RESEARCH ARTICLE OPEN ACCESS

Multiband Conformal Hexagonal Slot Patch Antenna

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Abstract
A Multiband Conformal Hexagonal Slot Patch Antenna fed by 50Ω microstrip line for multiband application is presented. The strip loaded MCHSPA antenna is fed through microstrip line to achieve proper impedance matching. This antenna provides maximum bandwidth of 2.2 GHz and return loss of -43 dB at resonant frequency of 13.5GHZ. The antenna has been carved out from a cylindrical geometry and FR4-epoxy substrate with dimension 42*55*1.6 mm^3 has been used. The MCHSPA antenna has been simulated on High Frequency Structure Simulator software version 13 (HFSS 13). This antenna performs basically in C, X band and Ku band. Return loss and radiation pattern for this antenna is evaluated here. The simulated return loss has been represented for different substrate material of varying thickness. This antenna is used in communication and navigation technologies, aircraft, automobiles or ships, radar and satellite communication.
Index Terms—MCHSPA, Multiband, Return loss, HFSS

I. Introduction

With the rapid development of wireless communications, compact multi-functioning antennas at multi frequency have been widely required in various communication systems. Conformal antenna is easily crafted on curved shaped structure. These antennas are solution to geometrical problems. Microstrip antennas in general have a conducting patch printed on a grounded microstrip substrate to achieve large scanning range, easy fabrication. The shape can be part of missile, aircraft or any vehicles with the radiating element mounted on or integrated on the surface. The main reason for designing a conformal antenna is that its integration makes the antenna less disturbing, less visible to the human eyes [9]. No backscattering of microwave radiation when illuminated by other transmitter is also one of the reasons. Conformal antenna gain depends on the shape of antenna

Out of the various feeding configurations available for feeding microstrip antenna microstrip line, coaxial probe, aperture coupling, and proximity coupling are the four type of feeding mechanism mainly used to feed microstrip antenna[8][7].The microstrip feed line is a simple method for feeding antenna and is easy to fabricate. The microstrip line is also a conducting strip line with a smaller width compared to the patch. The proposed antenna in this paper has been constructed using microstrip feeding mechanism [16].

In previous paper work [3], the antenna has been designed in planer surface with substrate thickness 3.2 mm. In this paper we have modified the previous antenna from planer to conformal with different substrate thickness & microstrip feed technique.

Microstrip antenna bandwidth depends upon the substrate material used in antenna and thickness of the substrate in antenna. The performance of the microstrip antenna is increased by using a hexagonal slot etched in a radiating element i.e. patch. In this paper we analyze the result using different substrate material and of different substrate height in MCHSPA antenna. A major challenge is to design a proper ground plane for multiband antenna that maintains the antenna performance over the entire frequency range.

Various conformal antennas are used in mobile communication, radar and satellite communication and are crafted on the surface structure of aircraft, missiles etc. to aid them in navigation, tracking etc.

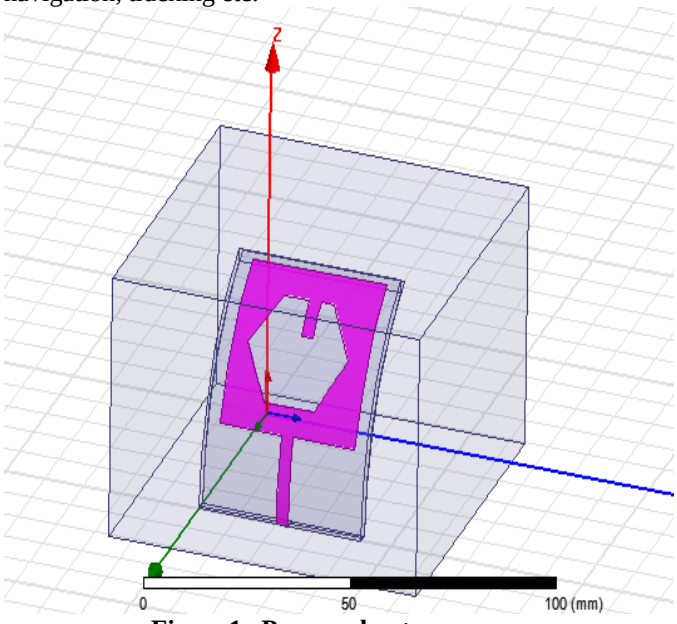


Fig no 1. Proposed antenna

II. Antenna Design

In the original study of paper [3], a broad band L – strip fed printed microstrip was demonstrated experimentally. This antenna has only

focused on broad band applications and has used dual substrate material. We have designed the proposed antenna for non planar surfaces and multiband application .In this proposed antenna single layer substrate material has been used. The geometry and parameter of multiband conformal hexagonal patch antenna with microstrip feed line 50 Ω is as shown in fig 1. The proposed antenna consists of ground plane, microstrip line and cylindrical substrate with square patch. The proposed antenna is supported by a dielectric substrate FR4 of thickness h= 1.6 mm and relative dielectric constant ε_r = 4.4. We choose a large diameter of cylinder to make a substrate. Substrate dimensions are 42*55*1.6 $mm^{3.}$ Both square patch and ground plane has been wrapped on the cylinder taking appropriate dimension.. Subsequently a hexagonal slot of dimension L2 mm is etched on the square microstrip patch antenna of dimension L_{1*} L_1 mm^2 [1]. The hexagonal slot patch has been fed with a microstrip line of 50 ohm characteristics impedances.

L	42 mm
W	55 mm
Lp	35 mm
Wp	35 mm
Wf	4 mm
L2	14.3 mm

Table 1: Proposed Antenna Parameter

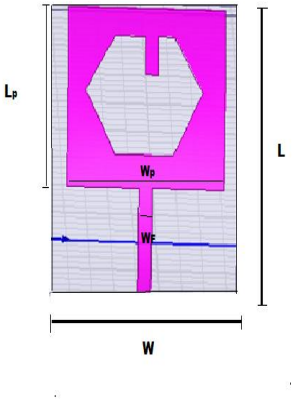


Fig no. 2. Front view of MSCPHA antenna

The proposed antenna has been simulated using HFSS [13] software.

III. Result

Return loss of simulated proposed antenna is as shown in the Fig. no. 3. Result shows multiband below -10 dB at operating frequency of 13.5 GHz. The proposed antenna for planar and non planar surface is simulated in High frequency Structure Simulator [HFSS 13]. The comparison result is as shown in the Fig 3.The proposed antenna's impedance band widths are 28.57% (3.6-4.8 GHz), 5% (7.9-8.3 GHz), 6% (11-11.7Ghz), 17% (11.8-14 GHz) and 2.7% (14.4-14.8Ghz) at each frequency band.

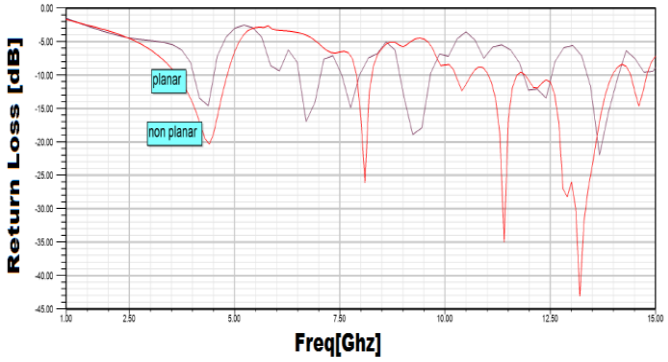


Fig no. 3. Return Loss Planar and non planar antenna

The first investigations of the Hexagonal slot conformal microstrip antenna uses different substrate material like FR4 – epoxy, Roger RO 3203, Duroid (tm) and Nelco N4000-13 etc. The percentage bandwidth for different substrate material is as shown in table 2 and return loss (S11) for different substrate material shown in the Fig 4.

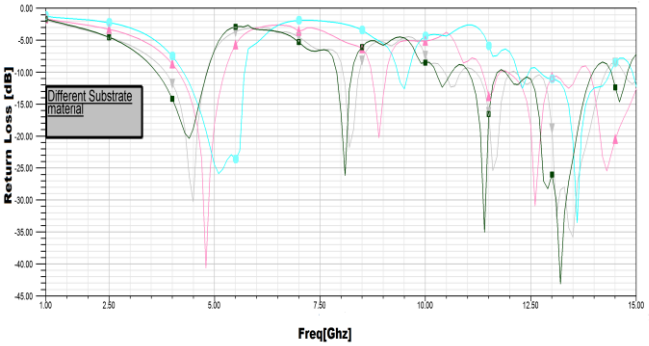


Fig no. 4. Return Loss of Different substrate material

We have performed simulation on a Hexagonal slot conformal microstrip antenna with FR4 - epoxiy as a function of thickness. The result is summarized in Table 3. Return loss (S11) for varying thickness of FR4 – epoxy substrate is shown in the Fig 5. Proposed antenna gives satisfactory performances for substrate thickness h= 1.6 mm and substrate material FR4. These geometry parameters give the best result for the proposed antenna.

Material name	**Dielectric constant (□r)**	**Band Width (GHz)**
FR4 – epoxy	4.4	11.8- 14
Roger RO 3203 (tm)	4.2	12.75-14.3
Duroid (tm)	3.5	11.9- 13.75
NelcoN4000- 13 (tm)	3.02	12- 14.3

Table 2: Different substrate material.

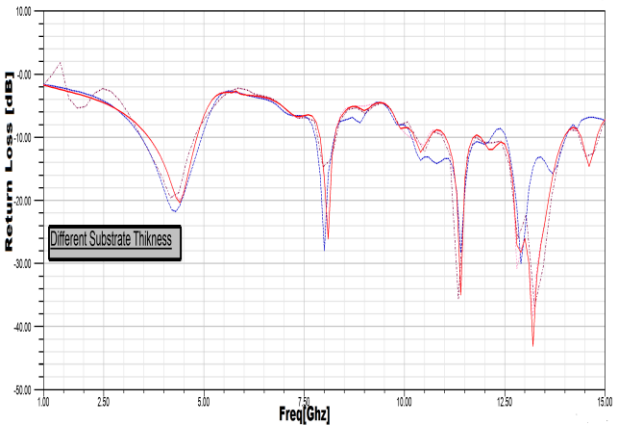
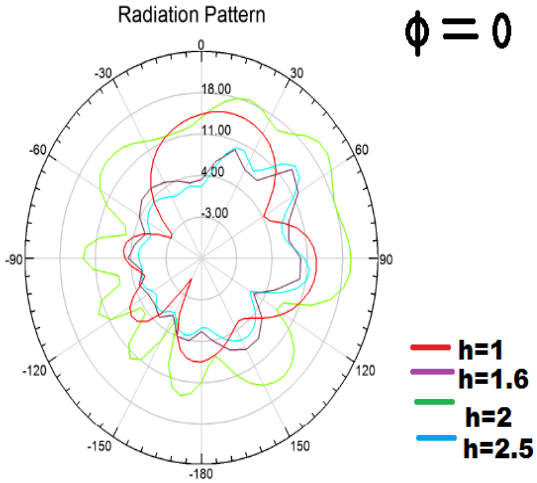


Fig no. 5. Return Loss of Different substrate thickness

Substrate Thickness (h)	Band Width GHz
1mm	12.6 – 14.1
1.6mm	11.8- 14
2mm	11.8- 14.2
2.5 mm	11.75-14.2

Table 4: Band Width for different Substrate thickness of FR4-epoxy substrate material.

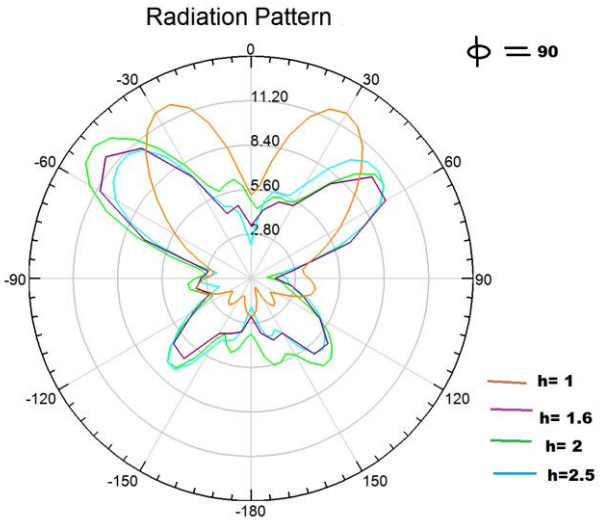
For the proposed antenna, radiation pattern at XZ plane and YZ plane at 13.5 GHz are plotted in Fig 6 respectively.



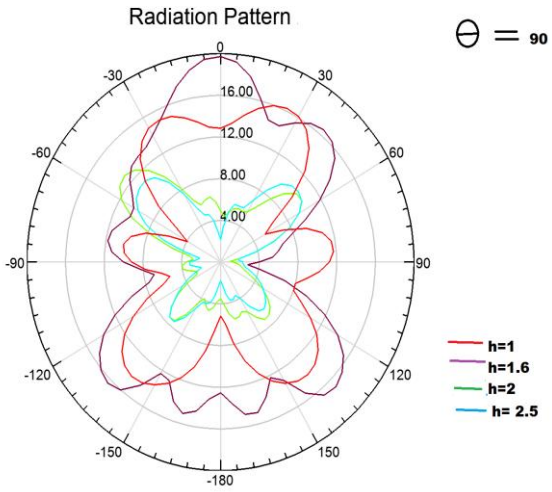
E1 Field

IV. Conclusion

In this paper , a Hexagonal Microstrip Multiband Conformal antenna is investigated and developed A complemented non planar proposed antenna increases the performances of the planar Hexagonal Antenna .The simulated results shows that substrate thickness h=1.6 and substrate material FR4 – epoxy gives the best result. Proposed antenna is investigated for multiband applications. At present time this type of antenna is easily assembled on curved surfaces structure like missile, radar tracking system, air craft etc.



E2 Field



H field

Fig no.6. E and H field Radiation pattern for different substrate thickness material.

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