to know how to miniaturize the antennas. There are many ways of decreasing the size of the antennas: quarter-wavelength, planar inverted f-antennas, capacitive loading, and meandering.
If you want to miniaturize the antenna, one of the simplest ways is to create a quarter-wavelength microstrip. This is a rectangular microstrip antenna that had its dimensions reduced with an added shorting sheet, as shown in the picture below.

3-D View



(a) Microstrip feed

Fig. 14.45

Design Equations

Resonant length

$$L + W - W_{sp} = \lambda / 4$$

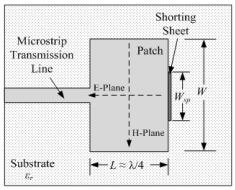
where W_{sp} is the width of the shorting sheet.

If the shorting sheet runs the entire width of the patch,

$$W = W_{sp} \Rightarrow L = \lambda / 4$$

If it is just a pin ($W_{sp} \ll W$)

$$L + W = \lambda / 4$$



(a) Using the design equations, find the parameters L, W, and W_{sp} for the desired frequency. Remember to use the effective permittivity approach.

(b) With the dimensions found in part (a), research about the input impedance of this antenna and calculate it using the dimensions found above. Cite your reference(s).