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High Gain Conformal Tri Band Antenna

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Abstract
In this paper, a tri-band E-shaped microstrip patch antenna is presented for SHF and microwave data links. The proposed antenna has symmetrical properties and has been designed by forming E-shape structure on substrate with Wave guide feed. It radiates for three bands having two bands in SHF and one in lower EHF frequency bands. It is demonstrated that the fabricated antenna offers improved values of S_{11}, gain and efficiency. Parametric study is done for different patch dimensions. The return loss S_{11} of the fabricated antenna was simulated using Ansoft HFSS which was in good agreement when compared with CST STUDIO
Index Terms—*Patch antenna; tri-band; SHF; EHF; return loss; VSWR.*

I. Introduction

Conformal antennas are increasingly being mounted on surfaces of air and land vehicles .Their popularity stems from the fact that they are 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 [10]. 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 antenna models include surface curvature so that the effect of surface geometry on their performance can be predicted more accurately. As wireless systems continue to enjoy increased application 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 interest for 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 monopole and wavelength patch antennas.

Various feeding mechanism has been studied this far such as microstripline ,coaxial probe, aperture coupling and proximity coupling[1],[2],[2],[3],[4],[5][6].Here in this paper a cylindrically conformed version of E-shaped patch antenna[9] is proposed which is the extended work of previously proposed E-shaped planar antenna[9] Waveguide feeding is proposed in this paper. The advantages of an antenna that resembles the shape of the object 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 [2].

The paper is organized as follow:
The II section consists of patch designing issue in III parametric study is worked through in IV obtained result is discussed and in V conclusion is there.

II. Structure Formation

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 surface providing 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; it demonstrated a bandwidth enhancement by 30 %. E shaped patch as dimensions as 15.7 x 9.9 mm.

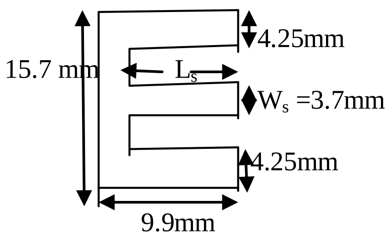

Fig 1 Geometry of E shaped patch

A. Simulation Setup

The antenna's resonant properties were predicted and optimized using High Structure simulation software (HFSS) Ansoft version13 and compared with simulation result in CST also. 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 the waveguide 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 wide-band characteristics.

III. Parametric Study

The patch obtained following the process above gives a patch having three parallel strips. The center one is varied in terms of its length and width and the same design is also analyzed in CST so as giving same results.

A. Variation in Ls

Variation in slot length Ls makes the difference of return loss. Return loss vary for the three band in different way initially increasing Ls leads to increase the return loss of the third band and with further increment return loss of third band reduces while increases for the first one.

For Ls from 8.4 to 8 third band return loss improves and afterward reduces with further reduction in Ls till 6.4. Now for next reduction in Ls S_{11} of patch improves up to the length of 4.5 mm. reducing the length further leads to again improving S_{11} of the third band with the initial variation of return loss the resonance

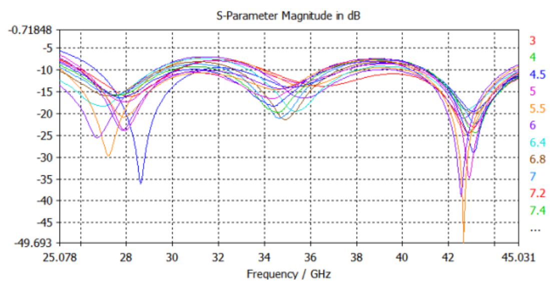

Fig2 : S_{11} plots for various patch length in CST

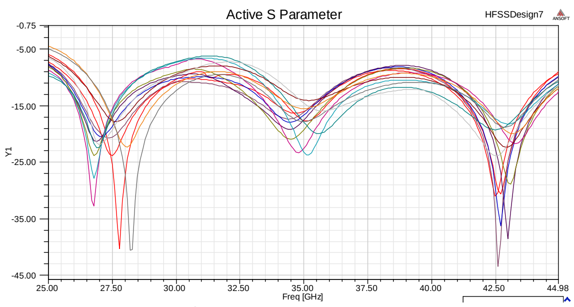

Fig3: S_{11} plots for various patch length in HFSS

frequency reduces upto 6mm and than again shifts to the higher side. The frequency shift is significant for the first band only but for the third one it is not that much to be considered.

B. Variation in Ws

The next parameter varied in this work is width of the central patch Ws. The width variation of central patch makes a significant shift in previous case of planar antenna working in dual band. In the planar case with the increase in the width of central patch the second band shifts to lower frequency band. But in case of conformal one the width variation making no any significant change in the resonant frequency. The plots are shown below both from HFSS and CST STUDIO

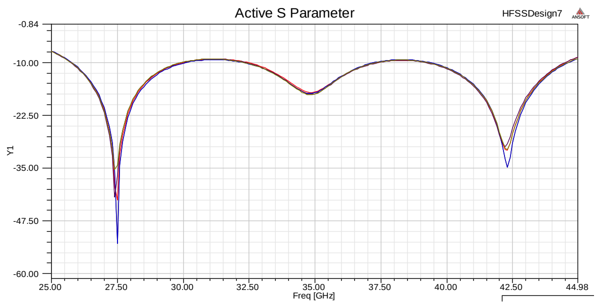

Fig4 : The S_{11} plot for increasing Ws HFSS

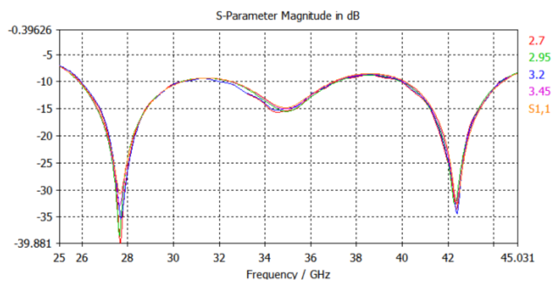

Fig 5 : The S_{11} for increasing Ws CST STUDIO

IV. Results and Discussion

As we have gone through results of parametric study and observed the variation in the return loss plot with varying width and length of the patch. The variation in the width and length of the patch acts as tuning of S_{11} plot. In planar case[8] the center arm of the E-shaped patch antenna acts like a tuning capacitor. Widening the center arm will increase capacitance. But in case of conformal antenna it does not affect much with this variation so does not matters what width of the center patch is.

As far as the case of length of center patch it acts as tuner of antenna as with initial decrement in the patch length the local inductive effects causes the surface current to flow around the slot and so causes the resonance frequency to shift toward lower side. With further reduction in the patch length the capacitive part gets activated as with small length of central patch further increase in current could not take place around the central slot and so surface current diverts towards side patch. Due to this diversion the resonant frequency starts to move again towards higher side.

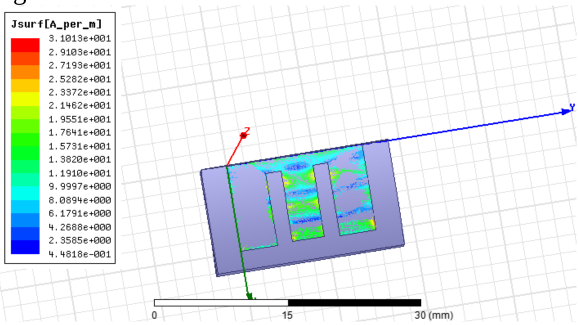

Fig.6: Surface current for initial decrement in patch length.

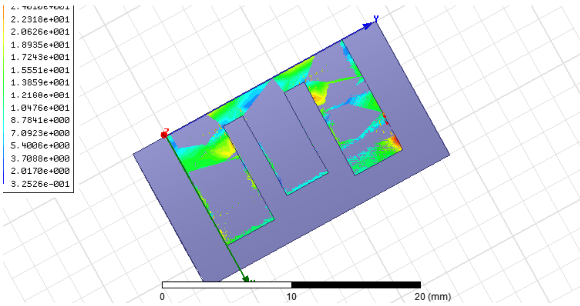

Fig7:Further reduction in patch length causes less current in centre one

V. Conclusion

The work in this paper thus the effect of variation in Ws and Ls is obtained and analyzed . The result shows that width variation of central patch does not causes effect in resonant frequency as the patch has obtained the surface curvature of cylinder but the length of central patch induces inductive and capacitive effects consecutively. With inductive effect the resonant frequency shifts to lower side and with capacitive effect it shifts to higher side.

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