CPW FED PENTABAND MICROSTRIP ANTENNA FOR WIRELESS APPLICATIONS

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Abstract

This paper suggests the layout of a penta-band modified meandered shaped microstrip antenna for wireless applications. Proposed design presents a compact antenna with microstrip feed having dimensions of 1.823 inch × 0.866 inch. The penta-band resonance is obtained by using modified meander patch and ground on the same plane. Various types of substrates like Bakelite, FR4, Teflon and Roger are tried and results are compared but the best results are obtained for FR4 substrate with thickness of 0.629 inch. The designed antenna resonates at five useful frequencies and obtained values of VSWR are 1.31, 1.09, 1.12, 1.67 and 1.48 respectively. It exhibits total gain of 8 dB along with good radiation properties and can be used for wireless applications. HFSS software is used to simulate the proposed antenna structure.

Keywords

Meander, FR4, Monopole, Multiband

1. Introduction

This paper focuses on the design, simulation and analysis of modified Meander line antenna, it is kind of microstrip antenna [1]. Such antennas are discussed with the goal of achieving a miniaturized wireless transceiver design which is capable of providing better performance using minimal space on a printed circuit board (PCB). Various modified meander structures have been studied and analyzed [2][3][4]. The meander line antenna was proposed to for reduce the resonant length [2]. Much higher compactness can be achieved by using Meander geometry. It is designed by combination of perpendicular conductive paths arranged in such a way to minimize the overall length of a monopole or dipole antenna [5][3].

Efficiency of this antenna is enhanced with number of turns and its resonant frequency decreases if spacing between turns is increased [1][6][7]. Spacing of meander elements and width of conductive paths are important factors on which antenna size reduction factor 'α' depends [8][9].

Such antennas have an edge over other structures in terms of its small electrical length, low profile and easy to design [10]. If its size is considered its radiation efficiency is related to it i.e. if size of antenna is reduced, the radiation efficiency is reduced [1].

2. Antenna Design

Proposed modified Meander antenna has been designed with co-planar waveguide feed (CPW) by adopting equations [6][11]:

$$hs \leq \frac{0.3c}{2\pi f\sqrt{\varepsilon_r}} \quad (1)$$

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Where, hs = height of the substrate. F = frequency in GHz. C = velocity of light in m/s. ε_r = Substrate dielectric constant.

The width of the patch can be determined through the following equation [11]

$$wp = \frac{c}{f} + \sqrt{\frac{2}{\varepsilon_{r+1}}} \quad (2)$$

Also, the length of the patch can be calculated from the specified equation [11]

$$L = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad (3)$$

ΔL= physical length can be calculated from the below equation [11]

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad (4)$$

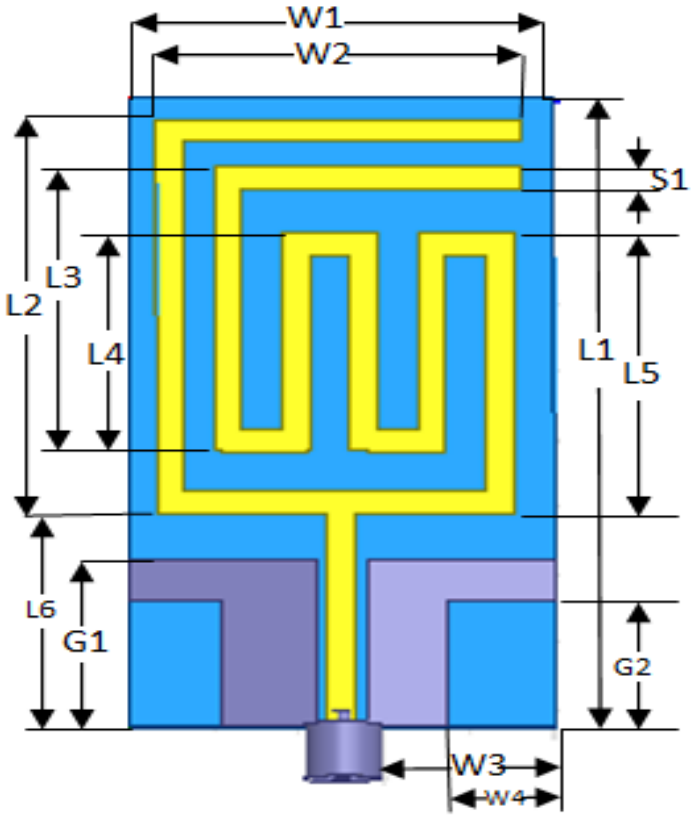

Figure 1: Geometry of Meander shape antenna with modified CPW feed

Proposed structure of the antenna has been designed in HFSS electromagnetic simulation as shown in figure 1. Proposed radiating antenna structure has been created over flame retardant substrate having dielectric constant of εr=4.4, loss tangent tan δ=0.02 and thickness of 0.629 inch & measurement of 1.823 inch × 0.9842 inch.

The ground plane cuts small notches to improve the performance of antenna. The ground plane dimension 12.32 mm ×11 mm. The width of ground is partially in increased in both side and ground length is reduce. It can be used in many applications in the wireless technology such as military telemetry, WLAN, GPS, cellular phone etc.

Table 1

Geometrical details of the proposed Meander shaped antenna

Parameters	Dimensions (mm)	Parameters	Dimensions (mm)
L1	46.32	G2	9.24
L2	28.4	W1	25
L3	20	W2	20
L4	16	W3	11
L5	19.8	W4	5.5
L6	16.32	S1	1.6
G1	12.32		

3. Results and Discussion

A comparison was done by designing the antenna initially on different substrate materials like Bakelite (εr = 4.8), FR4 (εr =4.4) Teflon (εr =2.1) and Roger (εr =2.2) as show in figure 2.

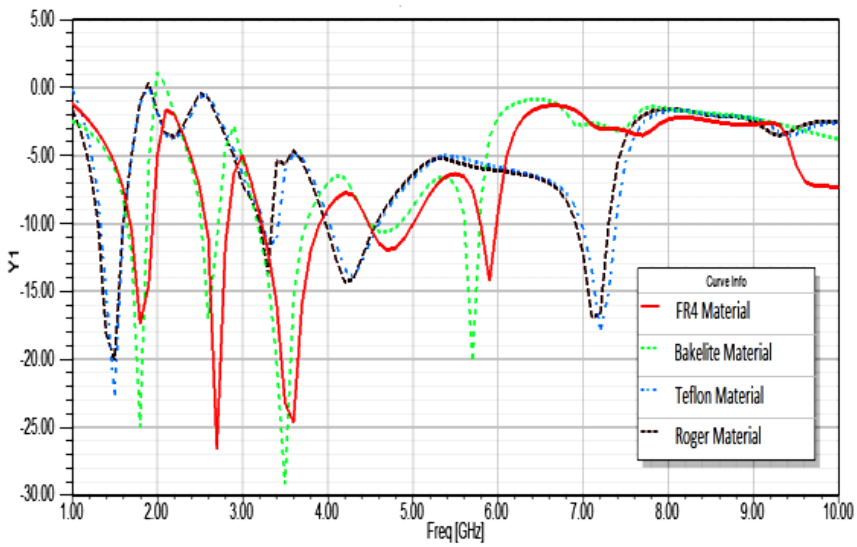

Figure 2: Equivalence of S11 parameters for various substrate material.

Table 2

Dispensation of reverberant frequencies

Sr No	Fr (GHz)	S11(db) max	VSWR
1	1.8	-17.40	1.31
2	2.7	-26.61	1.09
3	3.6	-24.62	1.12
4	4.8	-11.77	1.67
5	5.9	-14.25	1.48

Mentioned comparison portrays that best results were obtained for FR4 substrate. S11 results shown in figure 3 renders that suggested layout generated foremost results for flame retardant substance.

The VSWR graph of the suggested layout is shown in figure 3. Figure 4 expresses the simulated radiation pattern of reverberant frequencies.

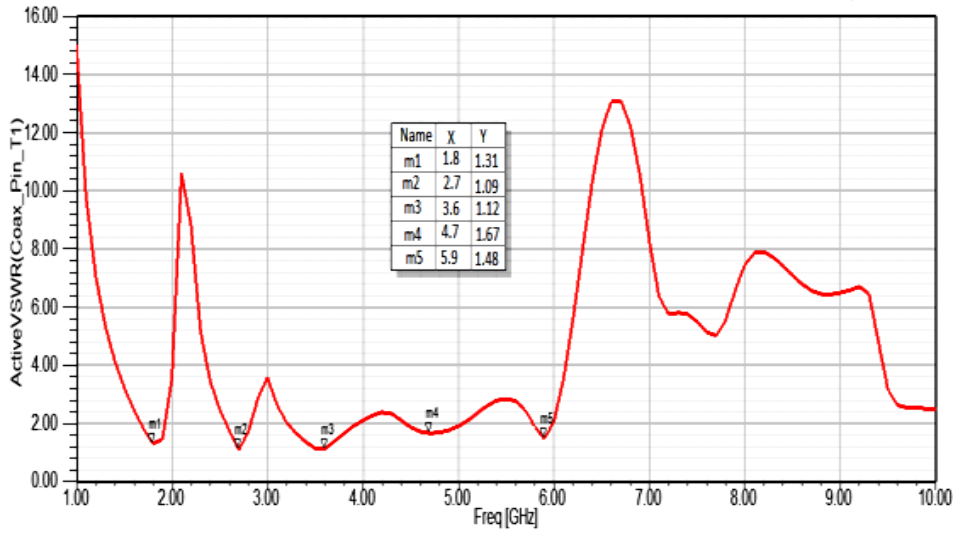

Figure 3: Simulated VSWR for proposed Meander antenna.

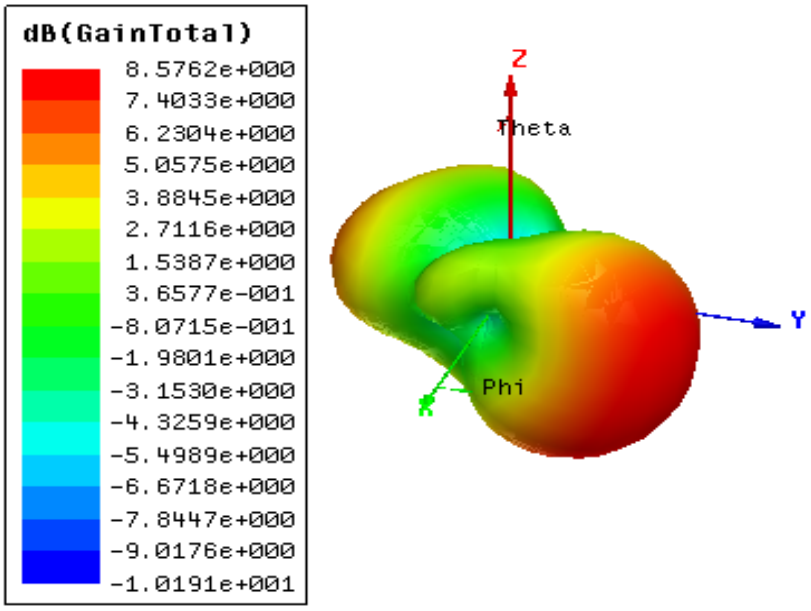

Figure 4: 3D radiation pattern and gain of the proposed meander antenna

Suggested layout resonates at five divergent frequencies when simulated on flame retardant substance. The meander shaped patch resonates frequencies at 1.8GHz, 2.7 GHz, 3.6GHz, 4.8GHz and 5.9GHz is -17.40dB, -26.61dB, -24.62dB, -11.77dB and -14.25dB respectively. Figure 5 shows the simulated 3D gain for the suggested meander antenna, gain of 8 dB is distinguished.

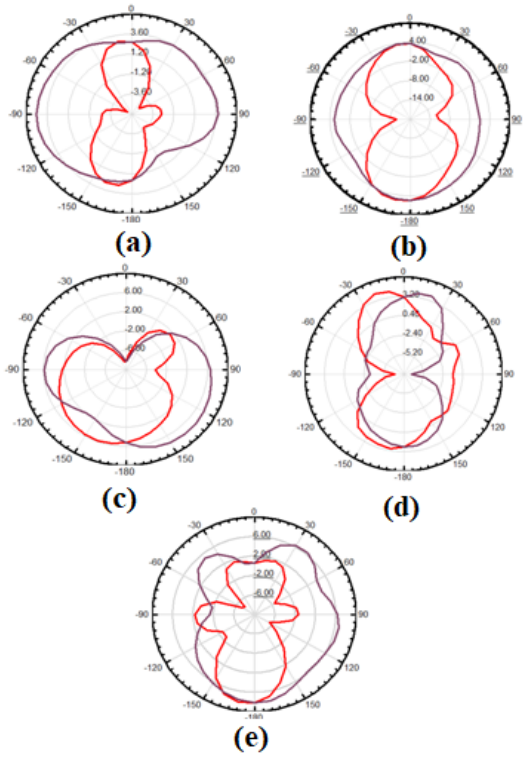

Figure 5. 2D Radiation Pattern of Proposed Geometry Meander Antenna (a) 1.8 GHz (b) 2.7 GHz (c) 3.6 GHz (d) 4.8 GHz (e) 5.9 GHz.

4. Conclusion

A meander antenna has been drafted and mimicked on flame retardant material and outcome is scrutinized. The suggested layout has compact dimension of 1.82 inch × 0.98 inch × 0.0629 inch & reverberates at five non-identical frequencies along with admissible values of S11, Gain, VSWR and bandwidth.

5. References

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