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A Compact Dual Band Triangular Patch Antenna with Spiral Resonator for wireless applications

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Abstract- A novel dual band triangular patch antenna designed using Spiral resonators (SR) in its patch is presented. The metamaterial structure (SR) used in this design effectively reduces the size of conventional patch resulting in dual resonances with wide apart spectra. The antenna is found to resonate at 10.38, 13.99 GHz with gains of 3.6 and 5.4 dBs respectively. The antenna has an Omnidirectional pattern and good directivity at the resonant bands.

Keywords: Triangular Microstrip patch antenna, linear polarization, wireless applications

I. INTRODUCTION

Microstrip patch antenna (MPA) are printed antennas widely prefered in market due to many of its remarkable features like cheapness, light weight, easy integration. These features make them an apt candidate for almost all wireless system [1]. In this paper a triangular patch is modelled to resonate at dual frequencies using a metamaterial (MTM) structure, Spiral Resonator; The shape is chosen as it occupies less space and can be easily realized.. Literatures providing adequate information about triangular patches are available in[2-6]. The artificially synthesized materials supporting backward waves exhibiting negative permeability, permittivity was originally suggested by Vessalago in 1968 [7]. Design of MPA with MTM are seen in [8-14]. This paper is presented in three up coming sections; The Proposed Design, Analysis and Conclusions.

Design of the Proposed Antenna

The conventional patch antenna (Designed with duroid substrate of 60 mil thickness) fed with a microstrip line is etched with three spiral resonators this is targetted to create dual resonances. The optimized dimensions are shown in Table 1. The model is shown in Figure 1. The spiral resonators are excellent structures aiding miniaturization up to λ/30 where λ is free space wavelength. The design equations presented in this section are applicable only for certain values of *N*, as given below.

$$N_{SR\max} = Integer\left[\frac{l-(w+s)}{2(w+s)}\right] \quad \ldots \quad (1)$$

The design equations for the spiral resonators are as follows;

$$L_{SR} = \frac{\mu_0}{2\pi} l_{SRavg}\left[\frac{1}{2}+\ln\left(\frac{l_{SRavg}}{2\omega}\right)\right] \quad \ldots \quad (2)$$

$$C_{SR} = C_o \frac{l}{4(\omega+s)} \frac{N^2}{N^2+1} \sum_{n=1}^{N-1}\left[l-\left(n+\frac{1}{2}\right)(\omega+s)\right] \quad (3)$$

Where ω stands for width, s for spacing , N is an integer, n stands for number of turns, l stands for length while the expressions for l_{SRavg} and C_o are available in [9].

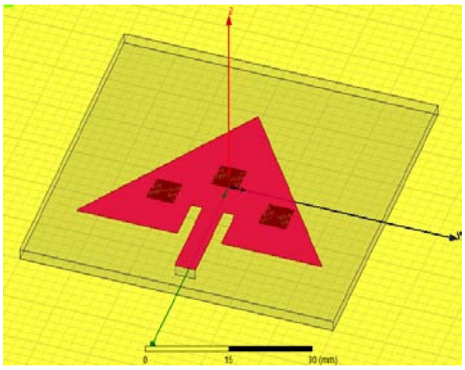

Fig. 1: Top View of the Proposed Antenna.

Table 1: Dimension of the Proposed Antenna.

Parameters	Size (mm)
Substrate	*60 x60 x1.524*
Ground Size	*60x 60*
SR turns	*10*
Width	*0.125*
Distance	*0.25*
Thickness	*0.002*

Analysis of The Proposed Antenna

The proposed antenna resonates at two frequencies *10.38, 13.99* GHz with a return loss of -12.48, -21.87 dBs ; This is Shown in Figure 2. Further at this frequencies Radiation plots are simulated and are shown in Figures 3,5.

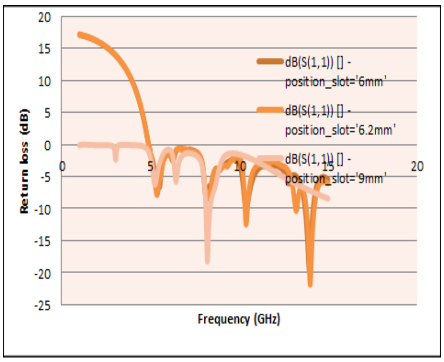

Fig. 2:.Return Loss of the Proposed Antenna.

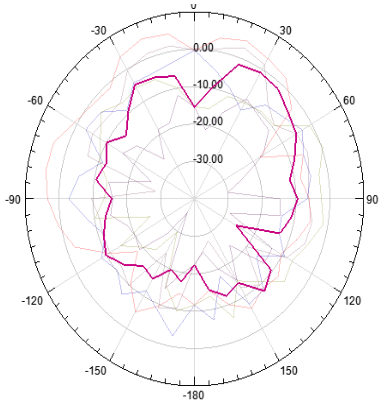

Fig.3: Radiation Pattern of the Proposed Antenna.

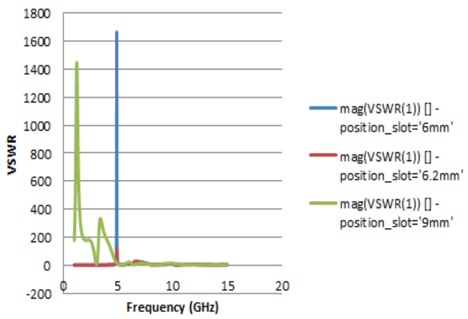

Fig.4: VSWR of the Proposed Antenna.

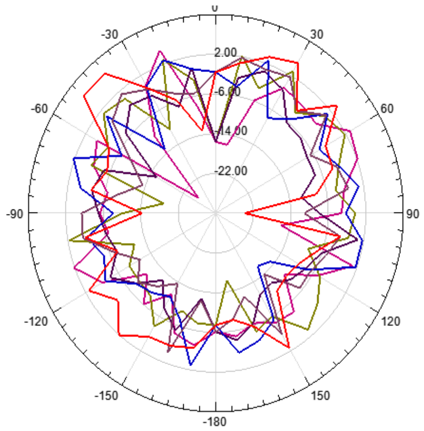

Fig. 5: Radiation Pattern of the Proposed Antenna

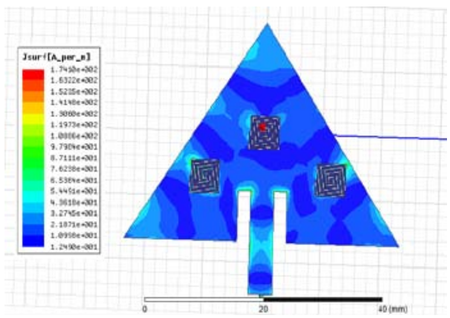

Fig. 6: Surface Current Density on the Patch

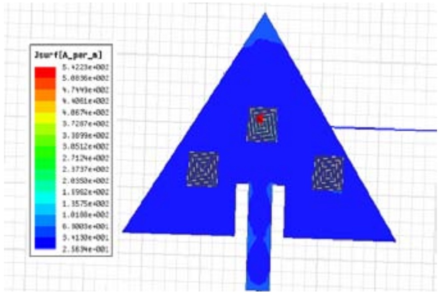

Fig. 7: Surface Current Density on the Patch

The VSWR variation is shown in Figure 4. The surface current density is depicted to show that the current travels long path making antenna resonate at lower frequencies(Figures 6,7). Thus making the patch dual resonant in nature. The simulated antenna parameters are consilidated and are tabulated in Tables2,3.

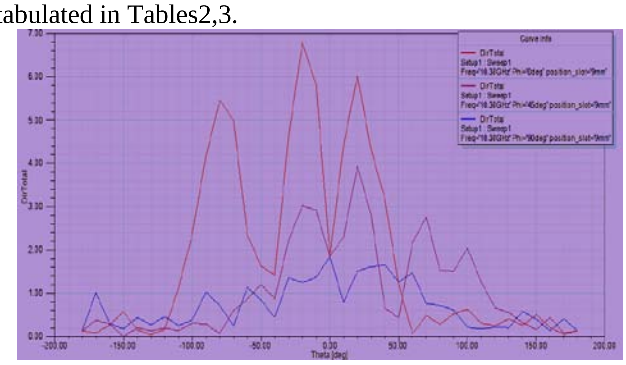

Fig. 8: Directivity of the Patch

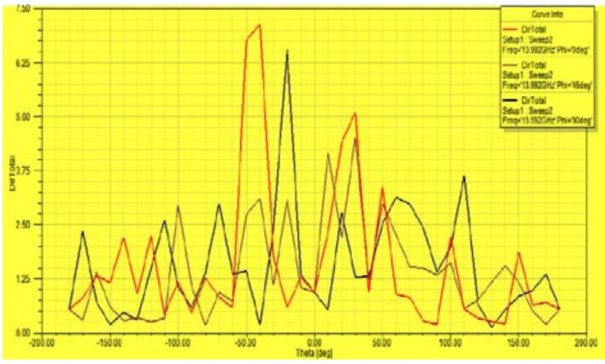

Fig. 9: Directivity of the Patch

Table 2: Simulated Antenna Parameters at 10.38 GHz.

No.	Quantity	Value	Unit
1	Max U	0.28303	w/sr
2	Directivity	6.7781	dB
3	Efficiency	98	
4	FBR	31.8	

Table 3: Simulated Antenna Parameters at 13.39 GHz.

No.	Quantity	Value	Unit
1	Max U	0.4284	w/sr
2	Directivity	7.131	dB
3	Efficiency	81.7	
4	FBR	30.45	

CONCLUSION

A novel dual resonant, size reduced, cheap antenna is designed succesfully using an innovative metamaterial; The spiral resonators. The proposed antenna has adequate gain, directivity and has an omnidirectional pattern. The antenna may be realized using PCB/Photolithograpghic techniques.

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