EEC 133 Antennas and Propagation
Final Design and Exam

Date: 11/29/2017 Due: 12/13/2017 at 5pm

Design a patch antenna on a PCB substrate that has a dielectric constant er = 3.0 and a substrate thickness of 0.5 mm and copper metal thickness 0.05mm. The resonant frequency is 3 GHz.

- Question 1 to 3 and question 5a are based on theoretical calculation. Please provide complete equations and final results for each question to obtain full credit.

- Question 4 and question 5b are HFSS simulation. Please provide figures that show your antenna structure in HFSS. For each question, show the plots and conclude the final results. The plots should look nice and clear for full credit. Add some of your comments (if applicable)

1) Determine the width and length of the patch antenna (dimension in mm)

2) Determine the bandwidth and input impedance of the patch antenna

3) Design the input matching network using two methods (See the figures at the end of this project for more details. You need to provide two separate solutions. Your answer should include all the equations, calculation and the final dimensions of the structure in mm)

a) Design the quarter wave transmission line to match the patch antenna to 50Ω.

b) Design the recessed structure to match the antenna to 50Ω

4) In HFSS, create two separate structures (i.e. two simulations) using the PCB substrate above. Each structure includes the patch antenna and one matching circuit as you designed above. For each question below, provide the result for both two cases.

a) Compare the matching results for the 2 cases using S-parameters (plot the input return loss S11 over frequency)?

Which method has better return loss at the center frequency? Which method has wider bandwidth? Note: Your antenna is considered matched only if it has at least -10 dB S(1,1) at the center frequency (i.e. S(1,1) must be smaller than -10 dB). If you do not get the required value, you must go back to your design and do some tuning.

b) Determine the bandwidth of antenna and compare it with calculation

c) Determine the directivity, gain and radiation efficiency

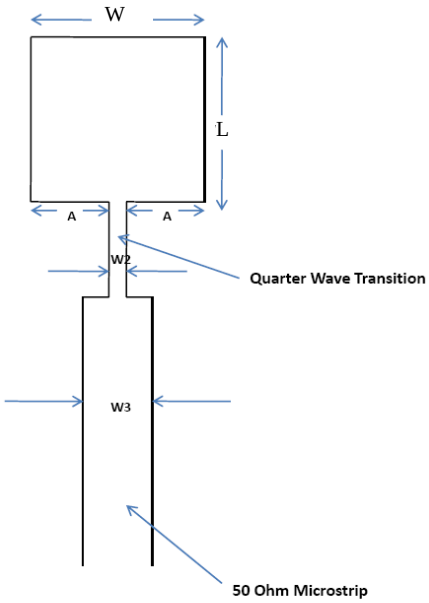
d) Plot the 3D far field pattern

e) Find HPBW

5) Choose one of the two antennas above and design a linear end fire array antenna with N = 4

a) Determine distance d to make sure that the maxima is at $\theta = 0$ degree

b) Simulate the array of N = 4 element and determine the directivity and efficiency of the array.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Quarter Wave Transition
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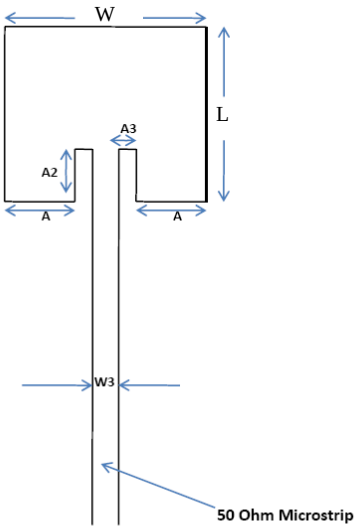
50 Ohm Microstrip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