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Design and analysis of T shaped broad band micro strip patch antenna for Ku band application

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Abstract:- This paper presents results of the new investigation of proposed antenna design based on the T shape at the 17.87GHz in application to perspective Ku band. This result is based on the work of computer simulation technology software. The design approach combines application in satellite and radar applications. A simple geometry of the proposed antenna geometry is shown to be composed two rectangular shape that are perpendicular to each other in form of the T shape that results in significant impendence bandwidth, gain and compact size. The antenna design is found to be equivalent FR-4 substrate slab backed by a PEC ground plane. The elevation radiation patterns and its field distribution confirm Ku-mode operation over a wide bandwidth, validating the compact design methodology.

Keywords:- Antenna design, Simulation results, Result discussion.

I. INTRODUCTION

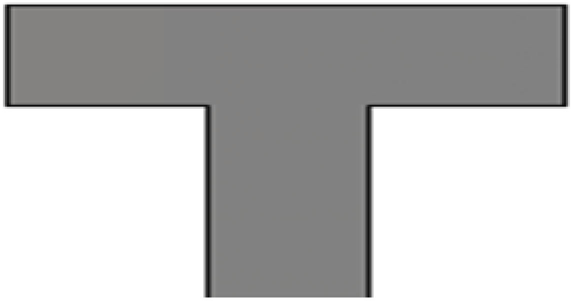
In present modern communication system, antennas are the most important components that are required to create a communication link, such device used to transform an RF signal [1, 2, 3]. A broadband impendence bandwidth, adjustable and moderate gain, simple construction makes it more advantageous structure as compared to other convention antenna geometry . Such antennas are useful in satellites and the radar application because these are easily mounted on the skin of the aircraft and the spacecraft [4, 5, 6, 7]. Due to characteristics of antenna such as ease of excitation, high gain and broadband impendence bandwidth, there is a need to develop novel antenna design solutions and strategies [8, 9, 10]. One of the more promising approaches that have been proposed to we can utilize to take a broad band micro strip antenna based on the T shape structure for above mentioned applications. A desired radiation pattern and current distributions can be obtained by using CST software; one can obtain a detailed analysis on Ku band T shaped antenna structure.

The proposed antenna offers the compact size and resonant frequency obtained at 15.8 GHz and 18.7 GHz & offers the impendence bandwidth 44 % or 7.5GHz. It has the maximum gain of 4.92 dBi at 12.7 GHz.

The paper is followed in the five sections. Introduction presented in Section I. Section II and III discusses the novel design of the proposed findings and results respectively. Section IV discusses the conclusion and future scope.

II. ANTENNA CONFIGURATION

A computer-simulated design model of the proposed T shaped antenna is shown in "Fig.1". The antenna consists of a section of two standard rectangular patch ending with in form of the T shape whose upper width is slightly extended above the lower rectangular width, compared to earlier studies with any complex antenna design. To provide additional degrees of freedom for optimizing the antenna performance characteristics with respect to the specific exposure uniformity requirements [11,12,13, 14]. The antenna is fabricated on the epoxy FR-4 substrate having dielectric constant $\in r = 4.4$ which provides results in reduction of the fabrication costs and improvement of the antenna performance, namely, impendence bandwidth, gain and a better symmetry of the main beam and lower side lobe level that is achieved due to natural suppression of the edge currents, which can be induced on the patch geometry. Generally, antenna profile is controlled by the two variable lengths, width and the dimensional of the waveguide port.

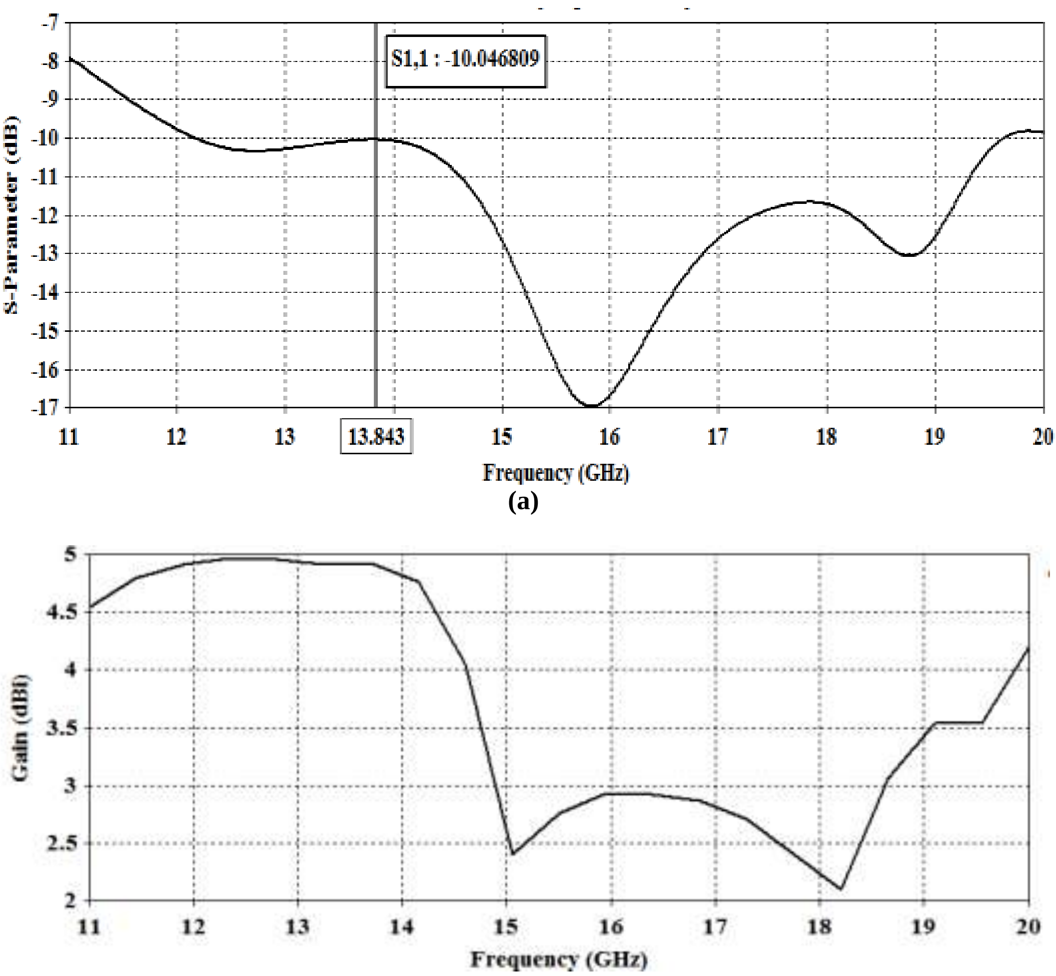


"Fig.1".The proposed antenna design

The dielectric layer is 1.625 mm thick foam with a dielectric constant of 4.4 and substrate thickness 0.035mm. The size of the rectangular upper unit cell is 14 x 5 mm and the lower rectangular unit 10 x 4mm on the surface layer. The dimensional of the proposed antenna is 20 x 20 mm. Extraction of the reflection coefficients through simulation allows computation of the broad bandwidth of 7.5GHz and gain 5dBi nearly in Ku band. This property satisfies the balanced condition over a wide bandwidth and allows the satisfaction elevation radiation be used in satellite application. T shaped antenna.

III. RETURN LOSS AND GAIN

Return loss of any antenna should be very less if the antenna is efficient. The S-Parameter results are shown in "Fig. 2(a)". The proposed antenna resonant at 15.8GHz to 18.8GHz between the 11GHz to 20 GHz frequency range that offers the moderate gain2.8dBi and 3.2dBi respectively. The maximum gain provided at 12.06GHz frequency shown in "Fig. 2(b)".

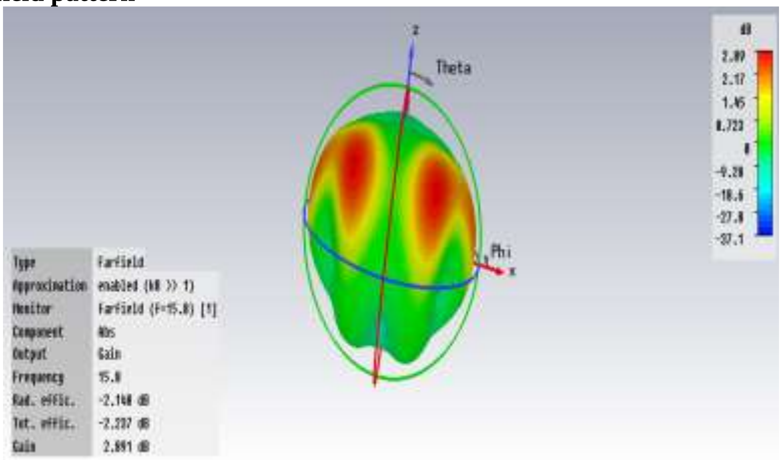


(b)

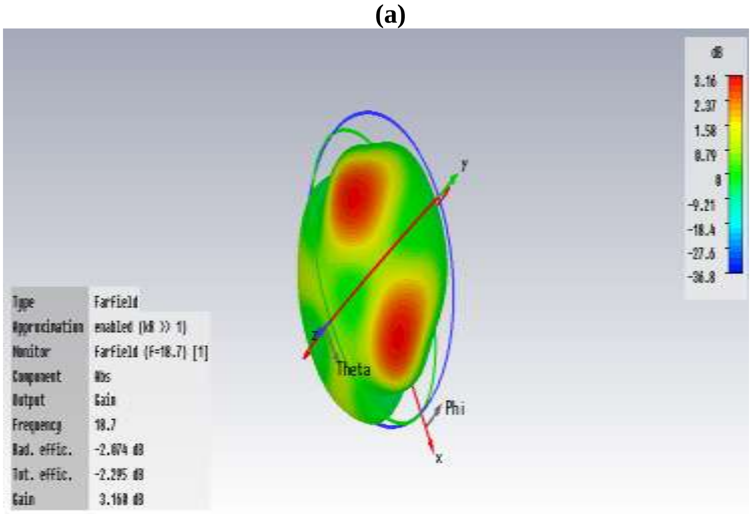
"Fig.2" Variation of (a) reflection coefficient (DB),
(b) Variation of gain (DBI) with respect to the frequency

IV. FAR-FIELD PATTERN

4.1 3D plot of far field pattern



(a)

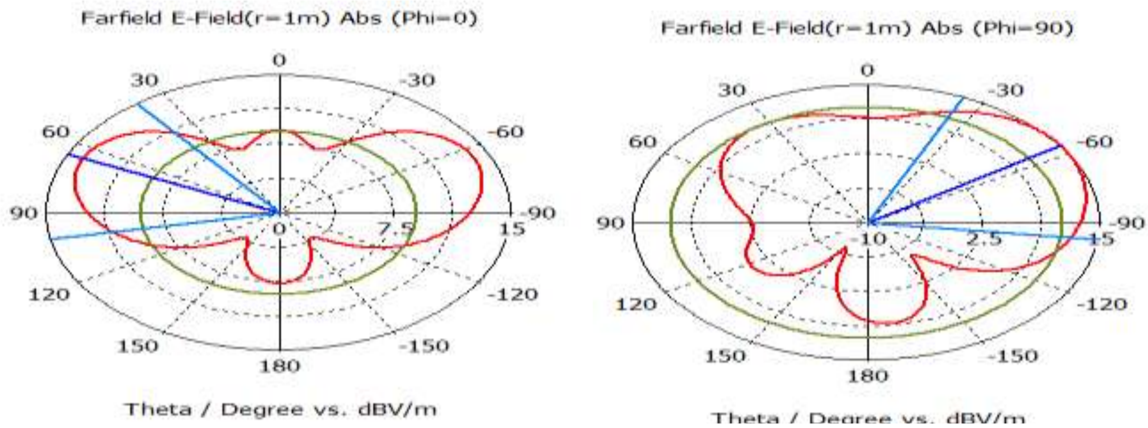


(b)

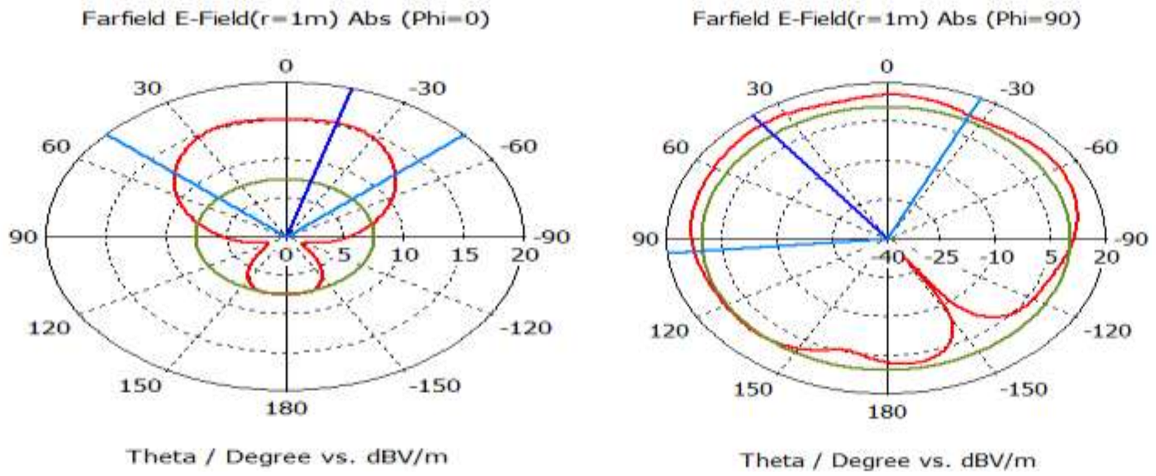
"Fig.3" 3D plot of far field pattern of proposed antenna at frequency at resonant frequency

(a) f =15.8GHz (b) f=18.7GHz

4.2 2D plot of far field pattern



(a)

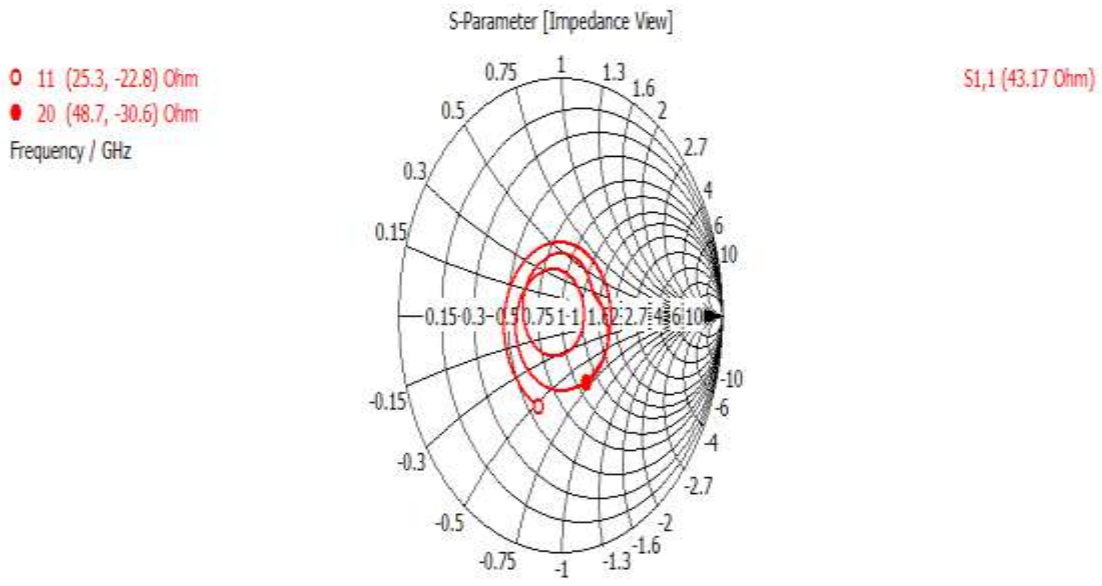


(b)

"Fig.4" 2D plot of far field E plane and H plane pattern of proposed antenna at frequency at resonant frequency

(a) f =15.8GHz (b) f=18.7GHz

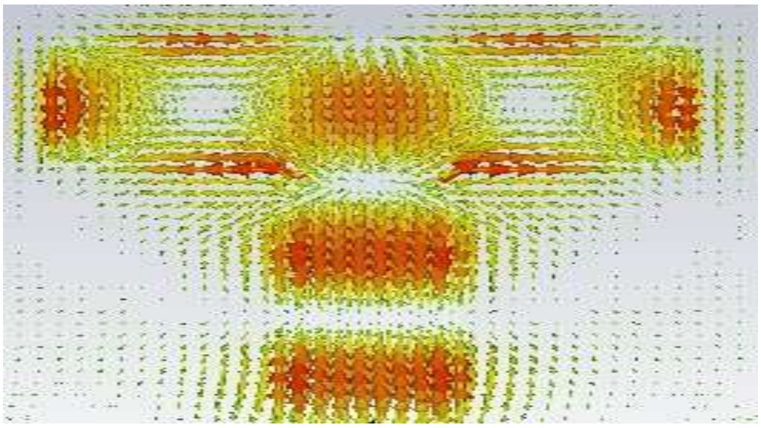
In 3D radiation pattern, the red spot shows the maximum gain which have the 60^0 in (x,-y) and (-x,-y) plane at their respective frequency as shown in the "Fig.3". The maximum E plane and H plane pattern is tilted almost at the 60^0 at 15.8GHz while at the 18.7GHz the maximum lobe direction at the 30^0 from the in front of the patch geometry indicated by the In "Fig.4"



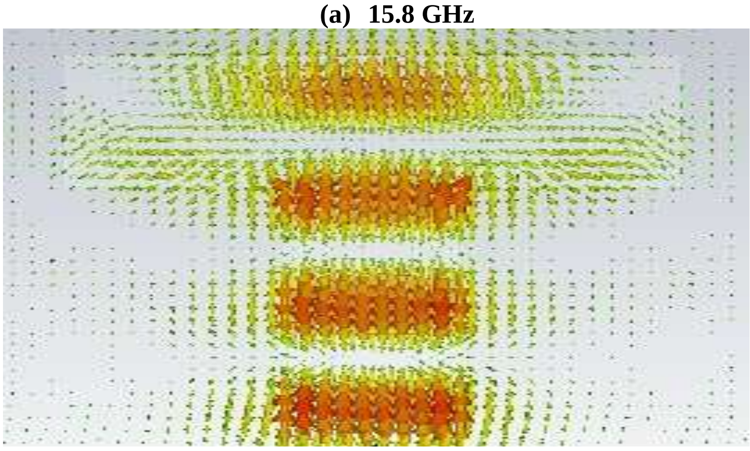
"Fig.5" Diagram showing smith chart of return loss

The measured input impedance are (25.3 – j22.8) ohm and (48.7 -j30.6) ohm respectively as shown in 6 which are quite close to 50 ohm impedance of the feed line shown in "Fig.5".

The surface current distribution on the patch geometry with respect to their resonant frequency is shown in the "Fig.6". At first resonance frequency, the current distribution is maximum at the centre and across the boundary of the upper rectangular shape while it is maximum at lower and upper part of the lower rectangular shape of the patch. The current density is minimum at the upper part and it is maximum at the junction of both rectangular shape.



(a) 15.8 GHz



(b) 18.7GHz

"Fig.5" Surface current distribution on the patch geometry

V. CONCLUSION

In this paper, T shaped Patch Antenna designed, simulated in Ku band at 15.8 GHz and 18.7 GHz successfully. The simulated result is carried out by computer simulation technology software. The proposed antenna design is suitable for the major requirement in satellite communication system. In this work, a broad band micro strip rectangular patch antenna with T shaped antenna is designed on FR4 substrate of thickness 1.6 mm which is aimed to achieve Ku band operational frequencies of 15.8 GHz and 18.7 GHz that can be used for satellite communication and radar system. The proposed antenna offers good elevation radiation pattern and higher impendence bandwidth. The antenna geometry is so compact and straightforward that can be used in satellite communication systems in the form of array at high power operations.

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