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Circular Microstrip Monopole Antenna with Radial Stubs for Wearable Applications

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Abstract: With the rapid increase in the wireless communication, miniaturized, compact and low profile antennas are a urgent need for wearable antenna applications.In this paper a coplanar waveguide (CPW)-fed circular monopole antenna is designed using $Ni_{0.5}Zn_{0.5}Fe_2O_4$–linear low-density polyethylene (LDPE) magneto-dielectric composite substrate. The magneto-dielectric material enables antenna miniaturization and reduces the influence of the human body on antenna performance. The radial stubs enhance the performance of the antenna. The antenna is designed and fabricated to operate in 6 GHz and reflection coefficient (S_{11}) of −24.31 dB at 5.27 GHz and −10 dB bandwidth of 21.44% is observed.
Keywords: Magneto-dielectric material, miniaturization, circular monopole antenna.

I. INTRODUCTION

Wearable wireless communication systems have rapidly growing and created a demand for compact antennas which establishes a path for developing low profile miniaturized antenna.Conventional antennas with metal backing ground plane reduces the flexibility of the antenna system. Coplanar waveguide fed (CPW) antennas introduces flexibility of the antenna to integrate it to other devices as no backside processing is required [9-18]. Magneto dielectric substrate has ability to reduce the antenna size by miniaturization of the antenna by maintaining the antenna performance [1-8]. Geometrical modificationwith radial stubs also adds to the size reduction of the antenna.CPW-fed circular monopole antenna with radial stubs is design using a $Ni_{0.5}Zn_{0.5}Fe_2O_4$–LLDPE composite substrate in C-band to enhance the miniaturization and overall performance of the antenna.

II. DESIGN AND FABRICATION OF THE ANTENNA

Before fabrication of the antenna, the antenna is simulated using CST microwave studio. The radius of the patch, r_0, and the dimension of the substrate is tabulated in Table 1.Radial stubs are incorporated at the periphery of the circular patc [13, 39-44]. Incorporation of radial stubs at the periphery of the circular radiator enhances low profiling of antenna [30]. The stubs are placed symmetrically 180° apart and transverse to the feed line. Initially, the length of the radial stub, r_1 is taken as $\lambda_g/2$, where λ_g is the guided wavelength and is givenby $\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{eff}\mu_{eff}}}$, λ_0 being the free space wavelength. Length of radial stub, r_1, is optimized using CST microwave studio for further improvement of impedance matching. All the design parameters are tabulated in Table 1. The schematic of designed antenna is shown in Figure 1. The fabricated antenna is shown in Figure 2.

Table 1 Design parameters of CPW fed CMMA with radial stubs on magneto-dielectric substrate

r_0 (mm)	r_1 (mm)	θ (deg)	a (mm)	b (mm)	c (mm)	d (mm)	g (mm)	s (mm)	f (mm)	k (mm)
7.9	20.5	22	23.5	20	30	1	1	1	4.5	5

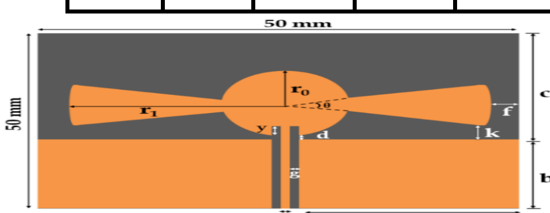

Figure 1 Schematic of CPW fed CMMA with radial stubs

Figure 2 Fabricated CPW fed CMMA with radial stubs on magneto-dielectric substrate

III. PERFORMANCE STUDY OF THE DESIGNED ANTENNA:

The S_{11} plot and E- and H- plane, co- and cross- polar radiation patterns at resonant frequency are shown in Figure 3 (a) and (b), respectively. The performance parameters are tabulated in Table 2.

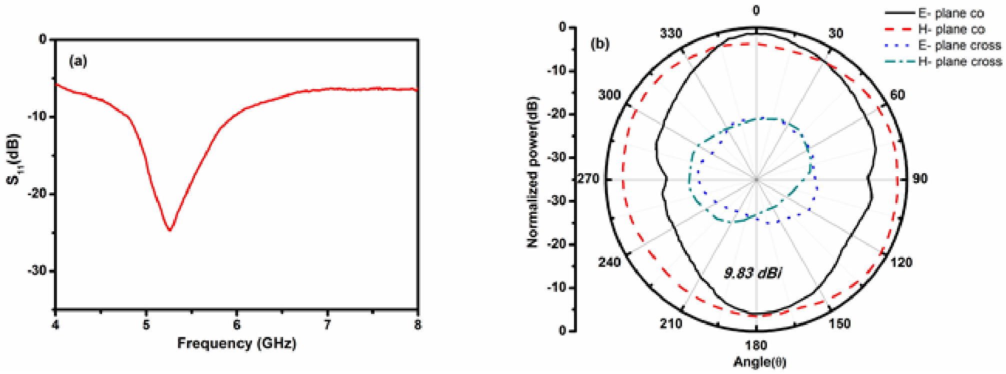

Figure 3 (a) Measured S_{11} plot and (b) E- and H- plane, measured co- and cross-polar radiation patterns of CPW fed CMMA with radial stubs at 5.27 GHz

Table 2 Performance parameters of the CPW fed CMMA with radial stubs on magneto-dielectric substrate

Resonant frequency (GHz)	S_{11} (dB)	Directivity (dBi)	-10 dB bandwidth	
			GHz	%
5.27	-24.31	9.83	1.13	21.44

IV. ANALYSIS OF THE RESULTS

The resonant frequency shifts marginally with introduction of radial stubs to lower side of the resonant frequency. Coupling effect between the patch and the coplanar ground plane and fabrication tolerances could be the reason for shift in the resonant frequency [19-24].

V. CONCLUSION

CPW fed circular monopole antenna with radial stubs is developed and designed on the $Ni_{0.5}Zn_{0.5}Fe_2O_4$–LDPE magneto-dielectric composite substrate for wearable application. Reflection coefficient (S_{11}) of −24.31 dB at 5.27 GHz and −10 dB bandwidth of 21.44% is observed for the designed antenna. Magneto-dielectric composite as substrate miniaturizes the antenna and enhances the overall performance of the antenna.The compact shape enhances the low profile of the antenna and makes it suitable for wearable antenna applications.

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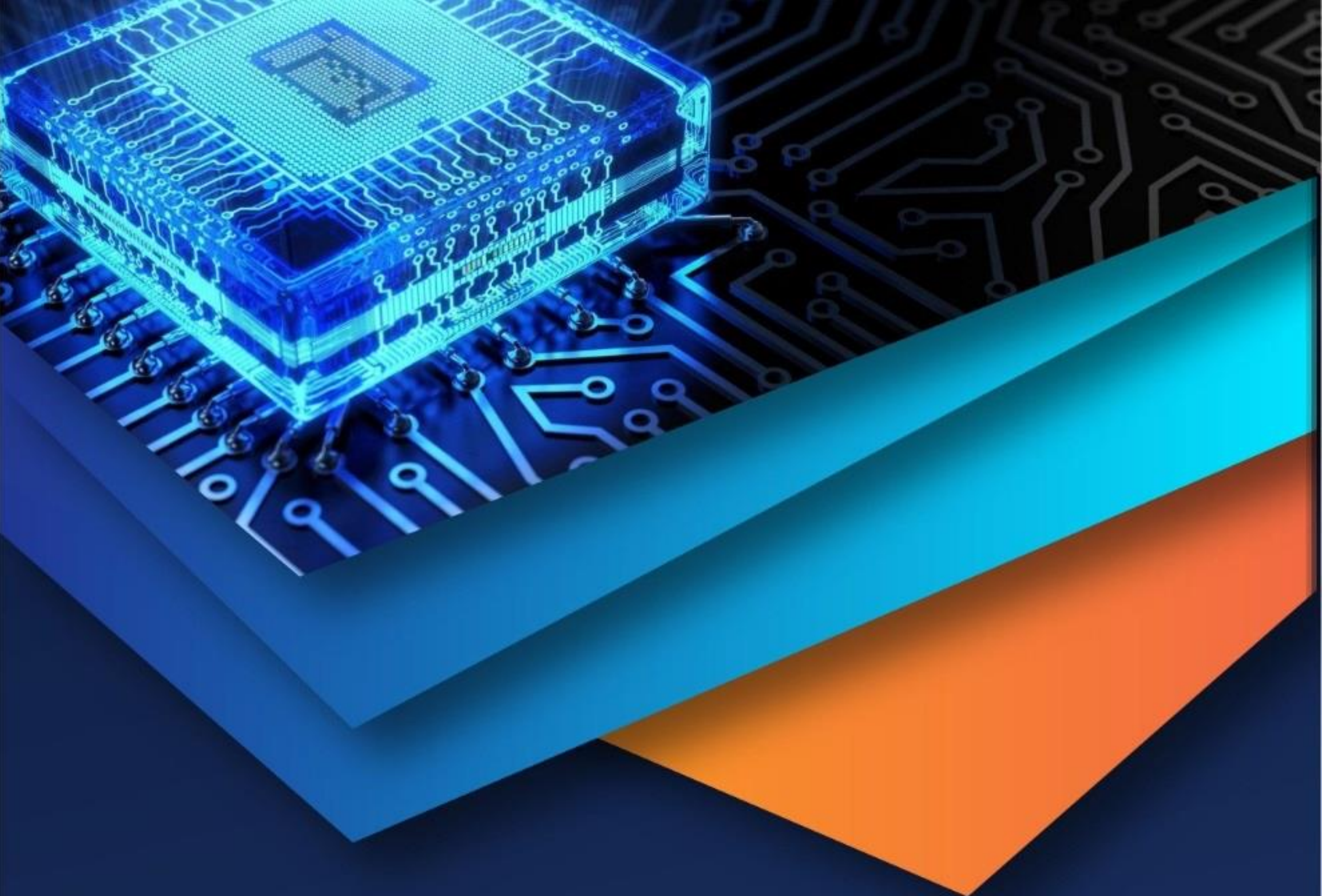

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