A Coplanar Waveguide (CPW) fed Circular MicrostripAntenna for UWB Applications

N. Prabakaran, S.S.S Kalyan,K.V.V.S.N Murthy, D. Sai Baba, C. Naveen, R. Sai

Abstract*: A coplanar waveguide (CPW) fed circular microstrip patch antenna for ultrawideband applications is proposed in this work. FR-4 substrate of dielectric constant 4.4 and thickness of 1.6 mm is used,and the overall dimension of antenna is 40 X 40 mm^2. The proposed antenna operated over the large bandwidth which tends to coverultrawideband of 1.2-7.2 GHz with two resonant frequencies at 1.6GHz and 5.2GHz.The proposed antenna is designed using High Frequency Structural Simulator (HFSS). The antenna resonates at multiple bands over a bandwidth which is covers GSM and WLAN applications.

Index Terms*: Coplanar Waveguide (CPW), Microstrip, Ultrawide band (UWB), WLAN.

I. INTRODUCTION

The requirement of the microstrip patch antenna is increasing day by day, mainly due to easy fabrication, compact size and cost-efficiency. A coplanar waveguide fed printed antenna with a rectangular shape which exhibits ultrawide band operation is reported in [1]. In [2] proposed that coplanar waveguide fed antenna with L-shaped feeding line is used to cover the entire UHF RFID frequency band and by varying the dimensions of L-shaped slot lines in a ground plane which is in circular shape gives broadband circular polarization and good impedance matching. A technique of adding fractal elements to the polygon patch using coplanar waveguide fed for bandwidth improvement is proposed in [3] for this technique the antenna covers the ultrawidebandrange of 3.1-10.6 GHz. A CSRR loaded compact coplanar waveguide is explored in [4] to design a dual-band bandpass filter, one passband is achieved due to interdigital capacitor and second is due to complementary split ring resonator with minimum insertion loss, which is suitable for GSM and LTE for wireless communications. In [5] a design of a dual notchedCPW fed UWB antenna with π-shaped slot and EBG is analyzedto produce impedance bandwidth (2.7-11.7 GHz) which is applicable for S-band and C-band. A novel broadband circular polarization using CPW structure [6] is proposed for Wi-Fi and LTE applications to produce a circularly polarized wave using dual modesthroughcontrolling of amplitude and phase differences between odd and even modes in CPW slots.A novel printed monopole antenna with a hexagonal patch with inverted L-shaped antenna with the coplanar waveguide is proposed in [7], and two L-shaped slots are inserted on the two sides of the hexagonal patch to improve radiation characteristics and return loss. In order to achieve high impedance bandwidth a rectangular slot is excited by a CPW than a microstrip line feed with a U-shaped stub. ACPW fed antenna isdescribed in [9] for body implantable applications, due to which a wideband feature is achieved with complementary split ring resonator structure through multiple modes, and miniaturization and impedance matching are obtained with a pair of asymmetrical arc-shaped annular ring slots within the main radiator.

This paper presents the designing of a CPW fed circular microstrip antenna for ultrawideband applications (UWB). In this design coplanar waveguide structure is used to enhance the bandwidth and the return loss of the antenna at GSM and WLAN bands.

II. ANTENNA DESIGN

The evolution of the antenna is shown in Fig. 1. A coplanar waveguide antenna which is printed on a 40 x 40 mm^{2}FR-4 substrate having1.6 mm thicknesswith dielectric loss tangent δ=0.02 and relative permittivity Ɛr=4.4. Thelength of the substrate is considered as Ls, width of the feedline asWf. The length of the ground plane be L1, and width of the ground is considered as W1. The radius of the circular patch is r1. The distance between ground plane and feed lineis L2. The evolution of proposed antenna is shown in Fig. 1. The optimized values are summarized in the Table 1.

Figure 1. Evolution of proposed antenna

Revised Manuscript Received on April 07, 2019.

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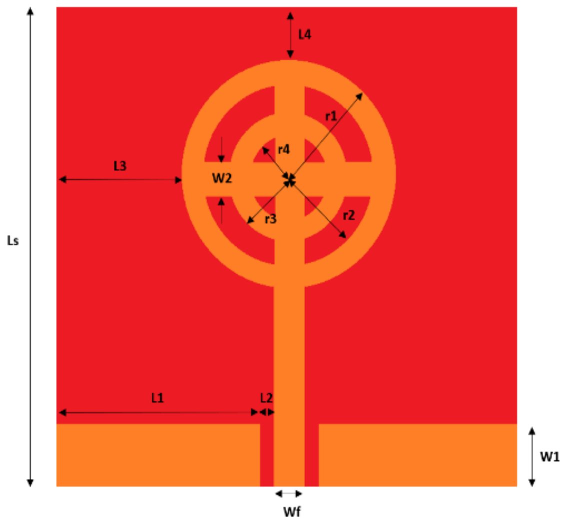

Figure 2. Proposed antenna geometry

Table 1: Optimized parameters of the proposed CPW antenna

Parameter	Value (mm)
Ls	40
L1	18
L2	1
L3	8
L4	3
Wf	2
W1	6
W2	2
r1	12
r2	9
r3	6
r4	3

III. RESULTS

Figure 3 shows the comparison of return loss vs frequency for different widths of the ground plane. By varying the width of the ground plane from W1=6mm to W1=9mm an improvement in bandwidth is observed.

At W1=6mm, the antenna resonates at 1.6GHz operating at (1.2 – 2.1GHz) band. At W1=7mm and 8mm the antenna operated in dual band covering (1.2-2.3 GHz), (5.8-7.1 GHz) (1.25-2.5 GHz), (4.6-7.2 GHz) respectively. Similarly, at W1= 9mm the antenna covered a bandwidth of 1.2-7.2GHz. In addition to bandwidth an improvement in return loss is also observed at both the resonating frequencies of 1.6GHz and 5.2GHz.

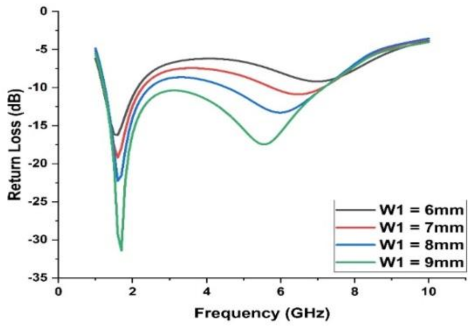

Figure 3. Comparison of Return Loss Vs Frequencyfor differentwidths of a ground plane

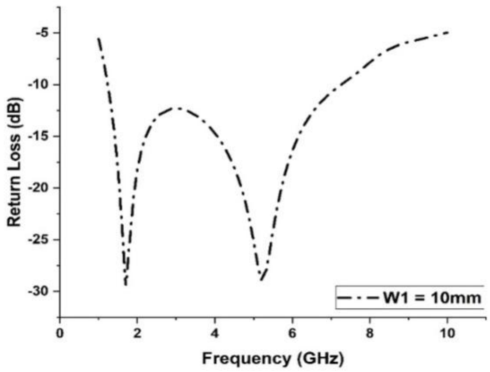

Figure 4. Return Losscurve for W1=10mm

Figure 4 shows the return loss curve for W1=10mm which operates over a wide band of frequency i.e. from 1.2 GHz -7.2 GHz range with a resonance at -29.5dB at 1.6 GHz and -28.9dB at 5.2 GHz. The VSWR comparison is shown in Figure 5. In practical applications VSWR < 2 is considered as an acceptable level. By changing the width of the ground plane from W1=6mm to W1=9mm it can be observed that the antenna achieved the acceptable level i.e. VSWR < 2 over the wide band i.e. 1.2 – 7.2GHz.

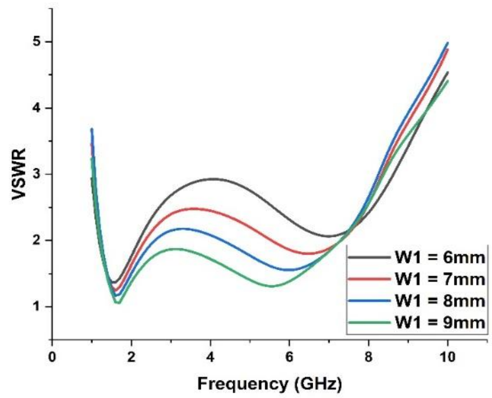

Figure 5. Comparison of VSWR for different widths of the ground plane

Figure 6 shows the VSWR vs frequency curve at W1=10mm.

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Blue Eyes Intelligence Engineering
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An improvement in VSWR i.e. VSWR < 2 is observed over the wide band range of 1.2GHz – 7.2GHz with close to 1 at the resonant frequenciesof 1.6 GHz and 5.2 GHz.Figure7 shows the radiation patterns of the proposed antenna at the resonated frequencies.

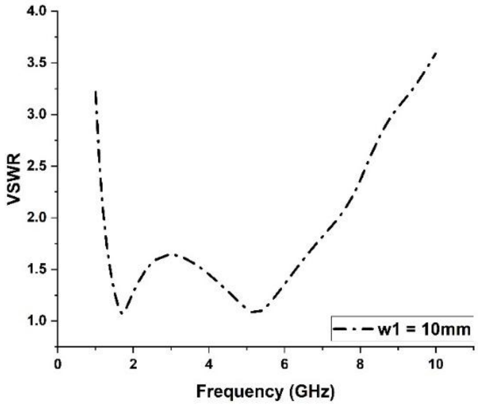
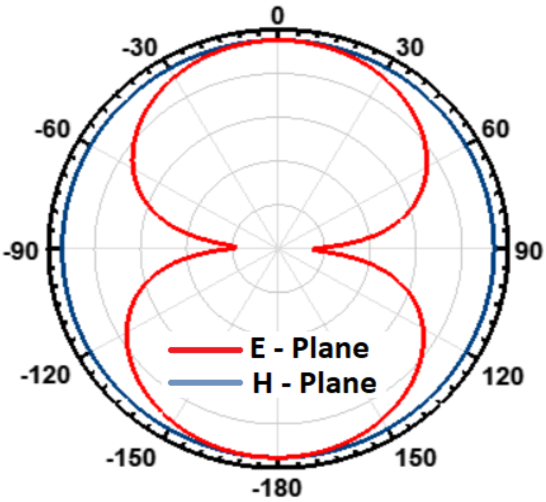
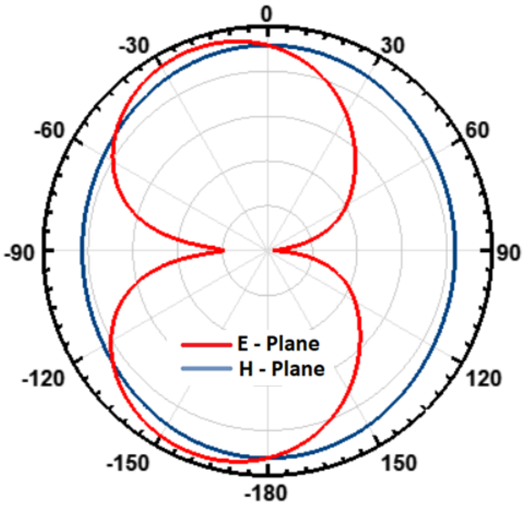


Figure 6. Proposed antenna VSWR



(a)



(b)

Figure7.Radiation Pattern of the proposed antenna at (a) 1.6GHz and (b) 5.2GHz

IV. CONCLUSION

A coplanar waveguide microstrip patch antenna is proposed in this work for UWB applications. The proposed antenna has a compact size of 40 x 40 x 1.6 mm^3. By varying the width of the coplanar waveguide an improvement in bandwidth and return loss is observedto a great extent. Due to this change the antenna achieves UWB which covers (1.2-7.2 GHz). The CPW fed antenna operates at two resonance frequencies of 1.6 and 5.2 GHz with reflection coefficients (S11) of −29.58 dB and −28.92 dBrespectively.

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