DESIGN OF WIDE BEAMWIDTH UNIDIRECTIONAL MICROSTRIP ANTENNA AT 3 GHz

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Abstract: *This paper shows that the microstrippatch antenna is designed at 3 GHz. It will be used for transmission of sensor data to the main server. Simulation studies were carried out for single element however to meet the required goal, arrays of 2x1 and 3x1 are carried out. The microstrip array antenna achieved a gain and return loss of 10.32 dB and -18.277 dBi respectively. The antenna was designed using Rogers_ RT_Duroid6002 substrate with a dielectric constant of 2.93 and a thickness of 0.06 inch respectively.*

Keywords: 3 GHz, Inset Feed, Center feed, Offset feed, Array, Return Loss, Gain, Directivity, Substrate thickness, Beam width,

I. INTRODUCTION

In the current era of communication, there is a very large demand by the end user for integrated wireless digital applications. Antennas which are used in these applications should be low profile, light weight, low volume and wide beam-width [1]. To meet these requirements, microstrip antenna is preferred. Although microstrip single antenna has several advantages, it also has several disadvantages such as low gain and low directivity. These disadvantages can be overcome by using multiple patch elements in different configurations called patch arrays [2][3].

In this paper, the design of single, 2x1 and 3x1 patch array microstrip rectangular antennas with microstrip line as feeding method is presented. Quarter-wave transformer is used to match the feeding line to the antennas[2]. The center frequency is determined to operate at 3 GHz. The 3x1 patch array antenna was then design on the substrate type Rogers_ RT_Duroid6002 with dielectric constant of 2.93 and thickness of 0.06 inch. This antenna offers a return loss of -18.277 dB and gain 10.32 dB. The design, simulation and measurements are performed by advanced design system (ADS) 2016 momentum.

II. ARRAY DESIGN

A comparative study has been made in a single patch, 2X1 and 3X1 array. Firstly, a single patch antenna is designed and analyzing its results, which show low gain and directivity, a 2X1 patch antenna array is designed. Further, to improve gain and directivity a 3X1 patch array is designed.

1) Single patch antenna

Selection of a proper substrate is also an important parameter in the design process [1]. In this design, dielectric constant is taken as 2.93, tangent loss 0.0013 and substrate thickness as 0.06 inch.Depending upon dielectric constant and substrate thickness patch width and length are calculated.Dimensions of the patch are as follows:

Table 1: Dimensions of microstrip patch antenna

Parameter	Size of patch (mm)
A	43.8
B	22.3
C	6.5
D	17.9
E	3.8(50 ohm)
F	15.2

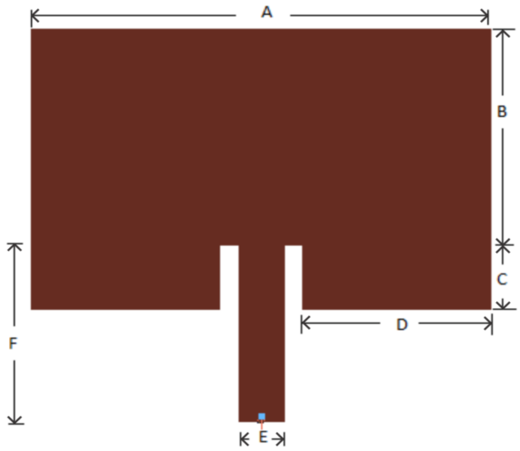

Figure 1: Layout of inset feed single patch antenna

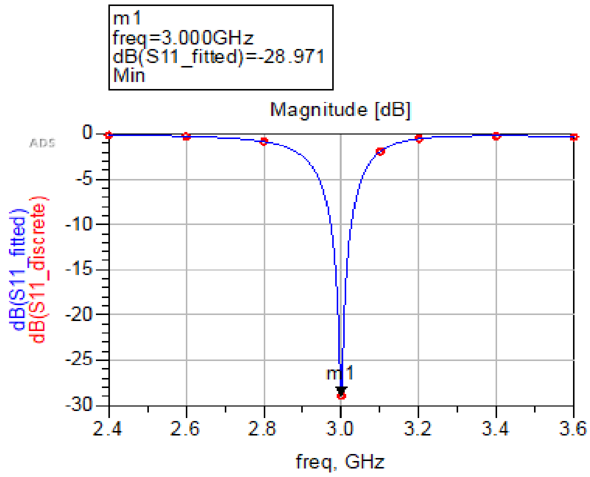

Figure 2: |S11| for single patch antenna

Antenna Parameters

Frequency (GHz)		3
Input power (Watts)		0.00249683
Radiated power (Watts)		0.0020048
Directivity(dBi)		7.24382
Gain (dBi)		6.29063
Radiation efficiency (%)		80.2937
Maximum intensity (Watts/Steradian)		0.000845751
Effective angle (Steradians)		2.37043
Angle of U Max (theta, phi)	2	90
E(theta) max (mag,phase)	0.798272	-12.0792
E(phi) max (mag,phase)	0.00130177	-32.5385
E(x) max (mag,phase)	0.00130177	147.462
E(y) max (mag,phase)	0.797786	-12.0792
E(z) max (mag,phase)	0.0278593	167.921

Figure 3: Antenna parameter for single patch

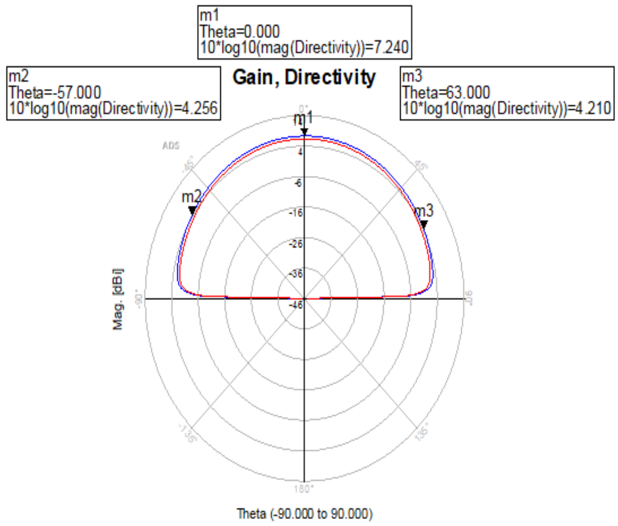

Figure 4: Beam width for single patch antenna

2) Center feeding 2X1 patch array:

The For 2X1 patch Calculating the physical dimensions the feed line network is designed by applying 50Ω feed line which splits into two 83.5 Ω[2]. Using Ads LineCalc tool, width of the microstrip line is calculated as w1=3.8 mm and w2=1.4mm.

The second most important point is the effect of mutual coupling that takes place between first and second patch. Due to this effect side lobes are seen in the radiation pattern. To minimize the side lobes the distance between the two patches must be appropriate. In this paper distance is 0.5λ.

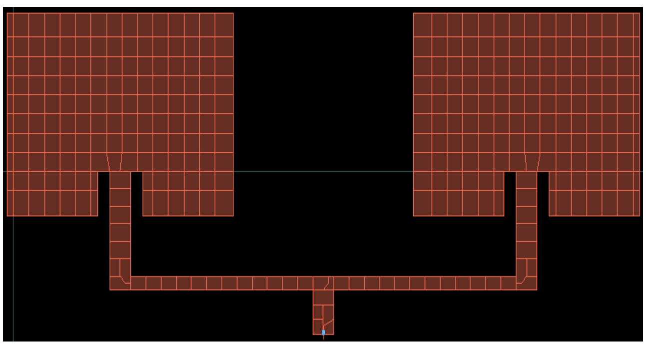

Figure 5: Layout of center feeding 2x1 patch antenna

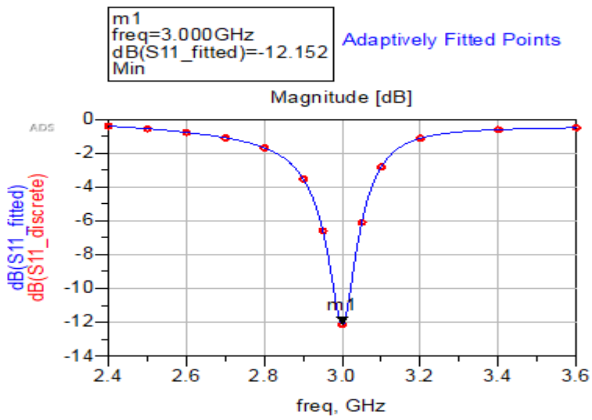

Figure 6: |S11| for center feeding 2x1 patch antenna

Antenna Parameters

Frequency (GHz)		3
Input power (Watts)		0.00234767
Radiated power (Watts)		0.00198587
Directivity(dBi)		9.9242
Gain (dBi)		9.19734
Radiation efficiency (%)		84.589
Maximum intensity (Watts/Steradian)		0.00155297
Effective angle (Steradians)		1.27876
Angle of U Max (theta, phi)	4	90
E(theta) max (mag,phase)	1.08171	105.723
E(phi) max (mag,phase)	7.24593e-05	18.692
E(x) max (mag,phase)	7.24593e-05	-161.308
E(y) max (mag,phase)	1.07908	105.723
E(z) max (mag,phase)	0.0754563	-74.2773

Figure 7: Antenna parameter for 2x1 patch

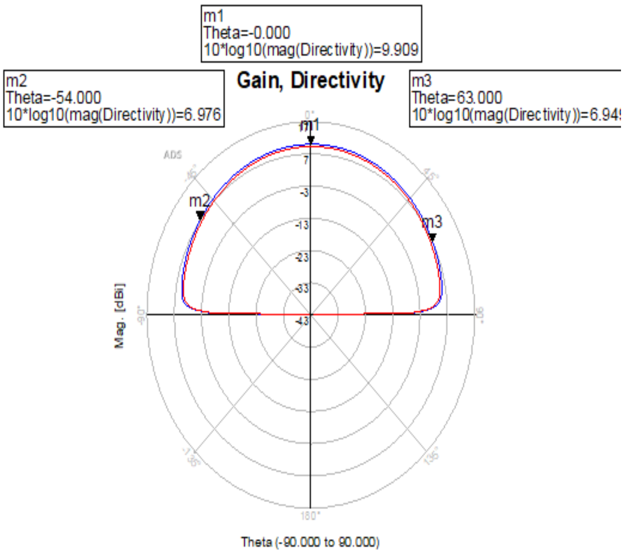

Figure 8: Beam width for 2x1 patch antenna

3) Offset feeding 2x1 patch antenna

Offset feeding off single patch is improving the antenna parameter like return loss, directivity and gain.

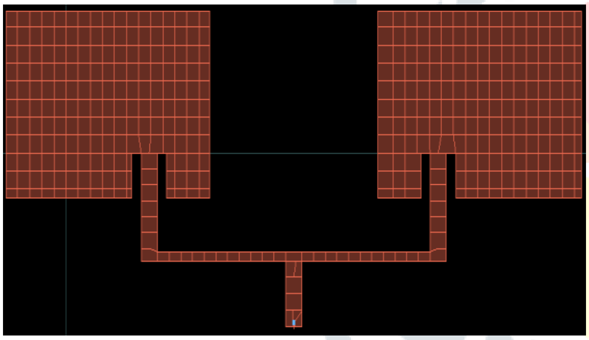

Figure 9: Layout of offset feeding 2x1 patch antenna

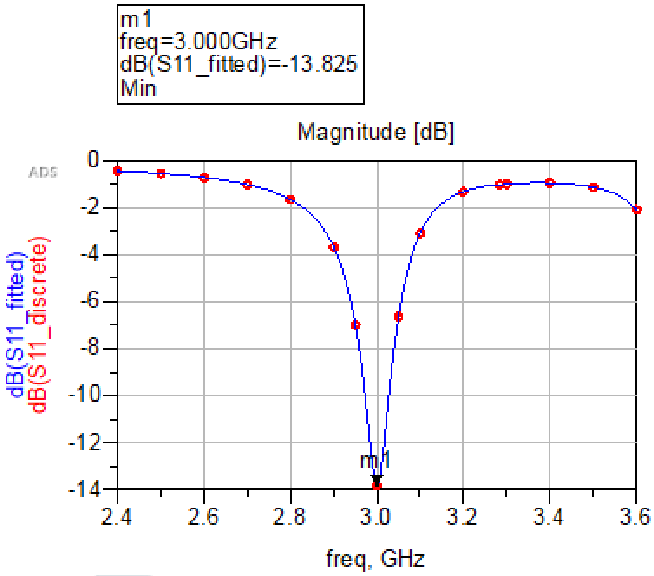

Figure 10: |S11| for 2x1 patch antenna

Antenna Parameters

Frequency (GHz)		3
Input power (Watts)		0.00239637
Radiated power (Watts)		0.00203986
Directivity(dBi)		10.4946
Gain (dBi)		9.79509
Radiation efficiency (%)		85.123
Maximum intensity (Watts/Steradian)		0.00181908
Effective angle (Steradians)		1.12137
Angle of U Max (theta, phi)	3	93
E(theta) max (mag,phase)	1.16908	116.353
E(phi) max (mag,phase)	0.0621162	-63.2071
E(x) max (mag,phase)	0.00104323	143.516
E(y) max (mag,phase)	1.16913	116.354
E(z) max (mag,phase)	0.061185	-63.647

Figure 11: Antenna parameter for 2x1 patch

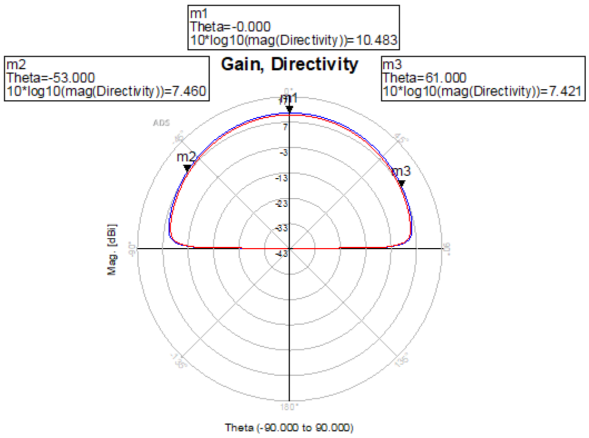

Figure 12: Beam width for 2x1 patch antenna

4) 3X1 patch array:

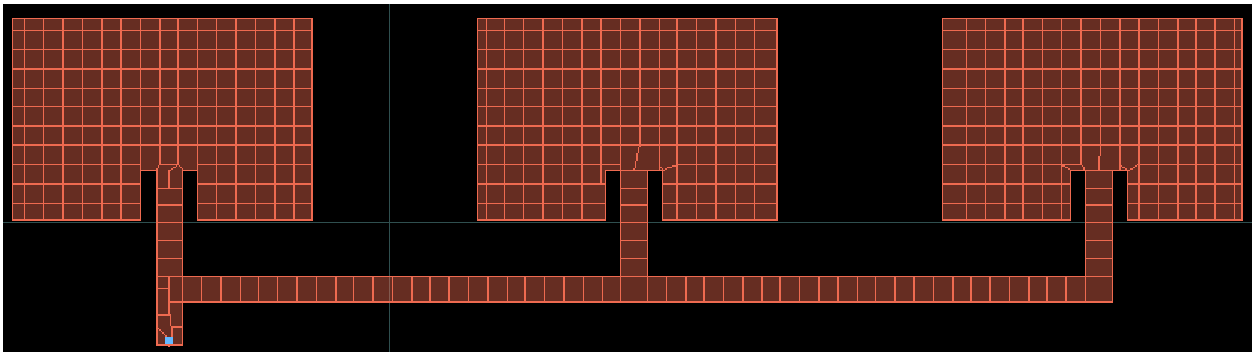

Figure 13: Layout of 3x1 patch antenna

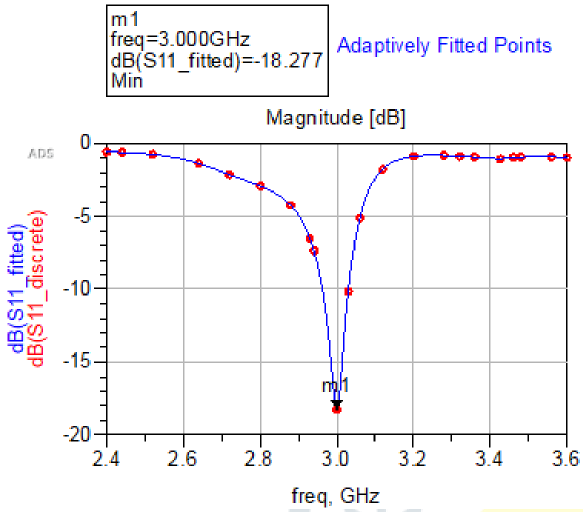

Figure 14:|S11| for 3x1 patch antenna

Antenna Parameters

Frequency (GHz)		3
Input power (Watts)		0.00246282
Radiated power (Watts)		0.00204712
Directivity(dBi)		11.1304
Gain (dBi)		10.3275
Radiation efficiency (%)		83.121
Maximum intensity (Watts/Steradian)		0.00211336
Effective angle (Steradians)		0.968659
Angle of U Max (theta, phi)	0	244
E(theta) max (mag,phase)	1.12972	91.5864
E(phi) max (mag,phase)	0.562204	92.0275
E(x) max (mag,phase)	0.010782	112.739
E(y) max (mag,phase)	1.26183	-88.3275
E(z) max (mag,phase)	0	0

Figure 15: Antenna parameter for 3x1 patch

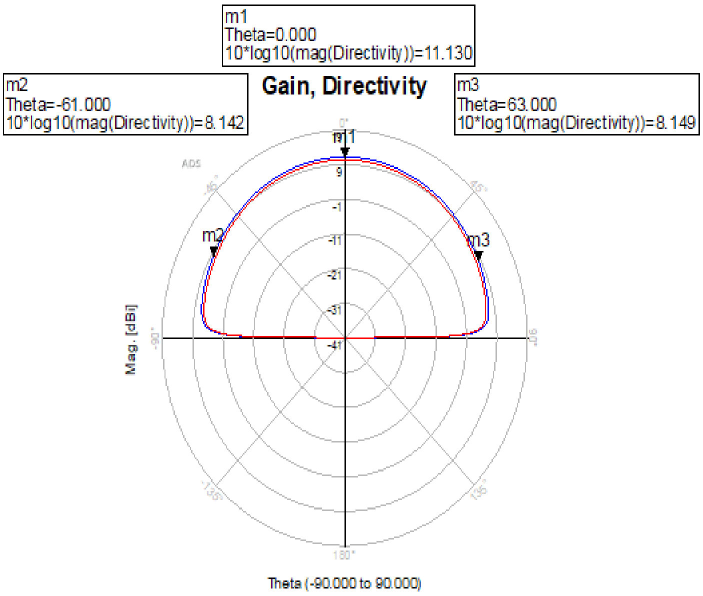

Figure 16: Beam width for 3x1 patch antenna

Table 2: Comparison of results

Number of element	FeedingTechnique	Return Loss(S11 in dB)	Gain(dB)	Beam Width
1	Center	-28.971 dB	6.29	120^0
2	Center	-12.152 dB	9.19	117^0
2	Offset	-13.825 dB	9.79	114^0
3	Offset	-18.277 dB	10.32	124^0

III. CONCLUSION

It can be concluded that using Rogers_ RT_Duroid6002 material having dielectric constant 2.93 and thickness 0.06 inch.The3x1 arraymeets the required specification. From the table 2, it can be said that the single microstrip antennas performance was then improved in terms of directivity and gain by using 2x1 and 3x1 array structures. The simulation return loss was equal to −18.277 dB at the centre frequency of 3 GHz. The maximum directivity and gain achieved for 3x1 array antenna was 11.13 dB and 10.32 dB respectively.

V.REFERENCES

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