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An Inverted Bowtie Type Patch Antenna for Multiple Applications

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Abstract:- A simple dual band high gain bowtie type patch antenna for multiple applications involving television, mobile phones, GPS, astronomy and remote sensing is proposed in this paper. The proposed antenna has small size and simple shape which enables it to be embedded inside any modern gadget operating in Ultra high frequency (UHF) and Extremely high frequency (EHF) frequency bands. The overall antenna dimensions are $13.98 \times 11.02\ mm$ with two triangular cuts of dimensions $5.8873 \times 5.8873 \times 11.02\ mm$ from left and right. The antenna is fed by microstrip line feed and the simulation results illustrates that the antenna resonates at dual frequency with a maximum gain of $11.9dBi$ which characterizes such a gain that the proposed antenna can be said to be with negligible losses.

Keywords:- Microstrip Antenna, Bowtie patch, dual-band, Antenna Gain, Reflection Coefficient.

I. INTRODUCTION

Signaling Microstrip Patch antennas, the pillar of the present day communication systems, have substantial advantages over other types of antennas because of its low price, small size and easy manufacture techniques [1]. However, the orthodox designs of microstrip patch antennas have a manifest shortcoming in the antenna bandwidth and gain. Accordingly, many scholars have focused their interest toward refining these two parameters. Even though the EHF band covering the frequency range of 30-300GHz experiences a very extraordinary atmospheric attenuation, it is desired by many engineers because of its less congestion than other bands of frequency including many wireless applications [2].

Many scientists deal with refining the microstrip patch antenna bandwidth and gain for high data rate UHF and EHF applications. The band width enhancement can be achieved either by designing an UWB antenna which covers widespread frequency range [3] or by exploiting the concept of multiband antennas [4]. On the other side, the improvement in gain can be attained by some designing techniques such as using artificial magnetic conductors [6] and using metamaterial lens [5]. Some distinct feeding methods are also offered for improvement of gain such as waveguide feed [7] and probe tangent feed [6].

In this paper, a simple dual band high gain bowtie type patch antenna for multiple applications is proposed for UHF & EHF applications. The proposed antenna is a bowtie type patch antenna with different gain properties at different resonant frequencies exhibiting very low radiation losses. Even though the antenna has a simple shape, the simulation results depicts the antenna dual band behavior as well as good radiation performance. The bandwidth of the antenna is determined by representing the antenna reflection coefficient S11 whereas the its radiation performance is assessed by reviewing its peak gain at the resonant frequency of the bandwidths of operation.

II. ANTENNA STRUCTURE

Like the orthodox microstrip patch antennas, the proposed Inverted Bowtie Type Patch antenna also has a conducting patch engraved on a dielectric substrate with a slotted metallic conductor opposite the upper patch on the other side of the substrate. This is further placed on the same type of substrate as shown in Fig. 1.

The substrate is a Rogers substrate with dielectric constant of 10.2, whereas the metallic parts of the antenna are made of copper. Fig. 2 displays the dimensions of the antenna. The patch of the proposed antenna is made from a rectangular patch with two triangular cuts. The complete antenna dimensions are $13.98 \times 11.02\ mm$ with two triangular cuts of dimensions $5.8873 \times 5.8873 \times 11.02\ mm$ from left and right. And the ground plane is a slot plane above another Rogers substrate. Hence compared to its equivalent antennas cited in Sections 1, it is a very simple design. Moreover, the substrate used here is superior than the special substrates utilized in the designs pointed out in the first section. It is worthy to comment that a microstrip line feeding technique is used in this proposed design with dimension of $2.06 \times 0.3\ mm$ with feed point located at the center of the junction.

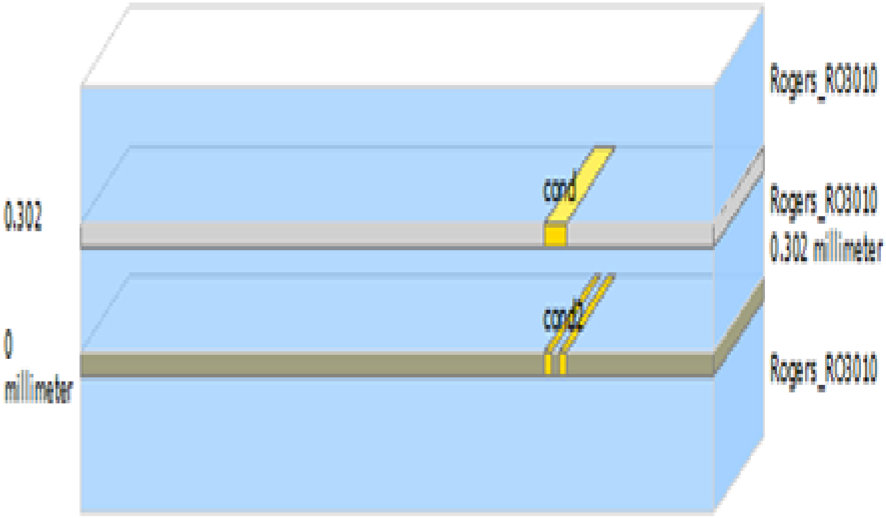

Fig. 1. The overall structure of the proposed antenna.

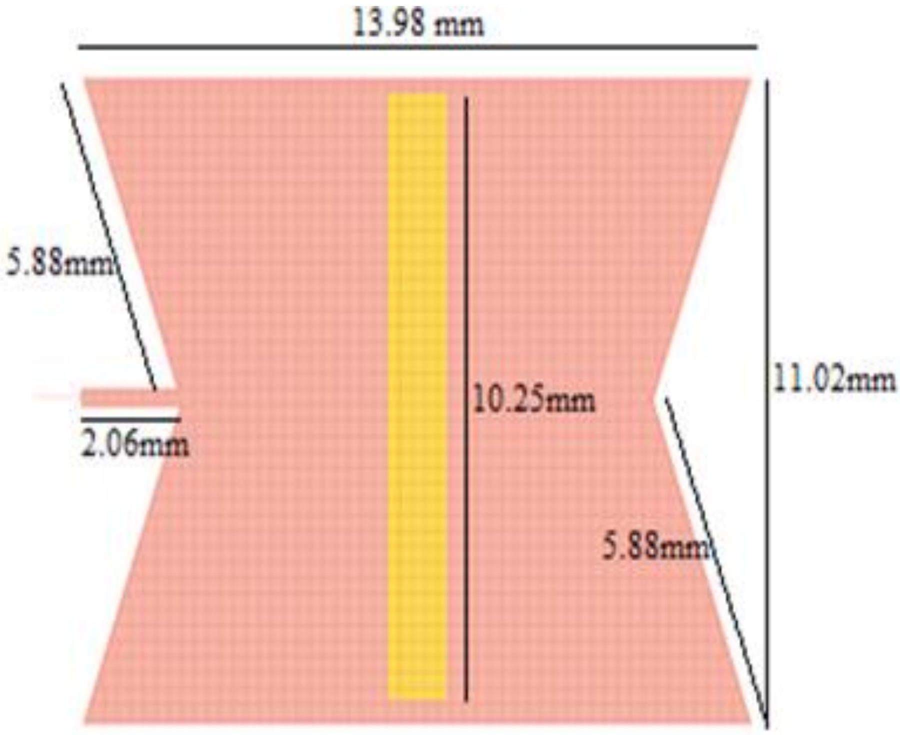

Fig. 2. The geometry of the proposed patch antenna.

III. RESULTS AND DISCUSSION

The simulation results are attained with utility of Advanced Design System (ADS) software simulation suite. Fig. 3 demonstrates the magnitude of the S11 referred as the reflection coefficient of the proposed antenna. This figure shows that the bandwidth of the antenna is 400 MHz extended through the frequency range of $2.122 - 2.164$ GHz. It is evident that the proposed antenna functions within the UHF frequency band for the first resonant frequency with a center frequency that qualifies it to support data rate systems involving TV, GPS and mobile phones. The distribution of the antenna current at 2.12 GHz, which is considered as the resonant center frequency of the band of operation is demonstrated in Fig. 4.

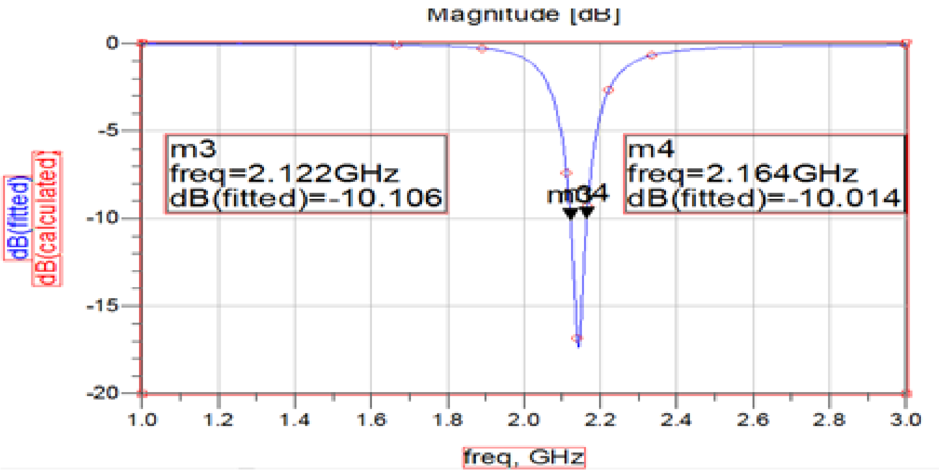

Fig. 3. The Frequency response of the proposed antenna.

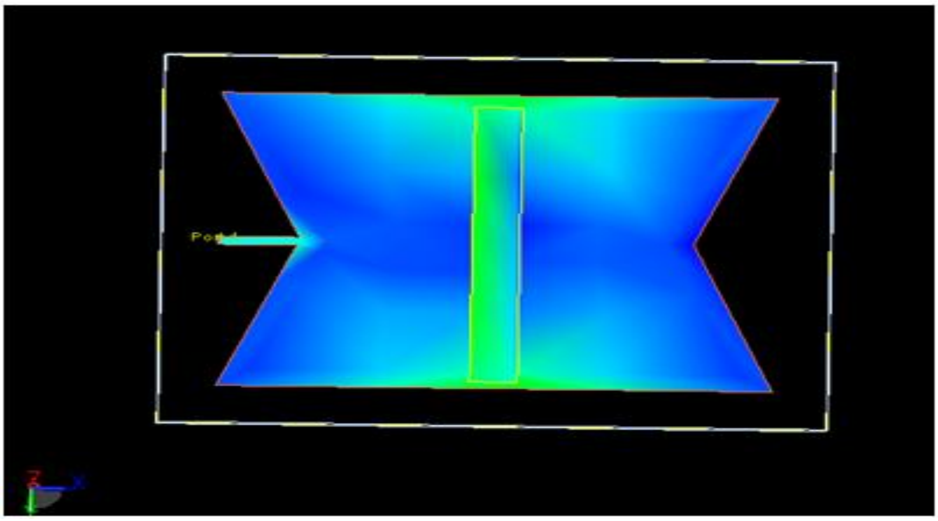

Fig. 4. The current distribution of the proposed antenna at f=2.12GHz.

The gain as a function of space coordinate system at $2.12\ GHz$ is demonstrated in Fig. 5 to focus the radiation pattern of the proposed antenna. The antenna is found to have bidirectional radiation pattern in E-plane (xz-plane) and in H-plane (xy-plane). The gain value at the first center frequency is found to be $3.66\ dBi$ at the same azimuth and elevation angle. Even though this is not bad and a valid configuration, we tried to improve the gain of this antenna.

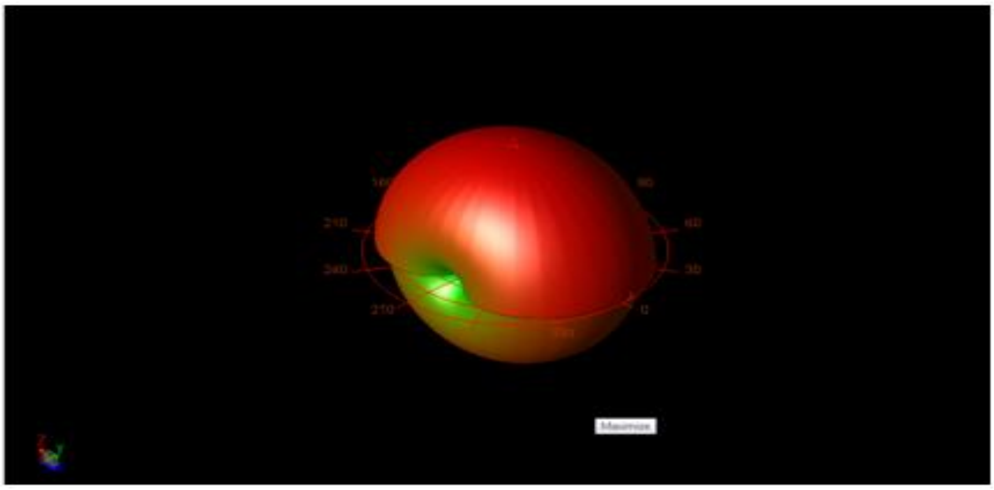

Fig. 5. The Radiation Pattern at f=2.12GHz.

Fig. 6 demonstrates the magnitude of the S11 at the second resonant frequency of the proposed antenna. This figure shows that the bandwidth of the antenna is 1430 *MHz* or 1.43 *GHz* extended through the frequency range of 33.57-35 *GHz*. It is evident that the proposed antenna functions within the EHF frequency band for the second resonant frequency with a center frequency that qualifies it to support data rate systems involving astronomy and remote sensing. The distribution of the antenna parameters at 34.3 *GHz*, which is the resonant center frequency of the second band of operation is demonstrated in Fig. 7.

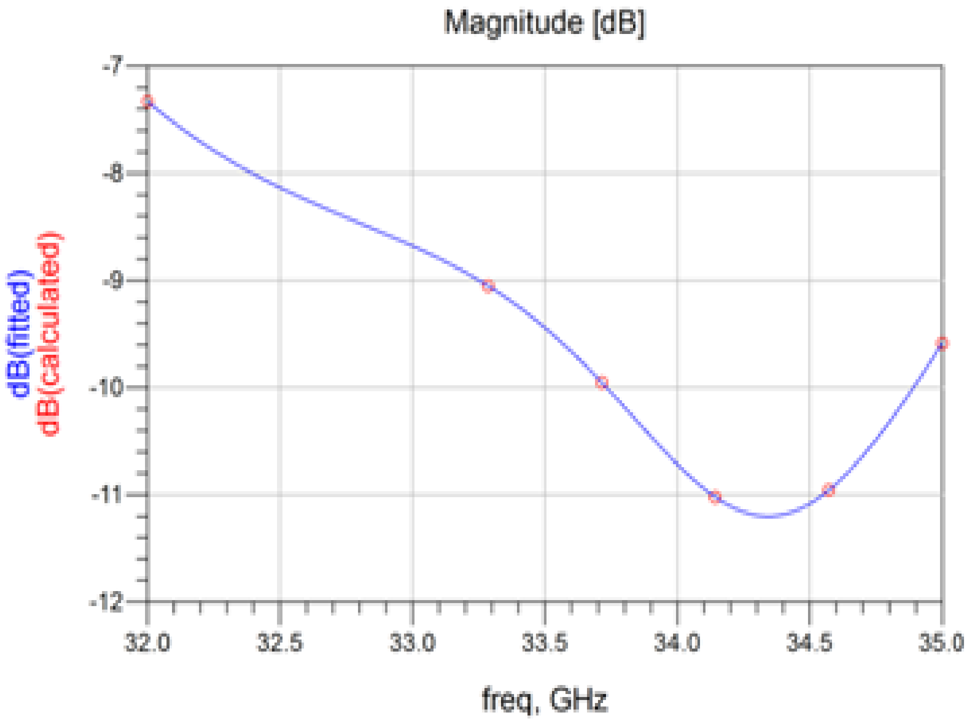

Fig. 6. The simulated magnitude of the reflection coefficient of the proposed antenna.

Power radiated (Watts)		0.0394116
Effective angle (Steradians)		0.885697
Directivity(dBi)		11.5192
Gain (dBi)		11.5914
Maximim intensity (Watts/Steradian)		0.0444978
Angle of U Max (theta, phi)	86	72
E(theta) max (mag,phase)	5.79023	52.5668
E(phi) max (mag,phase)	0.0230336	31.9718
E(x) max (mag,phase)	0.104592	56.7918
E(y) max (mag,phase)	0.390809	52.1997
E(z) max (mag,phase)	5.77613	-127.433

Fig. 7. The Antenna Parameters at f=34.3GHz.

The gain as a function of space coordinate system at $34.3\ GHz$ is demonstrated in Fig. 8 to focus the radiation pattern of the proposed antenna. The antenna has radiation pattern in H-plane (xy-plane) and also in E-plane (xz-plane) as shown in Fig. 8. The maximum gain value at elevation angle of 86^o and azimuth angle of 72^o ,is found to be $11.59\ dBi$ and this gain is better than the ones obtained in [3-11]. The antenna directivity at the same elevation and azimuth angle of the maximum gain is found to be $11.51\ dBi$. The antenna radiation intensity which consequences from apportioning the radiated power by the effective steredian angle of the antenna [1] is $44.49\ mW/steradian$.

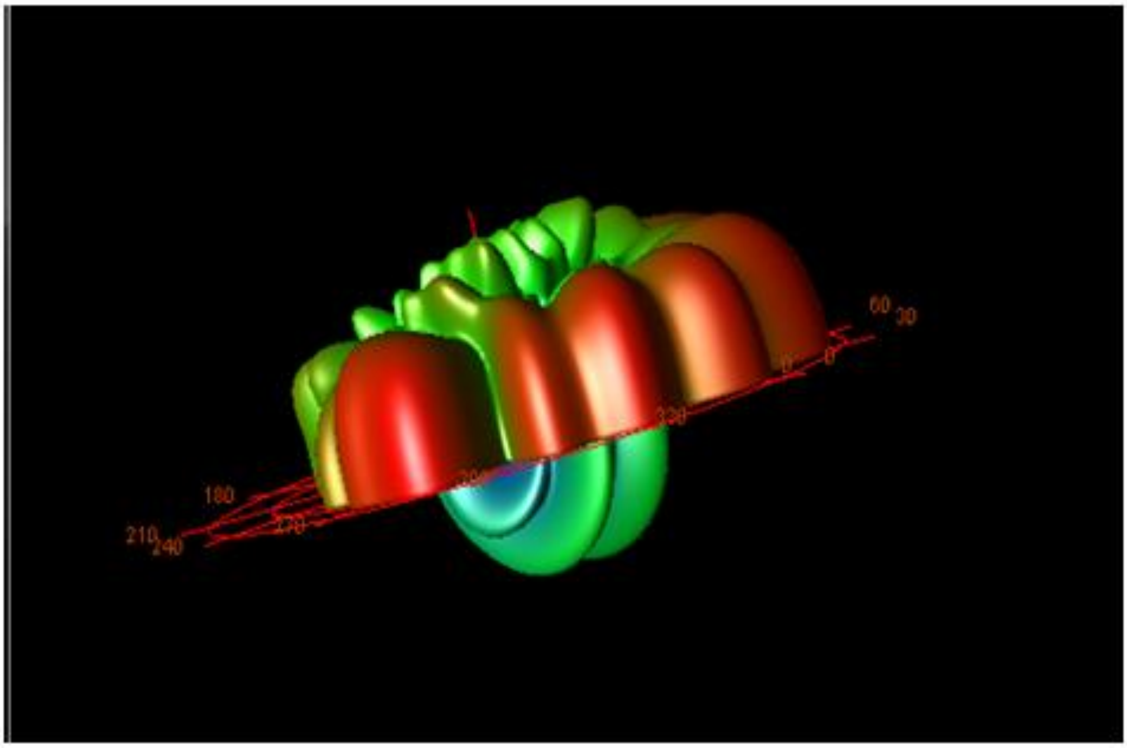

Fig. 8. The Radiation Pattern at f=2.12GHz.

The value of antenna gain and the dual center frequency proves that the antenna operates as a UHF and EHF antenna. This means that the antenna can be utilized for ultra-high frequency and extremely high frequency data rate applications with very good radiation characteristics. Thus, this antenna is appropriate for multiple applications involving television, mobile phones, GPS, astronomy and remote sensing. The gain and bandwidth at different frequencies can be observed in table 1.

Frequency (GHz)	S11	BW (MHz)	Gain (dB)
2.12	-17	400	3.66
34	-11	1430	11.9

Table 1. Proposed antenna parameters

IV. CONCLUSION

A dual band bowtie type microstrip patch antenna with simple shape high and gain is proposed in this work for UHF and EHF applications. Even though the antenna has a simple shape, it covers dual oscillating frequency range and offers very good radiation characteristics in comparison with the other complex designs. The simulation results through ADS show that the antenna has good second bandwidth of 1430 MHz and maximum gain of 11.9 dBi at 34.3GHz while the same antenna was able to be active in the low frequency range giving a bandwidth of 400 MHz. These two oscillation band values qualify the antenna to be embedded inside any modern gadget operating in Ultra high frequency (UHF) and Extremely high frequency (EHF) frequency bands.

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