CPW FED SLOT COUPLED WIDEBAND AND MULTIBAND ANTENNAS FOR WIRELESS APPLICATIONS

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ABSTRACT

A circular shaped CPW fed capacitive coupled monopole antenna is presented. Ground dimensions of the CPW feed are used to tune the proposed antenna's input impedance (bandwidth). Also, these dimensions (ground) can be used to work antenna either in ultra wideband or multiband mode. The capacitive gap introduced on the circular stub will also decide the working of antenna as either wideband or multiband operation. Placement of capacitive gap may be at any point on the circular stub. In this work we investigated its effect at three different places i.e., lower end, at the center, and at the upper end of the geometry. More than 100% (2-12GHz band) impedance bandwidth was achieved for UWB antenna design where as for multiband antenna design presented; triple bands with impedance bandwidth of 76.58, 35.73, and 23.11% respectively were obtained. Similar results were obtained for all the cases studied. The simulation studies presented here indicate the wideband and multi band operations with good radiation characteristics.

KEYWORDS: *Microstrip Antennas, Capacitive Coupling, and Wideband Antennas.*

I. INTRODUCTION

In recent years, research in the area of ultra wideband system (UWB) has generated a lot of potential in wireless applications [1]. It may be recalled that new definition of FCC on UWB bandwidth (3.1GHz-10.6GHz) has led to rapid growth in wireless applications in this range of frequencies [2]. To meet these demands CPW fed monopole antennas are the right candidates and are most popular in integrated circuits applications because of their ease of integrability into system on chip (SOC) applications. There are several UWB antennas reported in literature [1-13]. For example [1] explains the bandwidth enhancement technique using modified ground plane with diagonal edges. However, the antenna uses finite ground on the back side and hence bandwidth is limited to 18.3 %. In another work [3], asymmetric ground plane is used to obtain multiband operations which cover various commercial wireless applications.

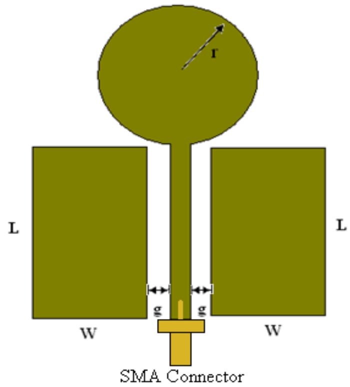
On the other hand antenna reported in [4] is a CPW fed slot antenna yields the impedance bandwidth of 52% and bidirectional radiation patterns. In another effort, antenna presented in [5] is suitable for dual band applications whereas antenna reported in [8] uses meta-materials for the antenna design which yields multiband characteristics. In yet another effort, A. K. Panda et. al., [9] have demonstrated the multiband operation using fractal geometry. In most of the cases reported in literature, either they yield less bandwidth or difficult to fabricate and assemble them.

In this paper, we propose a CPW fed capacitive gap coupled wideband antenna which is suitable for ultra wideband and multiband applications. The capacitive gap is used to tune the antenna operation as either for UWB or for multi band operation. Section 2 presents the basic geometry and its working. Simulation results and antenna geometry with capacitive gap have been presented in Section 3 followed by conclusions in Section 4.

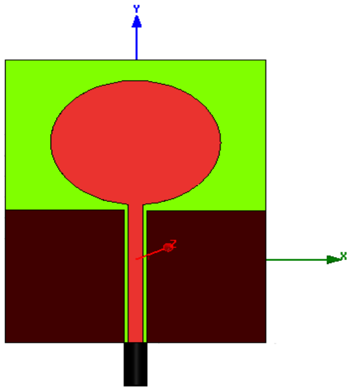
II. BASIC GEOMETRY

Figure 1 shows the basic geometry of the antenna. The geometry is basically a CPW fed monopole antenna. The substrate used for design and analysis is a glass epoxy material whose properties are chosen as listed in Table 1. Effective dielectric constant can be calculated from the design expressions listed in [6, 7]. The antenna was optimized using the Ansoft HFSS [14] which is the commercially available electromagnetic software. The physical dimensions of the antenna are listed in Table 1.

From the Figure 2 it can be noted that the basic geometry offers the ultra wideband operation (2-12GHz). This corresponds to more than 100% impedance bandwidth with good gain and radiation characteristics throughout the band of operation. In order to obtain ultra wideband operation, ground dimensions of the antenna have been varied and optimized for the ultra wideband operation. It may also be noted that these dimensions (L and W) can be varied and optimized for multiband operation. The capacitive gap introduced will also help in tuning the ultra wideband operation into multiband operation and is explained in next section (Section 3).



(a) Basic geometry



(b) Simulation setup in HFSS

Figure 1: Basic geometry of the CPW fed monopole antenna and its simulation setup in HFSS.

Table 1: Optimized dimensions of the proposed antenna

Parameter	**Value**
Length of ground (L)	17.0mm
Width of ground (W)	15.5mm
Radius of circle (r)	16.2mm
CPW gap (g)	0.5mm
Slot gap width (d)	0.1mm
Dielectric constant (ε_r)	4.4
Loss Tangent (tanδ)	0.001
Height of substrate (h)	1.6mm

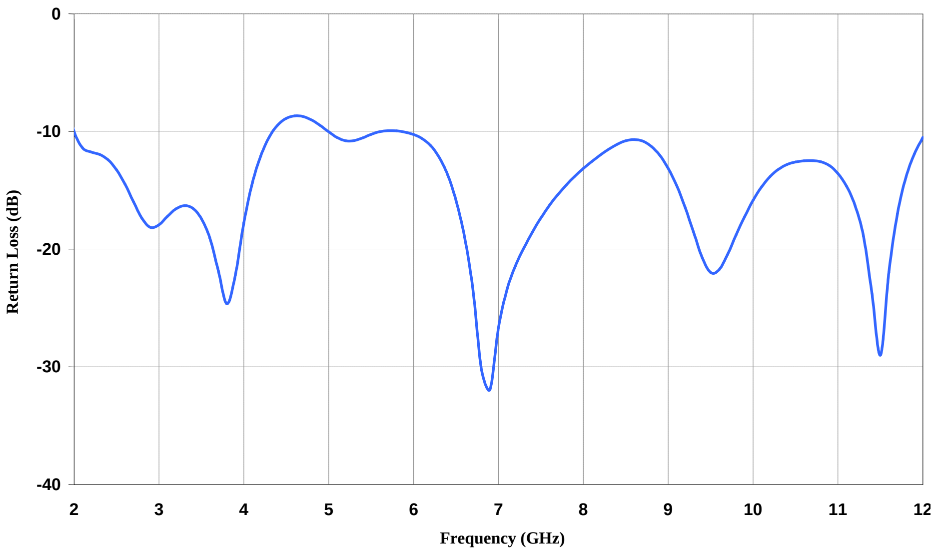
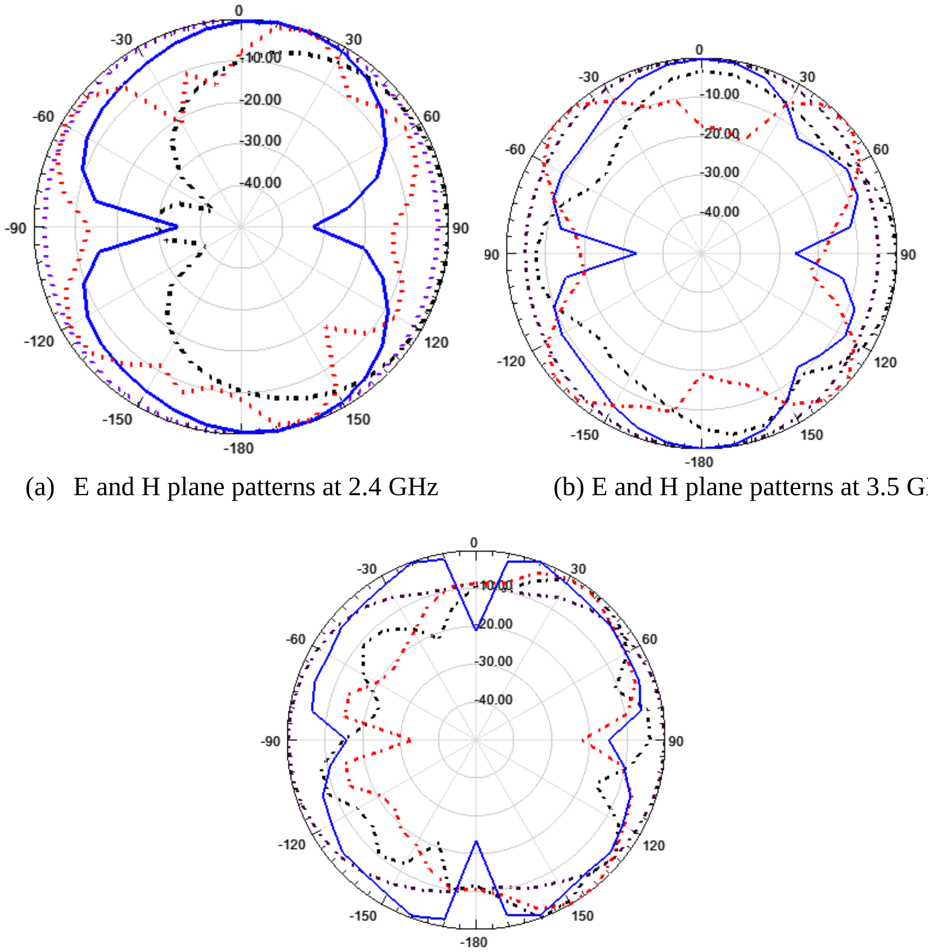


Figure 2: Simulated return loss characteristics of geometry shown in Figure 1.



(a) E and H plane patterns at 2.4 GHz (b) E and H plane patterns at 3.5 GHz

(c) E and H plane patterns at 6.5 GHz

Figure 3: Radiation patterns of antenna showed in Figure1at various frequencies.

III. SIMULATION SETUP AND DISCUSSIONS

As stated in Section 2, the geometry shown in Figure 1 was simulated using Ansoft HFSS software. All key design parameters (ground width (W), ground length (L), and capacitive slot (d)) have been investigated to analyze the effect on antenna performance and are discussed in the following subsections.

3.1. Effect of Ground Dimensions on Antenna Geometry

In order to merge all individual bands and to get the wideband operation suitable for FCC defined applications, ground dimensions have been varied. In the first step ground length was varied in steps of 2 mm as shown in Figure 4. From Figure 4 it may be observed that L=23.8 mm proves to be the optimum. In the next step width of the ground plane was varied from 25.4mm to 33.4mm keeping optimum value of L=31.8 obtained in the first step. Return loss characteristics for this case are presented in Figure 5. From these two steps optimum values of ground dimensions are L=31.8mm and W=25.4mm. An effort was also made to vary the circular stub radius from the current value of 16mm. However, no significant results were obtained for the cases studied (14mm to 18mm in steps of 1mm).

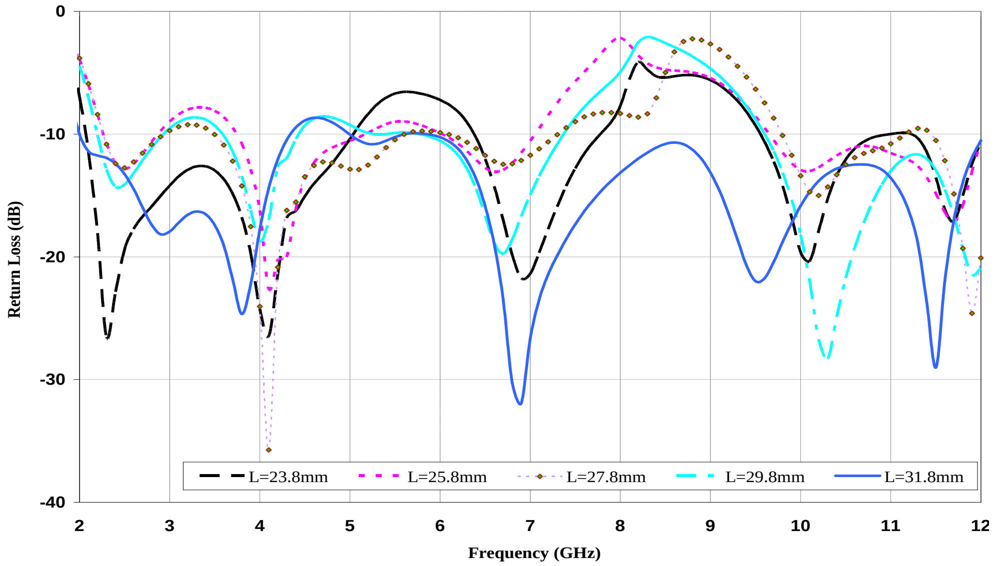


Figure 4: Return loss characteristics for different values of L keeping W=25.4mm constant. (All other dimensions are as listed in Table 1).

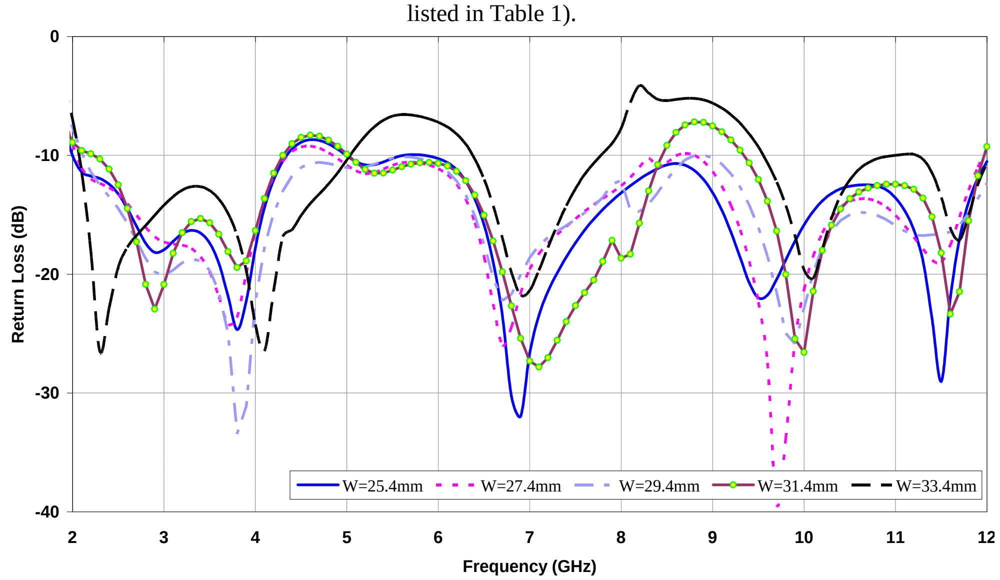
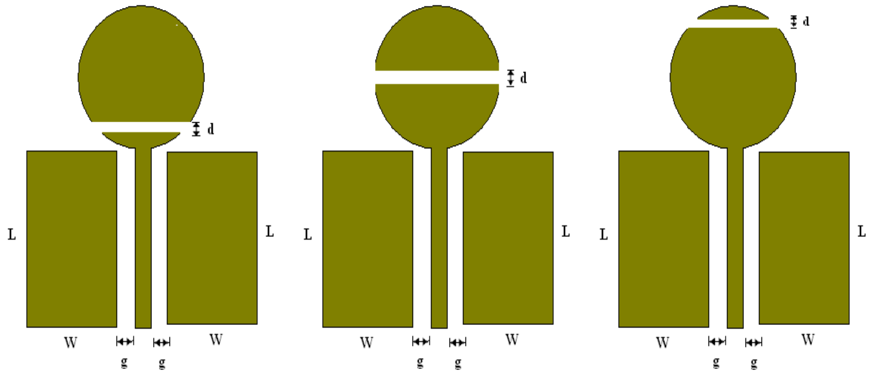


Figure 5: Return loss characteristics for different values of W keeping L=31.8mm constant. (All other dimensions are as listed in Table 1).

3.2. Effect of Capacitive Gap

The geometries of basic antenna with capacitive slot are presented in Figure 6. Slots were introduced at three different positions. These locations are center position, 5mm above from center (upper slot), and 5mm below from center (lower slot) of the circular geometry. All the cases were investigated with one slot at a time. The slot width (d) was varied in steps of 0.1mm by keeping all other dimensions constant. All the results are presented in Table 2. Return loss characteristic for the optimum case is depicted in Figure 7. From the Table 2 it may be noted that d=0.1mm case proves to be the best one as it offers three frequency bands with optimum bandwidth values. Gap width was not reduced below 0.1mm because it may be difficult to realize the geometry while fabrication. Similar results were obtained for other two cases (Figures 6 (b) & 6(c)). However, it was observed that for the gap placed at the lower side, the gain was not uniform throughout the bands of operation.



(a) (b) (c)

Figure 6: Gap coupled wideband antenna geometries. A capacitive slot is placed on (a) lower side (b) middle (c) upper side. All other dimensions are as listed in Table 1.

Table 2: Effects of variation of width of capacitive slot (d) on the VSWR bandwidth of the antenna

Slot Width (mm)	Frequency Range (GHz)			Bandwidth (%)		
	1st	2nd	3rd	1st	2nd	3rd
0.1	1.95-4.37	5.86-8.41	9.22-11.63	76.58	35.73	23.11
0.2	2.06-4.47	6.06-8.34	9.13-12.0	73.81	31.66	27.16
0.3	2.00-4.19	6.23-8.12	9.44-12.0	70.76	26.34	23.88
0.4	1.93-4.41	6.08-8.56	9.37-11.63	78.23	33.87	21.52
0.5	2.04-4.37	6.19-8.63	9.19-11.95	72.69	32.92	26.11

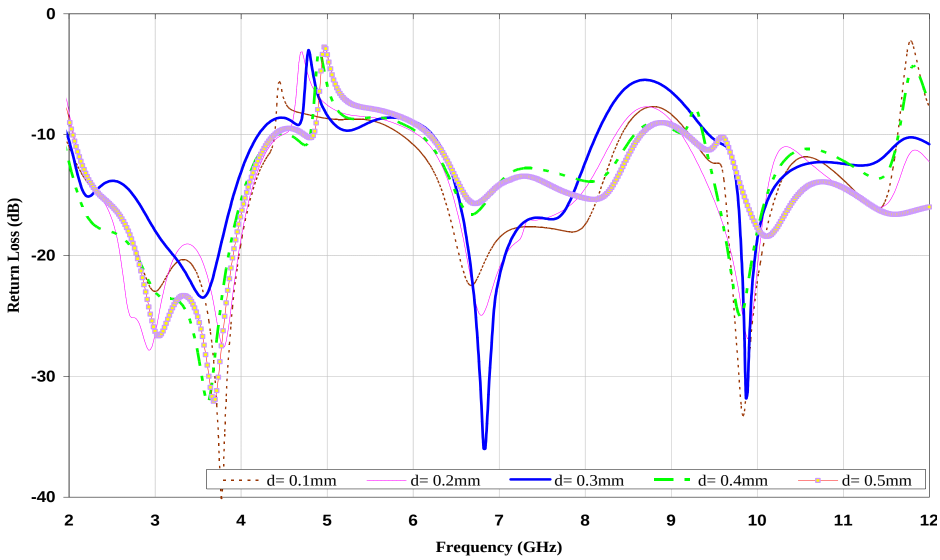


Figure 7: Return loss characteristics for different values of capacitive gap.

IV. CONCLUSIONS & FUTURE SCOPE

A circular shaped CPW fed capacitive coupled monopole antenna has been presented. Ground dimensions of the CPW feed have been varied to obtain UWB operation. The capacitive gap was introduced on the circular stub to obtain multiband operation. Placement of capacitive gap may be at any point the circular stub i.e., lower end, at the center, and at the upper end of the geometry. Similar results were obtained for all the cases studied. The simulation studies indicate the wideband and multi band operations with good radiation characteristics. For wideband operation more than 100% (2-12GHz) impedance bandwidth with good gain throughout the band of operation was obtained. Triple bands were obtained with impedance bandwidth of 76.58, 35.73, and 23.11% when a capacitive gap was introduced at the middle, and optimized. In future study it is planned to fabricate the proposed antenna and is to be tested for its practical validation, and should be modeled to investigate its performance in terms of impedance bandwidth, gain, and radiation efficiency. The antenna presented here proves to be the best candidate for FCC defined UWB operation.

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