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CPW-Fed Ring Antenna For UWB Applications

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ABSTRACT - This paper presents a Coplanar waveguide feed (CPW) monopole ring antenna for ultra wideband applications. The proposed antenna consist of ring type patch embedded with horizontal strip in the patch. The parametric study is performed to understand the characteristics of the proposed antenna. The antenna exhibits impedance bandwidth from 3.7 GHz to 10.7 GHz. The various antenna parameters are studied. The proposed antenna is suitable for UWB applications.

Keywords : UWB, antenn, IE3D

Introduction

Ultra-wideband (UWB) technology is one of the most promising solutions for future communication systems due to its high speed data rate and excellent immunity to multi-path interference. In 2002, the Federal Communications Commissions (FCC) allowed ultra-wide band (UWB) communications operating in the band of 3.1- 10.6 GHz with a -10 dB bandwidth greater than 500 MHz. After the release of Ultra Wideband (UWB) by the FCC, it receives much attention by the industries and academia due to its properties of low power consumption, support of high secured data rate and simple configuration [1]. With the rapid developments of such wireless systems, a lot of attention is being given for designing the UWB antennas, since they are the key elements to radiate and receive the UWB short pulse signals. To design an antenna to operate in the UWB band is quiet challenging one because it has to satisfy the requirements such as ultra wide impedance bandwidth, omni directional radiation pattern, constant gain, high radiation efficiency, constant group delay, low profile, compact and easy manufacturing [2]. In recent years, coplanar waveguide (CPW)-fed monopole antennas have received much attention for Ultra-Wideband (UWB) applications [3-5] with a bandwidth between 3.1 – 10.6 GHz. CPW fed planar slot antennas have the advantages of wide bandwidth, low cost and simple structure, less radiation loss, less dispersion and easy to integration with radio frequency front end circuitry [6-8].Hence, the CPW fed planar slot antennas [9-10] are identified as the most promising design for wideband wireless applications.

Antenna Geometry

The geometry of the proposed monopole antenna is shown in Fig. 1. The total size of the proposed antenna is 33 mm x 22.6 mm. As shown in the figure, the antenna consists of ring-type patch and horizontal strip at the centre.

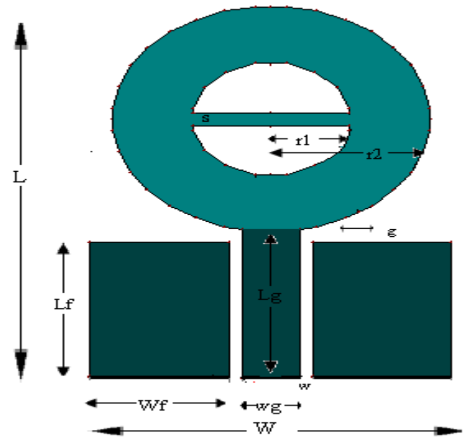

Fig 1: Diagram of proposed antenna

The inner radii of ring is 5mm and outer radii of ring is 10 mm. Horizontal strip of thickness 1.2 mm is inserted in patch. The antenna is constructed with the above described patch and fed by Coplanar Waveguide Feed (CPW) feeding. The patch is printed on a 1.6mm-thick FR4 substrate with relative permittivity 4.4.The ground size of the proposed antenna is 12 mm x 8.7 mm. The ground plane is symmetrical at the base line of the feeding strip line. To obtain the optimal parameters of the proposed antenna for UWB application, IE3D, full-wave commercial EM software that can simulate a finite substrate and a finite ground structure, is used. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters. The parameters of proposed antenna are shown in Table 1**.** The distance between patch and ground is 1.1 mm and between feed and ground is 0.8 mm.

Table 1: Parameters of proposed ring-antenna.

Parameters	Values(mm)	Parameters	Values(mm)
L	33	W	22.6
Lg	12	Wg	8.7
Lf	13	Wf	3.6
g	1.1	w	0.8
r 1	5	r 2	10
s	1.2		

The rectangular strip feed line has dimensions of 13 mm × 3.6 mm. Horizontal strip is embedded to increase the impedance bandwidth of proposed antenna. This antenna covers impedance bandwidth range from 3.7to 10.7 GHz.

Proposed antenna exhibits resonant frequency at 4.2 and 6.5 GHz.

Simulated Results And Discussions

The simulated return losses and other parameter results are obtained. The return losses of the proposed antenna are shown in Fig. 2. The result shows that the antenna exhibits impedance bandwidth from 3.7 GHz to 10.7 GHz. This implies that it covers UWB band.

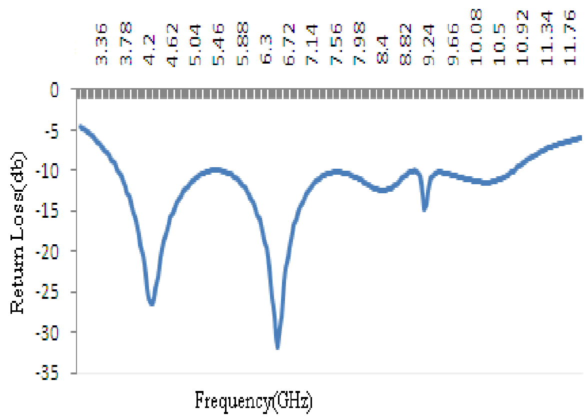

Fig 2: Result of proposed antenna

Fig. 3 shows the graph of return losses when there was no horizontal strip in patch. The impedance bandwidth of antenna decreased without horizontal strip. There was no impedance bandwidth from 8.8 to 9 GHz.

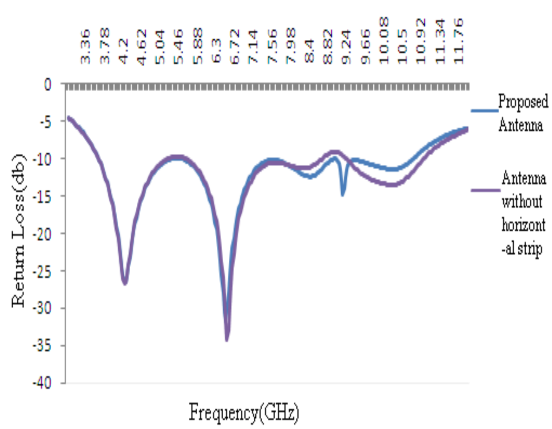

Fig 3: Result of proposed antenna with and without horizontal strip.

Fig 4 shows the parametric study of the proposed antenna. It shows the comparison graph of return losses when ground length and width is increased and when gap between feed and ground plane is increased.

Increase of ground length affect peak value of return loss and impedance bandwidth. Peak value of return loss increased but impedance bandwidth decreased. Increase of ground width decrease impedance bandwidth.

When gap between feed and ground plane is increased impedance bandwidth increased but peak value of return loss decreased.

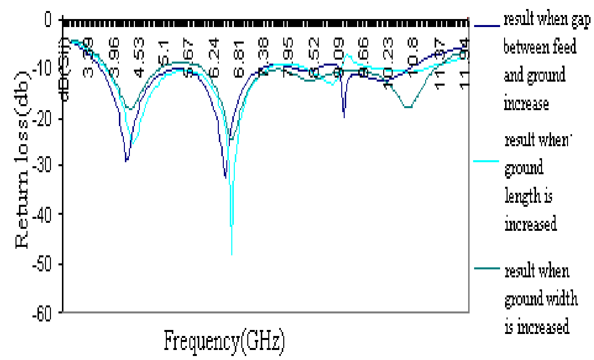

Fig 4: Comparison of return losses of antenna by varying different parameters.

Figure 5 shows the current distribution of proposed circular antenna. The formation of lower and upper frequency resonances can be explained by observing the surface currents on the conductors of the antenna.

Current distribution is changed by changing the length and dimensions of ground plane. The maximum current is 19 amperes.

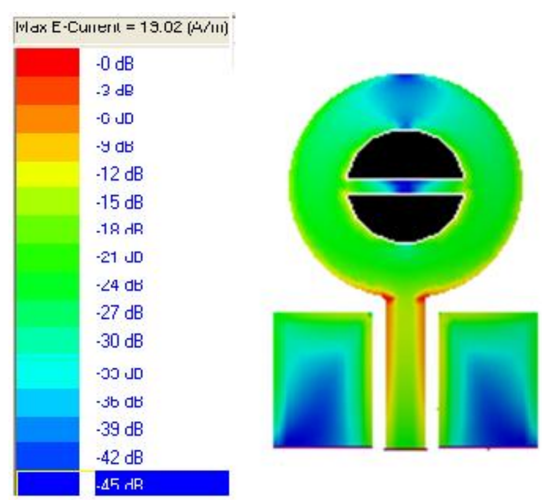

Fig 5: Current distribution of proposed antenna

In figure 6 and 7, simulated 2D pattern for elevation and azimuth plane respectively is shown. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. E-plane pattern at 90 degree at frequency 1 GHz is shown in figure 6, presenting the figure of eight like structure, which satisfies the condition of radiation pattern of a UWB antenna, which is same as that for a monopole antenna. Similarly H-plane patterns for 0 degree forms an omni-directional pattern. Figure 8 and 9 shows azimuthal and elevation radiation pattern at 6 GHz.

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Figure 10 shows the 3D radiation pattern of proposed circular UWB antenna. These patterns are desirable for UWB applications.

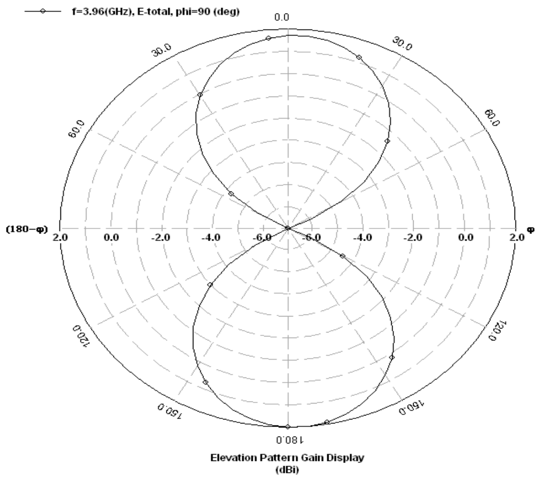

Fig 6: Azimuth radiation pattern at 1 GHz

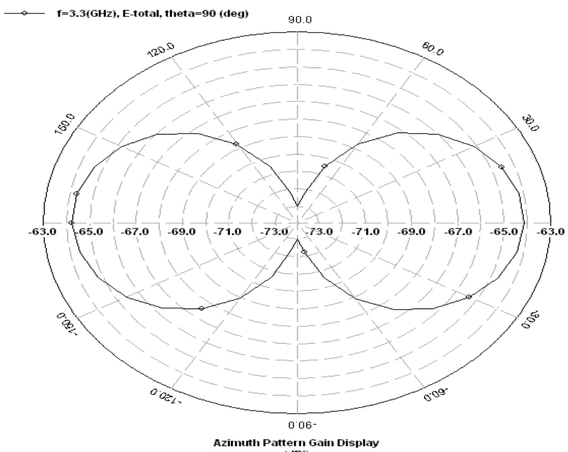

Fig 7: Elevation pattern at 1GHz

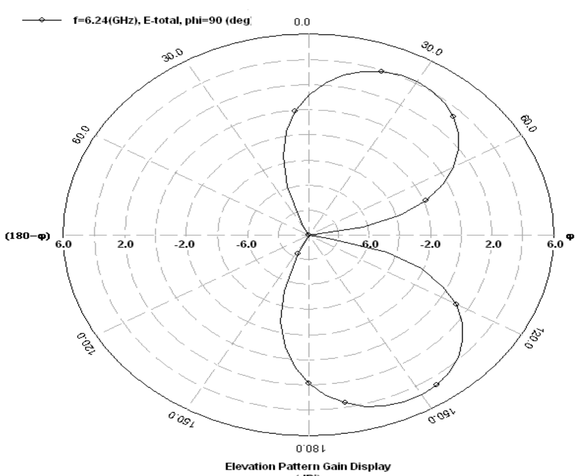

Fig 8: Azimuth radiation pattern at 6 GHz

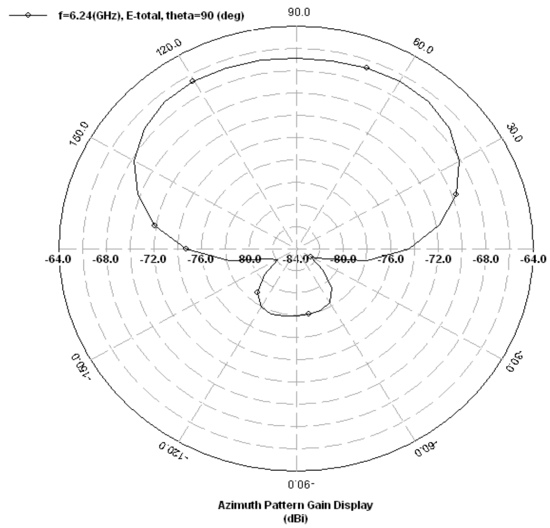

Fig 9: Elevation pattern at 6 GHz

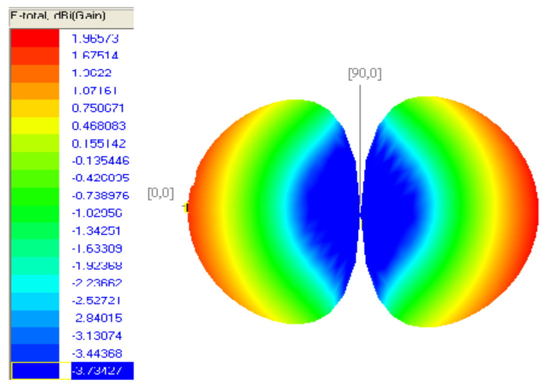

Fig 10: 3D pattern of proposed antenna

Figure 11 represents the gain versus frequency curve of the proposed UWB. The gain versus frequency curve shows that it has maximum gain around 8 dbi at 11.5 GHz at the desired resonant frequencies. The gain of proposed antenna within the operating band satisfy the requirement of UWB applications.

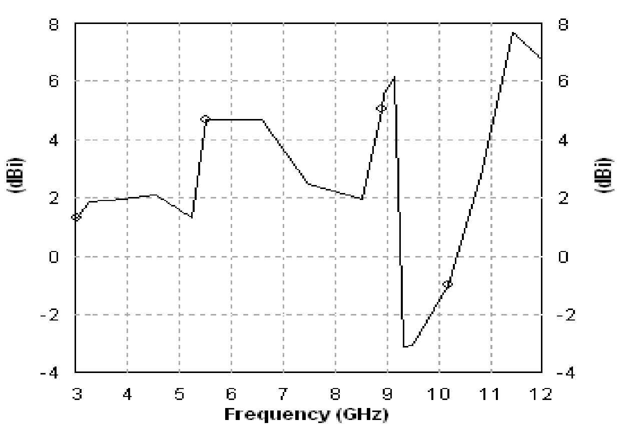

Fig 11: Gain of proposed antenna

Figure 12 shows the efficiency of proposed antenna. This antenna has maximum efficiency of 91 %.

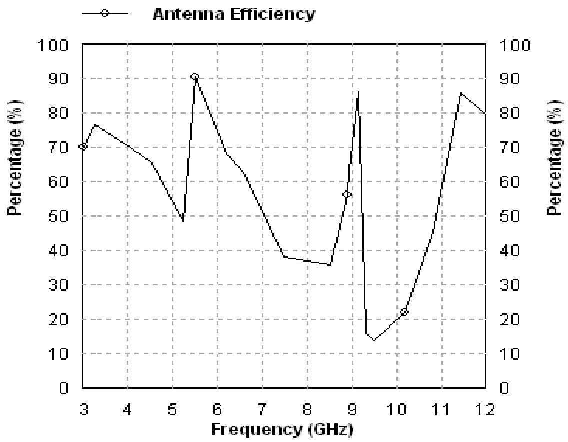

Fig 12: Efficiency of proposed antenna

CONCLUSION

A ring antenna suitable for UWB applications is proposed. Effects of varying dimensions of key structure parameters on the antenna and various parameters like length of ground, width of ground, gap between feed and ground plane are also studied. Moreover, the proposed antenna has several advantages, such as small size, excellent radiation patterns, and higher gains and good efficiency. These characteristics are very attractive for some wireless communication systems for a variety of applications. This antenna covers frequency band from 3.7 to 10.7 GHz

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