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The Study of Changing Central Angle of Conformal Triangular Patch Antenna

Pratibha Mehra, Sunil Kumar Singh

***Abstract* — Conformal microstrip antennas are required, whenever an antenna has to conform geometrically to some shaped surface like cylinder, prism, sphere. The cylindrical geometry can offer certain desirable antenna characteristics that are not provided by planar elements. The shape of rocket, spaceship, etc. is generally cylindrical. This paper proposes design of conformal equilateral patch antenna and the effect of varying central angle is studied which is fed through microstrip line to improve the gain, radiation performances and bandwidth. The proposed antenna operates at 1.5 GHz. Modeling and simulation of antenna has been carried out using CST Studio Suite™ 2010[1]. Return loss of -26.81 dB with VSWR 1.09.**

***Index Terms* — Conformal patch antenna; CST Studio Suite ™ 2010, Microstrip feed, Return Loss, Taconic TLT-0, VSWR.**

I. INTRODUCTION

Antennas are the most important devices to transmit electromagnetic waves from source to destination, which contains information. So, it is the important part of communication. Today, various types of antennas are available according to requirement and functionality of the user. Microstrip antennas are often used because of their thin profile, light weight and low cost. Furthermore, they can be made conformal to the desired structure. An antenna has to conform geometrically to some shaped surface, like that on an aircraft or a smaller flying platform. This may be due to reasons of payload space limitations, for aerodynamic reasons where the antenna shape has to adapt to an aerodynamically optimized non-planar surface, or the antenna has to be non-planar in order to reduce its radar cross-section. This makes the antenna an integral part of aircraft and flying objects. Conformal antenna is one of the most important innovations in modern antenna technology.

In this case, the conformal microstrip patch antenna is designed which is widely used where size, cost and ease of operation are the major factors. These have good potential for application in aerospace vehicles with excellent aerodynamic characteristics. Cylindrical antennas have attracted the greatest attention amongst conformal antennas. When the radius of the curved structure is large, the antenna can be analyzed as the planar one. However, for structure with smaller radii, more rigorous analysis methods should be used. If the antenna has a cylindrical shape, i.e., if one principal curvature is zero, the antenna can be analyzed as a circular-cylindrical one. In the case where both principal curvatures are different from zero, the antenna can be analyzed as a spherical one. This is the major difference between the cylindrical and spherical structure.

Pratibha Mehra, *Electronics and Communication Engineering, Jabalpur Engineering College, Jabalpur, India.*
Sunil Kumar*, Electronics and Communication Engineering, Jabalpur Engineering, Jabalpur, India.*

The cylindrical geometry [2], [3] can offer desirable antenna characteristics that are not provided by planar element and thus, the conformal antenna system can be used in cylindrical carrier such as aircraft and satellite. Cylindrical conformal structures, with radii greater than one half wavelengths, have been proposed for use as prospective candidate for mobile communications systems, cellular base stations, and Telemetry, Tele-ranging and Tele-command (TTC) communication that is essential to maintain space missions due to their full field of view advantage. Now this paper continues in the following manner: Section 2 extensively presents the design of antenna. In Section 3, involved formulation and calculation is discussed. Section 4 shows the simulated results and in section 5, we will conclude our work with its applications & in section 6 are references.

II. ANTENNA DESIGN

In this paper, an equilateral triangular patch antenna conformed on cylindrical surface is considered which is fed through microstrip line. Fig. 1 shows the proposed equilateral triangular patch antenna of 73 mm side and is fed from microstrip line of width 4.467 mm and length 54.8 mm. The antenna is conformed on a finite cylindrical Taconic TLT-0 (lossy) substrate of 1.6 mm thickness and relative permittivity ϵ_r of 2.45. The central angle of the cylindrical structure is optimized by varying its radius which is simulated using CST Studio Suite™ 2010[1]. Result obtained on return loss, VSWR and radiation pattern are presented and discussed.

Fig. 1 shows the geometry of a cylindrical triangular microstrip structure. The triangular patch is conformed on the cylinder. The side length of the triangular patch in the φ direction is d_2 *(= 2b φ_0)*, and the other two sides are assumed to be of the same length, d_1. The relationship of d_1 and d_2 is given [3] as

$$d_1 = \sqrt{\{(d_2/2)^2 + d_h^2\}}$$

where d_h is the distance from the tip of triangle to bottom of triangle.

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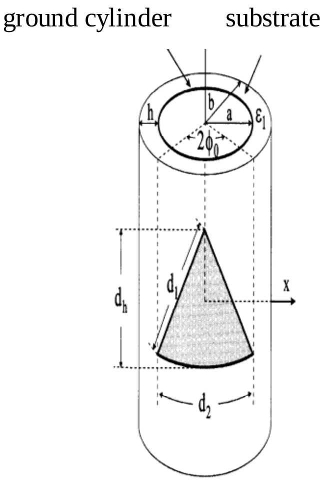

Fig. 1. Geometry of a cylindrical triangular microstrip structure [3]

TABLE 1 Parameters of Antenna

Substrate (Outer Cylinder)	
Thickness	1.6 mm
Material	Taconic TLT-0 (Lossy)
Epsilon (є)	2.45
Loss Tangent	0.0019
Thermal Conductivity	0.19 W/K/m
Ground (Inner Cylinder)	
Thickness	0.1 mm
Material	Copper
Electric Conductivity	5.8e+007 S/m
Thermal Conductivity	401 W/K/m
Equilateral Triangle	
Side	73 mm
Microstrip Feed Line	
Length	54.8 mm
Width	4.467 mm
Wave Port	
Length	21.4 mm
Width	8.1 mm

III. FORMULATION & CALCULATION

In [4], an approximate solution of capacitance of circular microstrip disk to account for the fringing field is used for calculation of resonant frequency of the equilateral microstrip patch antenna, which is further modified [5], [6].

The resonant frequency of equilateral triangular microstrip patch antenna is calculated by following equations[5], [6]:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{a}\right]^{-(1/2)}$$

and

$$a_{eff} = a + \frac{h}{\sqrt{\varepsilon_r}}$$

Hence, resonant frequency

$$f_r = \frac{2\,c}{3a\sqrt{\varepsilon_{eff}}}$$

For $\epsilon_r = 2.45$, a = 72 mm , h = 1.6 mm, c = $3\text{x}10^{11}$ mm, the calculated results are $\epsilon_{eff} = 2.36$, $a_{eff} = 73.02$ mm, $f_r = 1.80$ GHz.

To energise the antenna, feed is given to it. The feed location of the patch is found experimantally [8], by changing probe location and making measurements, a suitable feed point is determined. This makes the feed location confirmed.

IV. PERFORMANCE EVALUATION

Now we are going to show the return loss plot and VSWR plot of the antenna. Fig. 2 shows the return loss response of conformal antenna. It is clearly indicating that the antenna resonate at frequency at 1.52 GHz with return loss -26.81 dB. To reach desired triangular patch antenna with various central angles is simulated using CST Studio [2] and the result is tabulated in Table1 and in Fig 3 graph showing variation between central angle and S11 is plotted. Fig. 4 shows the VSWR at central angle 30^0. Fig. 5 shows the far field radiation pattern of proposed antenna. To get more acquainted with these results we are also representing the results.

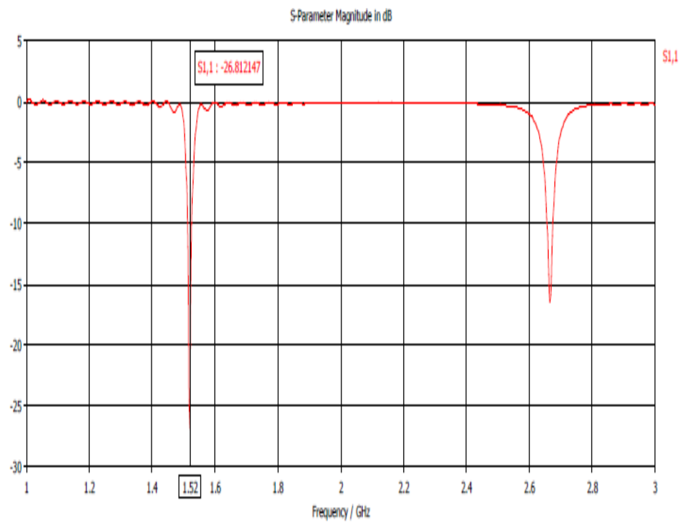

Fig. 2. Return loss obtained from CST Studio at 30^0

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TABLE 2 Central Angle Vs S11

Central Angle (in degrees)	Radius of Cylinder (in mm)	S11(dB)	VSWR
5	837.3	-23.59	1.14
10	418.6	-17.12	1.32
20	209.3	-21.84	1.17
25	167.4	-24.62	1.12
30	139.5	-26.81	1.09
35	119.6	-24.33	1.12
40	104.6	-18.88	1.25
45	93.0	-26.11	1.10
60	69.7	-22.14	1.16
90	46.5	-8.58	2.35

The central angle subtended by the patch at the centre of cylinder is varied and its effect is observed on the S11 plotted. Among all these S11 i.e. return loss, at 30^0 it is the best equal to -26.81. So the radius of cylinder equal to 139.5 mm is selected.

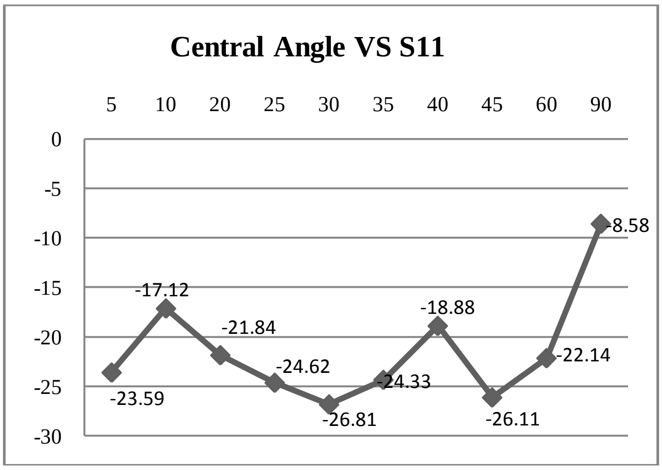

Fig. 3. Variation in Central Angle Vs S11

The central angle subtended by the conformal microstrip patch antenna gives various result. The VSWR is also plotted in CST software. For 30^0, VSWR is 1.09. which is less than 1.5.

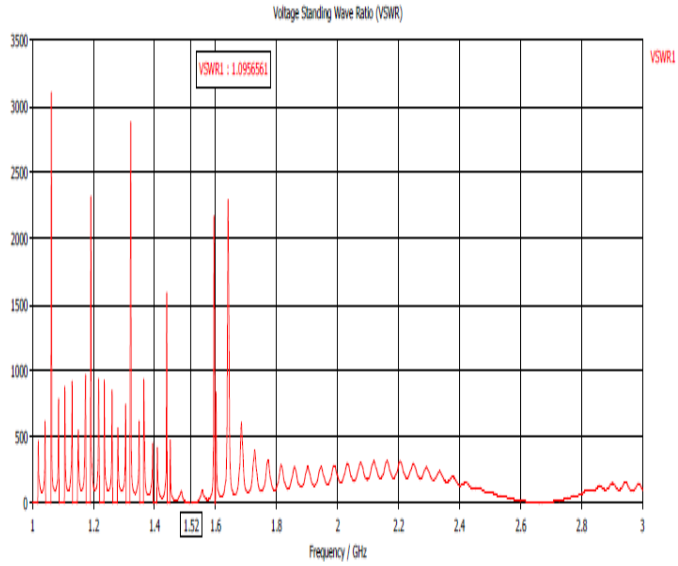

Fig. 4. VSWR obtained from CST Studio at 30^0

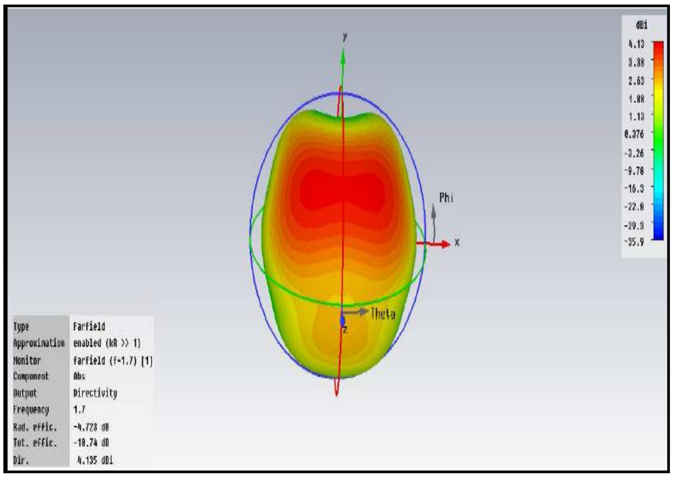

Fig.5. Far Field Radiation Pattern at 30^0

V. CONCLUSION

In this manner, it may efficiently be concluded that we designed equilateral triangular patch antenna which is conformed on cylindrical surface and fed through microstrip line is suitable to operate at 1.52 GHz for satellite communication. We obtained following results Return loss, VSWR and bandwidths in which we received maximum bandwidth of 13.41 MHz GHz and VSWR of 1.09. We received return losses at resonance frequency of 1.52 GHz which is a part of band used for satellite communication. In addition to military applications, the conformal antennas are also important in mobile communication and can conform geometrically to some shaped surface, like that on an aircraft or a smaller flying platform. Future, mobile base stations can be concealed for aesthetical reasons. The most important application of the conformal antenna concept in the future will be found in RFID [9], the smart skin approach, which envisages the integration of non-planar active antenna apertures in curved surfaces adapted to the skin of the platform like aircraft, satellite, car etc. Thus, antenna can be made integral part of the structure on which it is mounted.

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VI. REFERENCES

[1] E. S. Ahmed and J. K. Ali, " Performance Evaluation of Three Rectangular Patch Element Array Antenna Conformed on Small Radius Cylindrical Surface", PIERS Proceedings, March 2012.

[2] Kin-Lu Wong, "Design of Nonplanar Microstrip Antennas and Transmission Lines", John Wiley and Sons Inc., 1999

[3] CST Studio Suite^{TM} 2010

[4] W. Chen, Kai-Fong Lee and J. S. Dahele, "Theoritical and Experimental Studies of the Resonant Frequencies of the Equilateral Triangular Microstrip Antenna",IEEE, Vol. 40, October 1992.

[5] P. L. Zade, N.K. Choudhary, "Design and Implementation of A Broadband Equilateral Triangular Parasitic Patch Microstrip Antenna for Wireless Application", International Journal of Computer Applications, Vol. 28, August 2011.

[6] L. Kartikey, S.K. Singh, "Design of Triangular Arrays Conformal to both Planar and Cylindrical Surface", IJAREC, Vol. 3 November 2014.

[7] Constantine A. Balanis, "Antenna Theory Analysis and Design" 2nd edition, John Wiley and Sons Inc., 1997.

[8] Yinggang Tu, "A study of Triangular Microstrip Antenna", Department of Electrical and Computer Engineering, University of Colorado, 1983.

[9] T. Bjorninen, A. Z. Elsherbeni, L. Ukkonen, "Low Profile UHF RFID Tag Antenna for Integration with Water Bottles", IEEE, Vol.10, 2011

Pratibha Mehra, completed BE (Electronics and Communication Engineering), Pursuing ME (Microwave Engineering)

Sunil Kumar Singh, Assistant Professor in Jabalpur Engineering College, Jabalpur.

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