Design and development of Reflect Array Antenna for emergency communication

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Abstract— *During emergency conditions like Tsunami, cyclones and floods, the overall power and communications will be shut down so people can't communicate. Thus planar reflect arrays will provide bidirectional high data rate satellite links that are needed where other telecommunication infrastructure will not be available. In such situation, an antenna should be deployable, transportable and easily re-pointable. This research focuses on the design and analysis of Ku- band reflect array antenna using novel unit cell structure. The proposed reflect array is to pave way for a new generation miniaturized satellite communication and finding an important application in the satellite news gathering.*

Keyword—**microstrip antenna, square patch with cross stub embedded mushroom shaped microstrip antenna, microstrip reflectarray, microstrip antenna feed.**

I. INTRODUCTION

A reflectarray is an antenna consisting of a flat reflecting surface and it has many radiating elements with an illuminating feed antenna [1]. The reflectarray has become an attractive antenna because it overcomes the disadvantages of parabolic reflectors and phased array antennas in radar and satellite communication systems. The various advantages of reflectarray antennas are low profile, low mass, flat surface, ease for circuitry integration, and manufacture. For additional resonance L- and T-shaped slots are incorporation in microstrip monopole antennas [2].Various shape slot antennas are feeder with various shape patch antenna is demonstrated for obtaining optimum impedance bandwidth[3]. For enhancing the bandwidth electrically, by modifying the reflective surface by using a broadband element and decrease differential phase delay simultaneously [4].The art of implementing wide band antennas.

In this paper, desiged an element for Ku-band reflectarray antenna with rectangular source patch antenna. The array elements are feed by source patch antenna.

These antennas have been first analyzed using the ADS software. Measurements of fed and array patches were simulated by using Rogers substrate ($\varepsilon r = 3.5$, h = 0.5 mm, tan $\delta = 0.003$).

II. DESIGN OF REFLECTARRAY ANTENNA

The proposed microstrip reflectarray antenna is designed for Ku-band, hence the feed microstrip reflectarray patch antenna dimensions are calculated the frequency in its TM10 and TM01 modes. The array patches element is square patch with cross stub embedded mushroom shaped microstrip antenna. The antenna gain is increased by increase in aperture area of the antenna which is realized large size parabolic reflectors or by using printed reflectarray.

The effect of variation of distance "D" on gain, directivity, efficiency, and beam widths for this configuration has been studied in [7]. The maximum gain and directivity is obtained by comparing distance D = 3λ0/2, 5λ0/2.

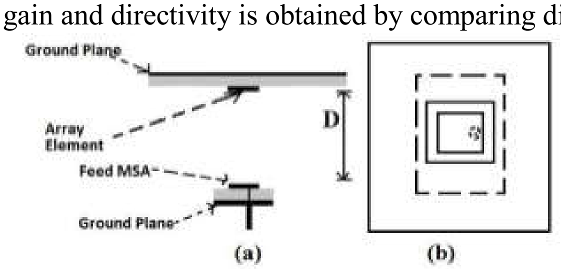


Figure 1: (a) Side view and (b) top view of microstrip reflectarray antenna.

The feed and the center patch path lenght is shorter than that between the feed and the parasitic patches. To compensate the phase difference between adjacent patches, the array element dimensions have been varied and this causes detuning of the resonant frequencies and ensures that the reflected waves are in phase with one another.

2.1 Proposed unit cell structure:

The proposed unit cell is rectangular cross stub with umbrella structure.The proposrd unit cell is given in Figure 2.

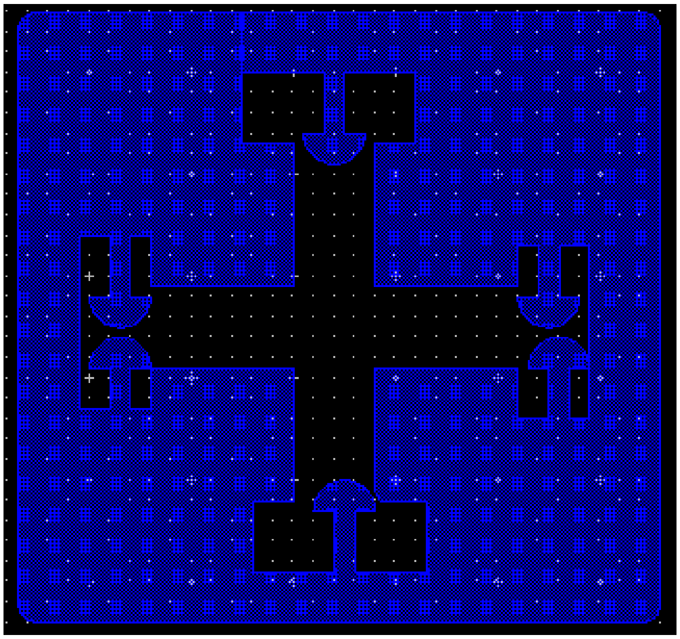


Figure 2:Proposed unit cell

The designed unit cell is compact size and it is high reflecting element and three different dimension element is designed for forming an array. The element is design with cross stub in square patch with embedded mushroom structure.

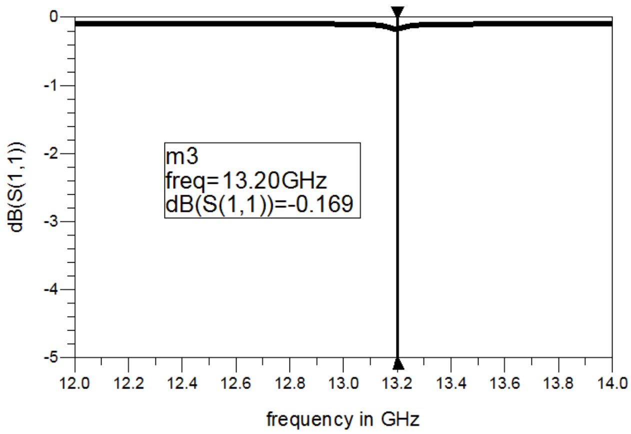


Figure 3:Simulated S_{11} of proposed unit cell

The simulated S_{11} of proposed unit cell is shown in figure 3,the S_{11} of proposed element is -0.169dB at frequency 13.2GHz..

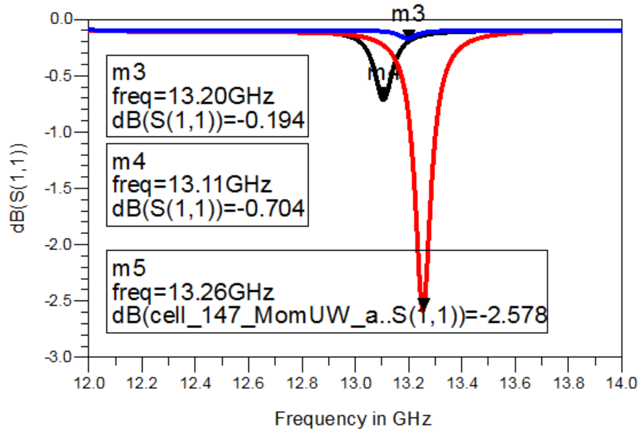


Figure 4: Simulated S_{11} of three different dimension unit cells.

The simulated S_{11} of three different dimension unit cells of reflect array antenna is given in figure 4.In figure 4,it shows return loss of various dimension elements in which the first element is -0.194dB at frequency 13.2GHz,second element is -0.704dB at frequency 13.11GHz and third element is -2.578dB at frequency 13.26GHz. The reflection produced by this elements is 90% which implies it is a good reflecting elements.

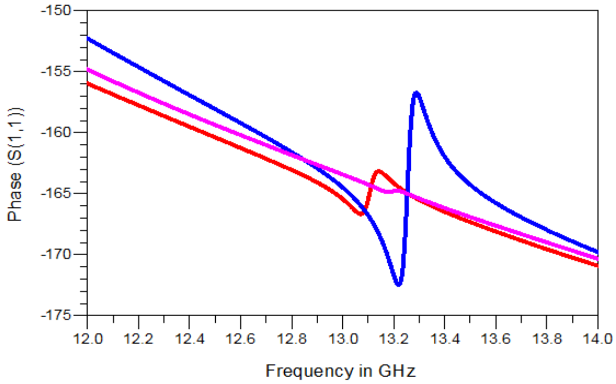
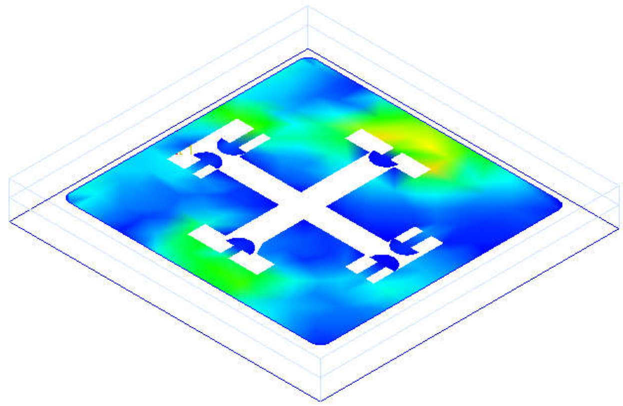


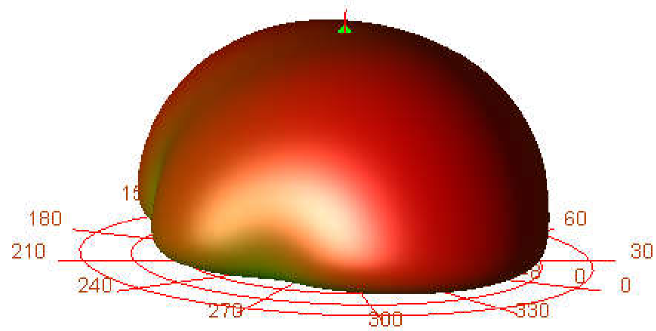
Figure 5:Phase differences of three different dimension elements

The phase changes of three different dimension elements are in figure 5 and each element have different phases based on the dimension variations.

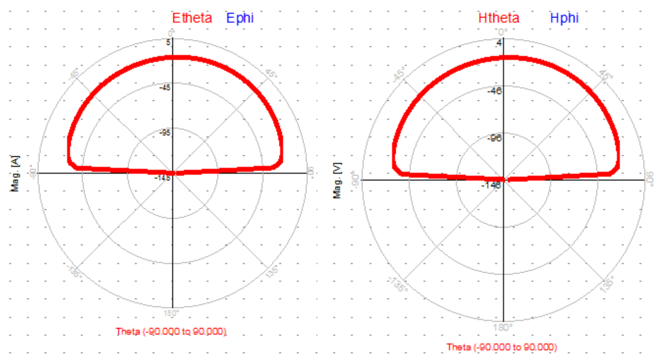
In figure 4, we can see that the designed reflectarray antenna elements are resonates at the desired frequency which is 13.2GHz and the reflection coefficient -0.1 to -2.5 dB is observed for various elements. EM solver is used to perform full wave simulation. It can be concluded that the square patch with cross stub embedded mushroom shaped unit cell has a good return loss and they can be considered as a good reflector.



6(a)



6(b)



6(c)

Figure 6:(a) 3D Preview (b) Radiation pattern and (c) E and H planes.

In Fig.3(a) shows the 3D preview of proposed reflectarray antenna element using square patch with cross stub embedded mushroom shaped unit cell. In array we can observe the distance between the array elements and feed patch because the distance is for obtaining maximum gain. The ADS momentum simulates the three dimensional view of the far field radiation pattern of proposed reflectarray antenna is a directional antenna ,is shown in Fig.3(b) and it is clearly visible that the proposed antenna has the main beam in the 90 to 270 degree range.

The E and H –planes of ring shape microstrip resonator is shown in Fig.3(c) and it shows the gain of the proposed antenna in E-plane and H-plane. The maximum gain of the proposed three different elements antenna is 1.5,1.7,2.1dBi and it is given in 3D graphs.

Elements	**Gain (dBi)**
First element	1.5
Second element	1.7
Third element	2.5

Table –I Gain for various dimension elements

The gain for various dimension elements is shown in table-I,in which first element has 1.5 dBi gain , second and third element the gain is 1.7 dBi and 2.5 dBi respectively.

III. CONCLUSION

In this paper a square patch with cross stub embedded mushroom shaped microstrip resonator is used to design the reflectarray antenna with microstrip feed patch.In square patch with cross stub embedded mushroom shaped microstrip resonator coaxial port is used for excitation.The obtained reflection coefficient for square patch with cross stub embedded mushroom shaped microstrip antenna is -0.1,-0.7,-2.5 dB which implies it as a good reflector. The simulated results shows that the antenna is having high gain and suitable for Ku-band Satellite communications. If the number of elements in the array increases, the gain and radiation pattern will be improve further.

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