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Review Article

ANALYSIS OF TRIANGULAR ANTENNA WITH TWO ANNULAR RINGS FOR MULTI-BAND APPLICATIONS

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Abstract
In this paper, a meandered slot triangular patch antenna has presented. The proposed antenna comprises a triangular microstrip patch element on top of the substrate embedded with meander line at center of triangular patch and two annular rings side by side to the feed line. The obtained frequencies are 6.76GHz, 9.6GHz, 12.6GHz, and 14.7GHz with return loss -32.3dB, -22.9dB, -25.5dB, and -13.7dB respectively. The maximum gain is obtained 9.51 dBi at 12.6 GHz frequency. This antenna find applications at radio astronomy, a mature satellites, defence systems.

Keywords: Meandered Slot, Annular ring, Return Loss, Gain, VSWR.

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INTRODUCTION

ANTENNAS are very important in all mobile devices, communication systems. But, the miniaturization of the antenna size is required. Microstrip antennas having attractive features like low profile, small size, low cost makes them excellent aspects for satisfying this design consideration [1]. Narrow bandwidth is the drawback in microstrip patch antennas. So, our aim is to increase the antenna bandwidth with antenna size reduction.

There are so many techniques to reduce the size of an antenna, one of the prominent techniques is by metamaterial substrate [5], [7]. Metamaterial based antenna development with size reduction was proposed in [1-8]. With this antenna the size reduction is almost 70%.

Another approach is there by increasing the electrical length optimizing the shape of a microstrip antenna. So, that its overall size is reduced for a given operating frequency. Meander slots are one of the best structures in microstrip patch antennas [1]. Meander slot technique allows an antenna to reduce its size and provides wideband performance [2]. The performance of the meander slot antenna depends on number of turns of meander line, width and gap between the meander lines. Triangular patch has been used to analyze the performance of single meander slot in center position. For this microstrip antennas are considered due to its ease of fabrication, low cost, low profile [6], [3].

From the literature survey, various types of antenna models have been designed for multiple frequency applications. A parasitic element rectangular patch antenna [9], with I-shaped ground stub was designed for dual band application. This antenna produces a maximum impedance bandwidth of 71.63% at 2.82GHz frequency. An oval shape planar PIFA antenna was designed for mobile phone application [10]. The antenna resonates at two frequencies with band widths of 900MHz and 1800MHz respectively. A dipole antenna with comb like structure [11] was designed for multiple frequency bands. The antenna resonates at 2.34GHz, 2.7GHz, 3.08GHz and 3.60GHz frequencies respectively. In [12], a rectangular patch antenna with split ring resonator was designed for UWB application with triple band notch. Similarly, an UWB antenna with dual band notch [13], was designed for lower and upper WLAN band frequencies.

In this paper, a monopole triangular shape patch antenna is designed for multiple frequency application. A meta-material shaped menader line slot at the center of the triangular patch and the two annular rings to the input feed line are considered to operate the antenna for multiple bands. The proposed antenna resonates at 6.76GHz, 9.6GHz, 12.6GHz, and 14.7GHz with return loss -32.3dB, -22.9dB, -25.5dB, and -13.7dB respectively.

DESIGN OF MEANDER LINE TRIANGULAR ANTENNA

The proposed antenna model is designed with $l_1 \times w_1$ of substrate area. FR-4 is considered as a substrate material. A triangular shape patch is metallized on the substrate material at a height of 1.6mm. An equilateral triangle with side length of *s* is etched with an meander slot. The dimensions of the meander slot are m_1, m_2, and n_1 as shown in Fig. 1. An input impedance of 50Ω is considered as input to the antenna through a rectangular patch with length and width l_2 and w_2. Two circular ring patches are added to the radiating patch through the rectangular stub with width w_3 and thickness of 1.6mm respectively.
The width of the circular ring is w_4 and the maximum radius of the outer ring is *r*. The parameter values of the proposed antenna are listed in Table. 1.

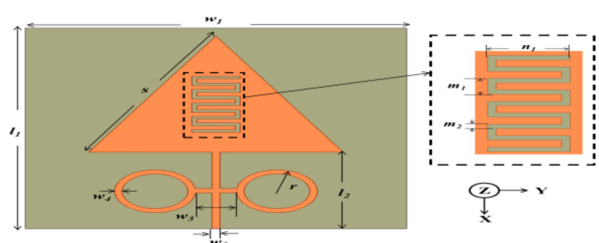


Figure 1: Geometry of meander line triangular antenna

Table 1: Parameters of the proposed antenna

Parameter	Values (mm)
l_1	75
w_1	75
l_2	24.2
w_2	1.6
w_3	8.4

w_4	1.5
s	50
r	8
m_1	3.5
m_2	1
n_1	9.5

RESULTS AND DISCUSSION

The meander line triangular antenna with two annular rings has simulated using CST Software. Fig. 2 shows the reflection coefficient of proposed antenna. The antenna resonates at multiple frequencies at 6.76GHz, 9.6GHz, 12.67GHz and 14.7GHz respectively. The reflection coefficient values of the antenna with respect to each frequency are -32.3dB, -22.9dB, -25.5dB and -13.7dB.

The evaluation process of the proposed antenna model is shown in Fig. 3. From the figure, a planar triangular shape patch antenna with a rectangular stub added to the input feed line is considered as Ant-1. This antenna model does not produce any frequency response within the frequency limit from 6GHz to 16GHz frequency. To generate the antenna for multiple frequencies application two annular ring slots are added to the rectangular stub and considered as Ant-2. The antenna resonates at four frequencies at 6.97GHz, 9.1Ghz, 10.3GHz and 12.7GHz with reflection coefficient -18.5dB, -19.2dB, -17.57dB and -16.3dB respectively. The final evaluation Ant-3 is designed by adding a meta-material structure meander line with 9 turns in order to increase the reflection coefficient and gain. The antenna resonates at. 6.76GHz, 9.6GHz, 12.6GHz and 14.7GHz frequencies with reflection coefficient -32.3dB, -22.9dB, -25.5dB and -13.7dB respectively.

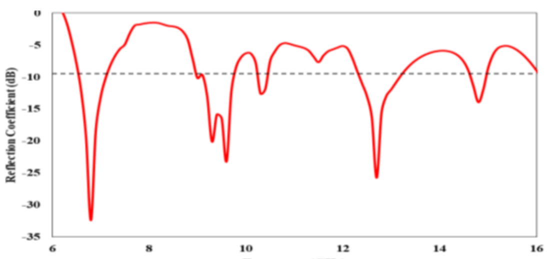
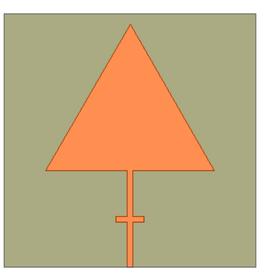
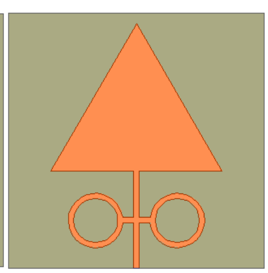


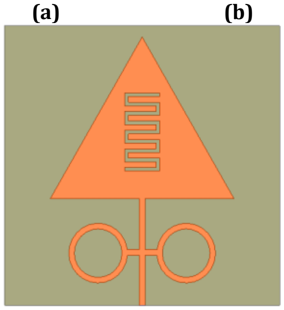
Figure 2: Return loss of meander line triangular antenna with two annular rings



(a)



(b)



(c)

Figure 3: Evaluation process of the proposed antenna (a) Ant-1, (b) Ant-2 and (c) Ant-3

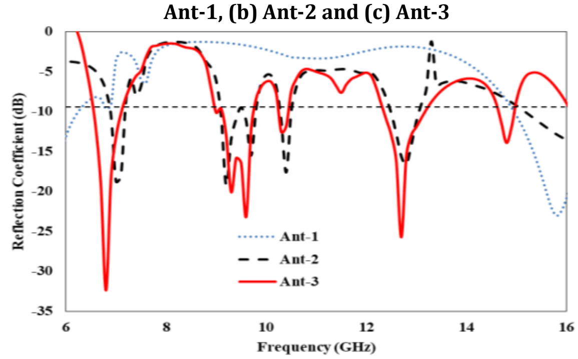
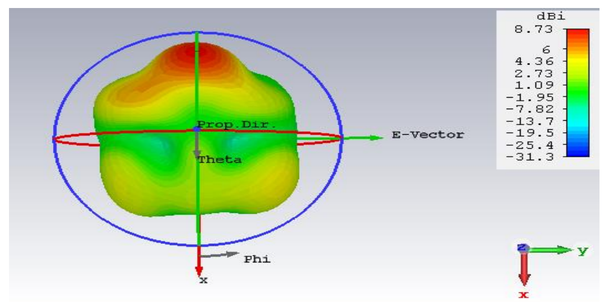
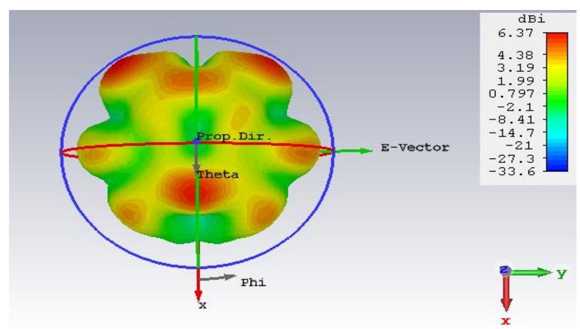


Figure 4: Reflection coefficient plot for evaluation process

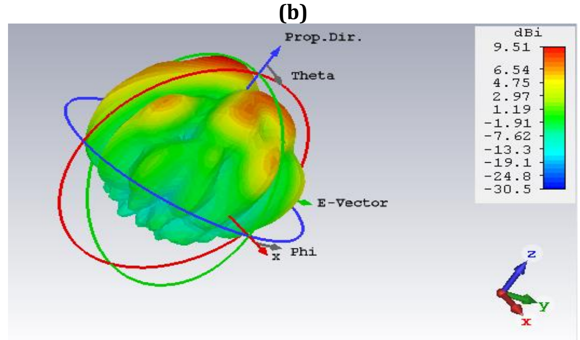
The gain plots of the triangular patch antenna are shown in Fig. 5. From the figure the gain values of 8.73dB, 6.37dB, 9.51dBand 7.49dB are observed at 6.76GHz, 9.6GHz, 12.67 GHz and 14.7GHz frequencies. A maximum gain of 9.51dB is observed at 12.67GHz frequency. The radiation patterns of the antenna at different frequencies with respect to E and H plane are shown in Fig. 6



(a)



(b)



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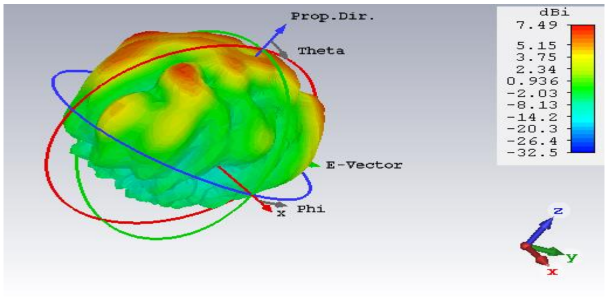

(d)

Figure 5: Gain pots of meandered slot Triangular antenna at different frequencies (a) 6.76 GHz, (b) 9.6 GHz, (c) 12.67 GHz, (d) 14.7 GHz

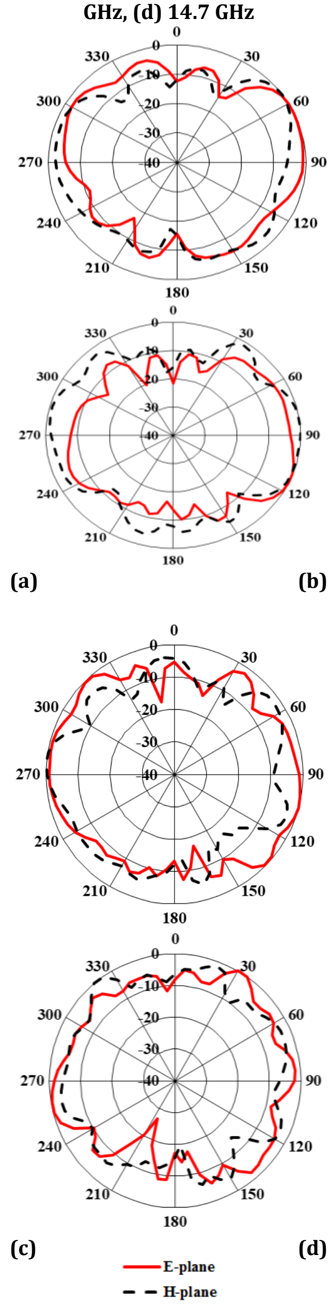

Figure 6: Radiation Patterns E-filed, H-field at (a) 6.76 GHz, (b) 9.6 GHz, (c) 12.67 GHz, (d) 14.7 GHz

CONCLUSION

The meander line triangular antenna with two annular rings has proposed for multi-band applications. Due to etching of meander line and adding annular rings resonant frequencies are generated with wide bandwidths. It has a better simulation results in terms of reflection coefficient, gain. The antenna radiation characteristics are also good. These results are used in passive sensors (satellite), radio astronomy, a mature satellites, defence systems.

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