E-Shaped Wideband Conformal Antenna

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Abstract
A compact wideband antenna with cylindrical conformal geometry is proposed . The radiating element of this antenna consists of an E-shaped patch that assumes a conformal orientation relative to the cylindrical surface in order to yield maximum bandwidth. The antenna is fed by waveguide feeding connected to the radiating patch at the longer side Radiation properties of the proposed including far-field patterns, axialratio, directivity, input impedance and voltage standing waveratio (VSWR), are studied simulating through HFSS (High Frequency Simulation Software).Simulation results are in good agreement, nearly equal E- and H-plane far-field patterns withhigh degree of axial symmetry over a bandwidth of more than 50%. Also, over a bandwidth of about 24% the axial ratio remains below 3 dB. The compact size and ultra wideband performance of this antenna make it advantageous for highspeed wireless communication systems and avionics.

***Index Terms**-E shaped patch* antennas, low profile antennas,HFSS 13(High Frequency Simulation Software),widebandantennas

I. Introduction

Wide Band conformal antennas with minimum physical protrusions are important in many modern radar and communication applications to meet stringent aerodynamic and scattering requirements.Conformal antennas are increasingly being mounted on surfaces of air and land vehicles .Their popularity stems from the fact that theyare inexpensive to fabricate, present minimal drag to airfoil surfaces, are aesthetically appealing, and are amenable to placement inefficient array configuration**.** A characteristic phenomenon of patch antennas Conformal to curved platforms is the dependence of resonant input impedance on surface curvature [1]. Understanding how surface curvature affects the input impedance and resonant frequency is crucial for matching with the feed network and efficient radiation. In light of this, it is vital that conformal antennamodels include surface curvature so that the effect of surfacegeometry on their performance can be predicted more accurately.

As wireless systems continue to enjoy increasedapplication and gain wider acceptance, performance and cost constraints on the antennas employed by these systems become more difficult to meet. Antennas that are conformal or low profile and that exhibit ultra wideband operation are of particular interestfor many of these new systems. Concomitant with increased performance levels is the need for antenna designs with the potential for low cost manufacturing. To address the requirements and the severe constraints imposed by commercial application of these antennas, new innovative antenna design methodologies are required. To date, most new wireless system antenna designs have been derived from existing canonical designs such as the monopoleand wavelength patch antennas.

Various feeding mechanism has been studied this far such as microstrip line ,coaxial probe, aperture coupling and proximity coupling [12], [13], [14], [15], [16],[17][19].Here in this paper acylindrically conformed version of E-shaped patch antenna[20] isproposed which is the extended work of previously proposed Eshaped planar antenna[20] Waveguide feeding is proposed in thispaper. The advantages of an antenna that resembles the shape of theobject to which it is attached are obvious. Some thinner varieties of microstrip that are commercially available today can change from their planar shape to represent some part of a cylinder [13]. Results are compared for various substrate thickness and materials. Withvarying permittivity and loss tangent variation in the bandwidth is analyzed. With reduced permittivity and loss tangent increase inbandwidth is obtained. Also increasing substrate thickness leads to higher bandwidth.

This paper is organized as follows. In Section II, the structure of the proposed antenna is described. In Section III, theproposed conformal antenna concept on various dielectric substrate isanalysed for the Wideband operation. Simulation results are also presentedwith varying thickness of substrate in section IV followed by the conclusion in Section V.

II

In the previous work an E shaped patch antenna proposed for wideband operation [20].The work is extended here in this paper to Obtain wideband operation while conforming on cylindrical surface. Waveguide feeding is used and the E shaped patch conformed to a cylindrical surfaceproviding good deal for large bandwidth.Recently there have been numerous methods of enhancing the bandwidth of an antenna for example modifying the probe feed,using multiple resonances, using folded patch feed, or using the slotted radiating element. The slots in the radiating element tend to have wideband characteristics. It also suggests that slots introduce the capacitive component in the input impedance to counteract the inductive component of the probe. Also to compensate the increasing inductive effect due to the slots, thickness of the substrate is increased. As we know that as thickness increases the bandwidth increases accordingly. The input impedance of about 42% is achieved. The slots making it to look alike inverted E shape; demonstrated a bandwidth enhancement by 30 %. E shaped patch has dimensions as 15.7 x 9.9 mm.

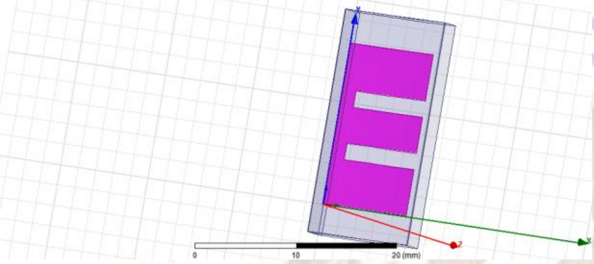

Fig.1 E Shaped Patch

A. Simulation Setup

The antenna's resonant properties were predicted and optimized using High Structure simulation software (HFSS) An soft version13.In previous work [20] first of all simulation has been setup for the basic rectangular micro-strip antenna and the parameters are optimized for the best impedance matching. Furthermore two parallel slots are incorporated and optimized such that it closely resembles E shape; this increases the gain of the antenna. At last theWaveguide feeding is introduced for attaining a required bandwidth, resonating frequency and gain value [20].In this work the same patch is conformed to a cylinder giving wideband characteristics.

III

The substrate chosen should be such to provide optimum bandwidth. To obtain Wide Band operation, various materials are analysed. In this analysis it is found that decreasing permittivity increases bandwidth. At the same time loss tangent is also considered. Best match of loss tangent and permittivity provides best result in terms of Wide Band. There should be small permittivity and at the same time small dielectric loss tangent. Substrate such as RogerRO3203,Teflon based(ε 2.08),Taconic TY(ε 2.2) and hard Rubber(ε 3) are used. All the respective results are compared in Fig.2

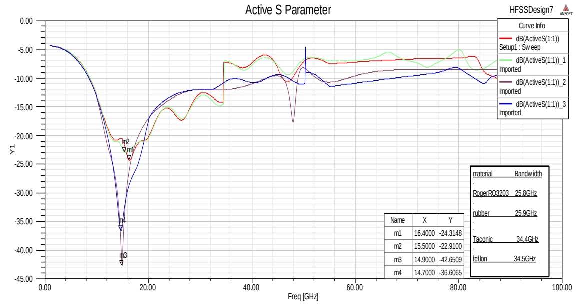

Fig2. S11 for various substrate materials

III

Various substrate thickness are studied in this work to obtain best possible result. After comparing various substrate thickness it is found that with increase in substrate thickness the operation bandwidth increases up to an extent and after that reduced again.Corresponding results are shown here in Fig.3

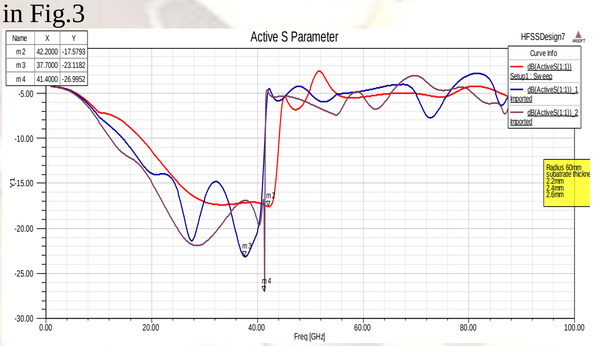

Fig 3. S11 for increasing thickness

In the figure above the plots are shown where the bandwidth is increasing with increasing thickness. While the next plot shows decreasing bandwidth when substrate thickness is increased further. At 2.6 mm thickness bandwidth upto 29 GHz is obtained.

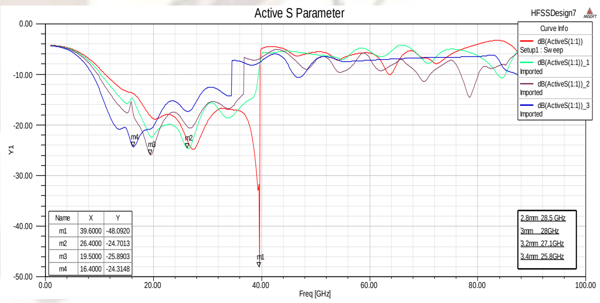

Fig4. Bandwidth reduced increasing thickness

IV. Conclusion

In this paper an E shaped patch is studied for various substrate materials and thickness. In this work the obtained simulated result conclude that the increment in the substrate thickness leads to increase in operational bandwidth to an extent and after that further increment leads to reduction in bandwidth.Permittivity of the substrate plays important role as reducing it leads to bandwidth

enhancement. At same time loss tangent should also take care of. Choosing lesser loss tangent is the best option. That's why good combination of loss tangent and permittivity should be chosen.
For all thick substrate, low permittivity, small loss tangent parallel slots to obtain E-shapedpatch are some factors found suitable for large bandwidth and thus provide Wide Band operation

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