

1)

*Material : FR-4*  
*Dielectric Constant : 4.3*  
*Desired Frequency : 2.4GHz*  
*Height of the Material : 1.6mm*

2)

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r + 1}} = \frac{c_0}{2f_r}\sqrt{\frac{2}{\epsilon_r + 1}}$$

3)

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[ 1 + 12 \frac{h}{w} \right]^{-\frac{1}{2}}$$

4)

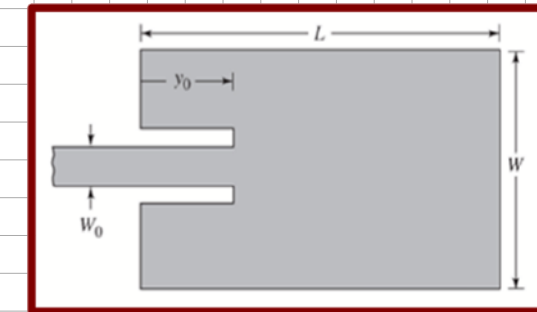
$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{eff} + 0.3) \left( \frac{W}{h} + 0.264 \right)}{(\epsilon_{eff} - 0.258) \left( \frac{W}{h} + 0.8 \right)}$$

5

$$L = \frac{1}{2f_r \sqrt{\epsilon_{reff}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta L$$

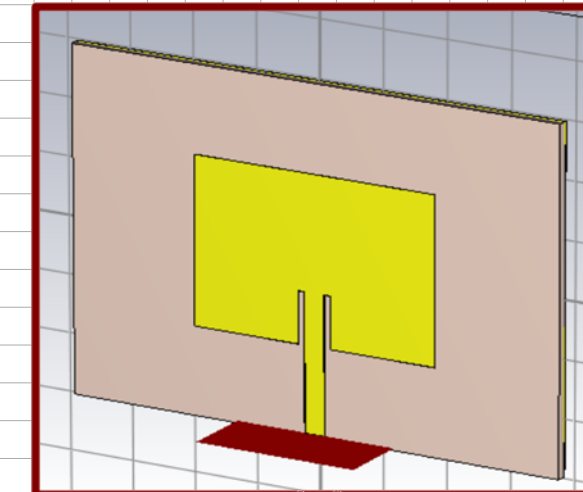
$$L_g = 2 * L$$

$$W_g = 2 * W$$





*Wg : Width of the Ground*  
*Lg : Length of the Ground*

11)



9)

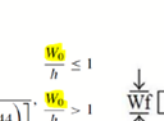




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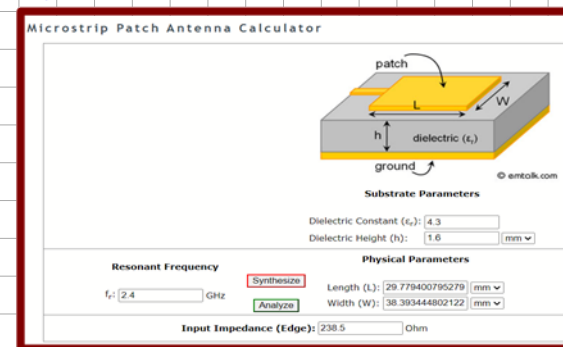
To design the microstrip feed line (inset-fed)

- The input impedance is usually 50 Ω.
- The width of Microstrip feed line (Wf).

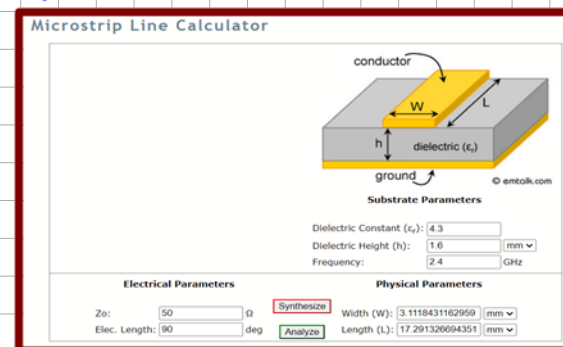
$$Z_c = \begin{cases} \frac{60}{\sqrt{\epsilon_{\text{reff}}}} \ln \left[ \frac{8h}{W_0} + \frac{W_0}{4h} \right], & \frac{W_0}{h} \leq 1 \\ \frac{120\pi}{\sqrt{\epsilon_{\text{reff}}}} \left[ \frac{W_0}{h} + 1.393 + 0.667 \ln \left( \frac{W_0}{h} + 1.444 \right) \right], & \frac{W_0}{h} > 1 \end{cases}$$


where  $W_0$  is the width of the microstrip line, as shown in Figure 14.11.

7)



8)

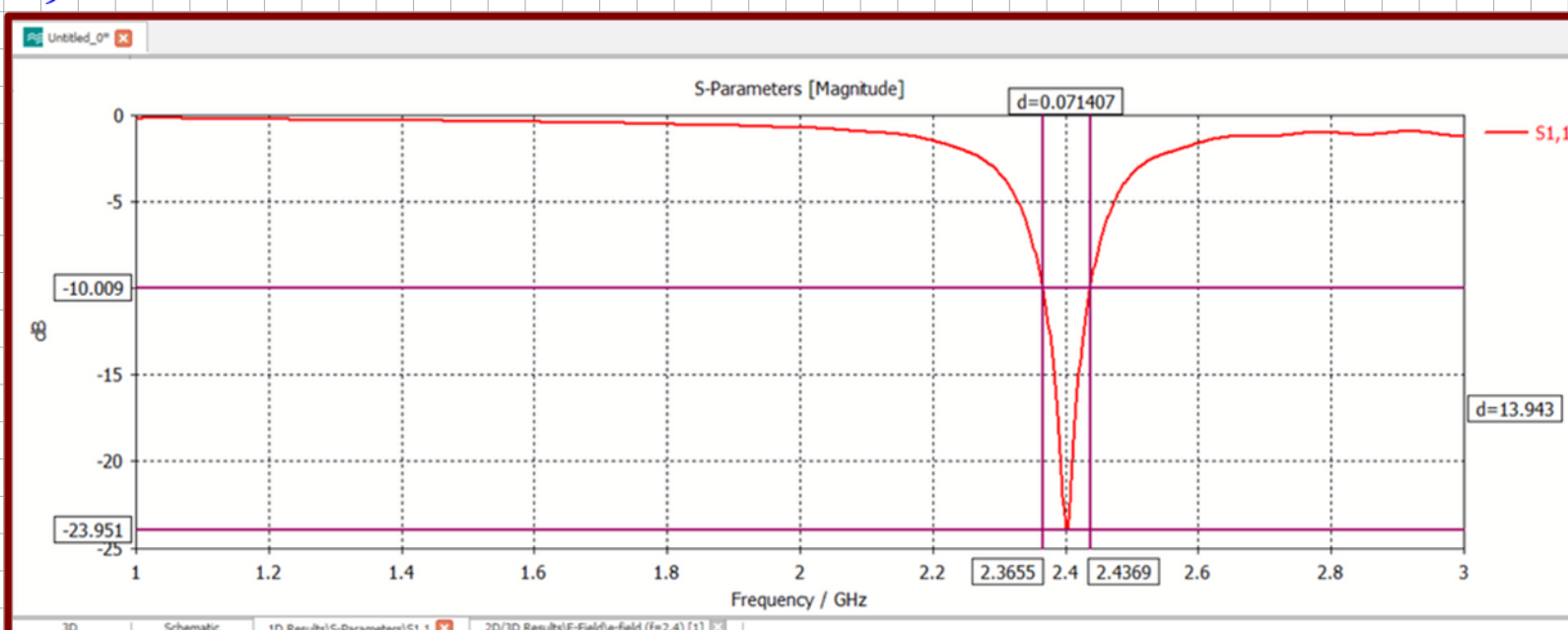


10)

Parameter List				
	Name	Expression	Value	Description
[-]	Ws	= 76.8	76.8	
[-]	Ls	= 59.4	59.4	
[-]	Hs	= 1.6	1.6	
[-]	Wp	= 38	38	
[-]	Lp	= 29	29	
[-]	Hp	= 0.035	0.035	
[-]	Wg	= 5.1	5.1	
[-]	Lg	= 9	9	
[-]	Wf	= 3.1	3.1	
[-]	Lf	= 23.9	23.9	
[-]	Wgr	= 76.8	76.8	
[-]	Lgr	= 59.4	59.4	
[-]	Hg	= 0.035	0.035	
<new parameter>				
<i>Optimized Parameters</i>				
Parameter List		Result Navigator		

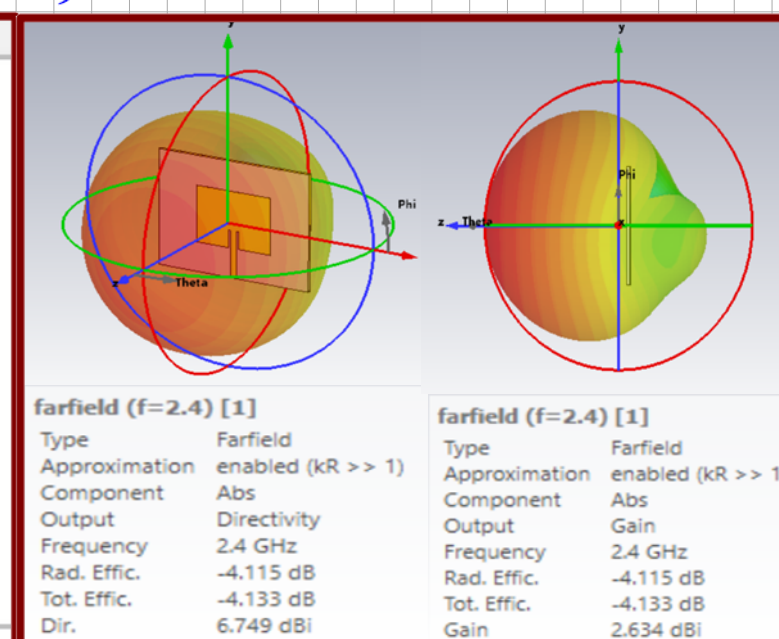
### Optimized Parameters

12)



*VSWR at 2.4GHz is about 1.13  
Then Reflection Coefficient is about 0.06*

13)



14)

## Pyhsical Design Example

