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A Novel Design slot cut Shape Microstrip Patch Antenna for wireless application

[1]Dr. Sumit Gupta, Sunrise University, Alwar

[2]Harish Kumar Jangam, Research Scholar, Sunrise University, Alwar

Abstract

In this paper a novel coplanar waveguide (CPW) fed Microstrip patch antenna is proposed and designed using Ansoft HFSS software. Antenna structure is printed on a dielectric substrate and fed by a coplanar waveguide (CPW). The designed CPW micro strip antenna has small dimension. The advantage of CPW fed is that no via hole is required. The design of proposed antenna is described and simulated results are discussed to evaluate antenna performance. This antennas is suitable for ISM band, Wi-Max 2.13 GHz (1.92-2.40 GHz)., WLAN and Bluetooth application.

Roger 5880 is used as dielectric with value of dielectric loss tangent constant of 0.0009 and relative permittivity with 2.2. The antenna is fed by coplanar waveguide of 50Ω micro strip line with ground plane is excited by a coaxial SMA connector. The antennas is small, cheap and easy to fabricate, and achieves good radiation characteristics with return loss less than -10 dB. The gain of the antenna is 5.0655dB which is fairly well to operate the antenna for wireless application. In this paper the slot is cut on the proposed patch to increase impedance matching .

Keywords: CPW, SMA, WLAN, Wi- Max

Introduction

Scope of the work

In response to the ever increasing need of antenna bandwidth, a variety of techniques have been devolved for the designing of compact, low profile, low cost, multiband antennas. One possible solution to this demand is to use **CPW fed Microstrip antennas**, that can be used for Industrial, Scientific, and Medial (ISM) band. These CPW fed antenna are becoming an important means of wireless communications including WLAN and Bluetooth applications. These demands have stirred significant renewed interest in antenna design particularly at the ISM band, since it is unlicensed band. Therefore, the development of appropriate antenna designs is imperative. Although many antennas are proposed in the literature but still the door is open for novel antennas with improved performance than in past.

Designed and Simulation of CPW Fed Microstrip Patch Antenna

Introduction: In present era of technology Microstrip antennas are preferred mostly. Because of its miniaturization it has great aspects in field of wireless communication. Nowadays Microstrip antennas are most preferred type of antenna, for communication in mobile phones, spacecrafts, and industrial application and for medical uses. But the main drawbacks of Microstrip antennas are the limitation of its low impedance bandwidth and low gain. So the various methods are used to improve its bandwidth like using material of low dielectric constants, using stacked structure with multilayer dielectric or metal, and designing of antennas using air gap method.

Design, Analysis and Simulation of CPW Fed Microstrip Antenna with Resonant Frequency of 2.13GHz

Antenna Design: Designed antenna is CPW feed shaped antenna for dual band operation. The antenna is designed for 2.13GHz for WIMAX and Bluetooth application.

Specification

Resonating frequency f_r=2.13GHz

Dielectric constant (ε_r) = 2.2

Height of substrate= 1.6 mm

Substrate used Roger 5880

Microstrip Format: Ground and patch lie on same plane and antenna is fed by coplanar wave guide structure.

In order to Design the Antenna Following Equation are Used:-

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{\frac{1}{2}} \qquad \text{.....................} (1)$$

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2+\left(\frac{n}{W}\right)^2\right]^{\frac{1}{2}} \qquad \text{.....................} (2)$$

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}} \qquad \text{.....................} (3)$$

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

Design, Analysis and Simulation of CPW Fed Microstrip Antenna with Resonant Frequency of 2.13GHz

Two CPW fed Microstrip patch antenna are designed. Firstly the antenna was designed without slot but since it was not having good impedance matching, a second antenna with slot was designed.

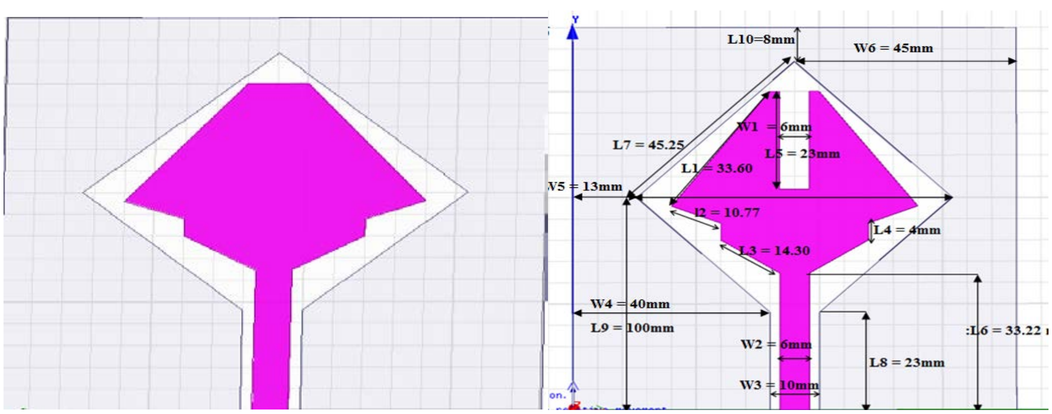

Figure 1: Proposed CPW Patch Antenna (a) without slot (b) slotted to improve impedance matching

Optimal parameters of proposed antenna are

Length	Width	Length
L1=33.6mm	W1=6mm	L8=23mm
L2=10.77mm	W2=6mm	L9=100mm
L3=14.3mm	W3=10 mm	L10=8mm
L4=4 mm	W4=40 mm	
L5=23 mm	W5=13mm	
L6=33.22mm	W6=45 mm	
L7=45.25mm		

Table 1: Optimal Parameter of Proposed slotted Shaped MSA

Above figure 1 (a)(b) shows the proposed patch antenna .Roger 5880 is used as dielectric with relative permittivity of 2.2 and dielectric loss tangent of 0.0009.The overall dimension of the antenna is 90x90x1.6mm^3.

Simulation results of antenna without slot

S-Parameters

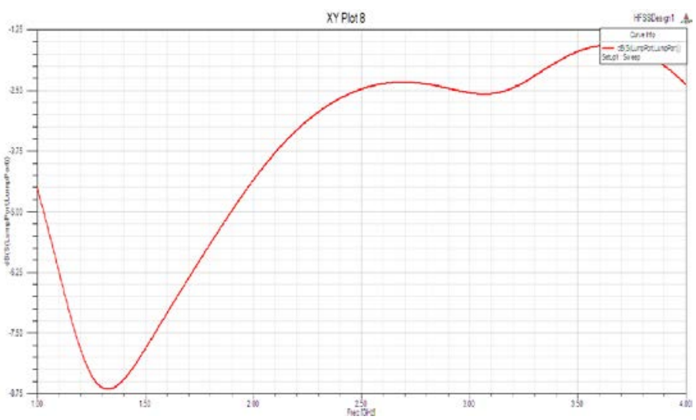

Figure 2: Return Loss of Proposed Antenna (without slot)

Above Figure 2 shows simulated return loss $|s_{11}|$ response of antenna against frequency. The antenna has poor impedance matching thus it is required to cut slot in the patch to get desired VSWR <2 at 2.13 GHz.

VSWR Proposed (without slot) MSA

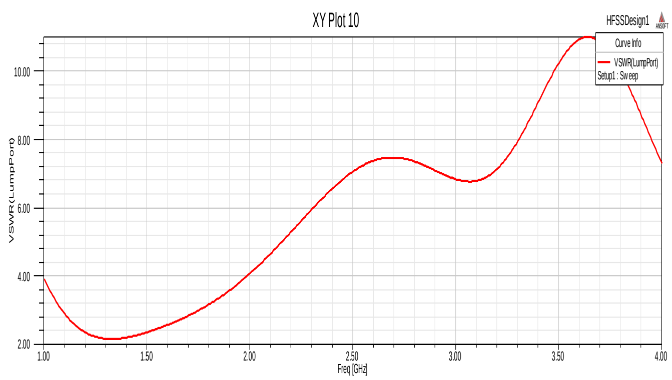

Figure 3: VSWR of Proposed Antenna

Above figure 2.3 show the VSWR of proposed without slot cut shape MSA. The antenna has poor matching hence we cut a slot in patch to resonate the antenna in 2.13GHz.

Smith Charts

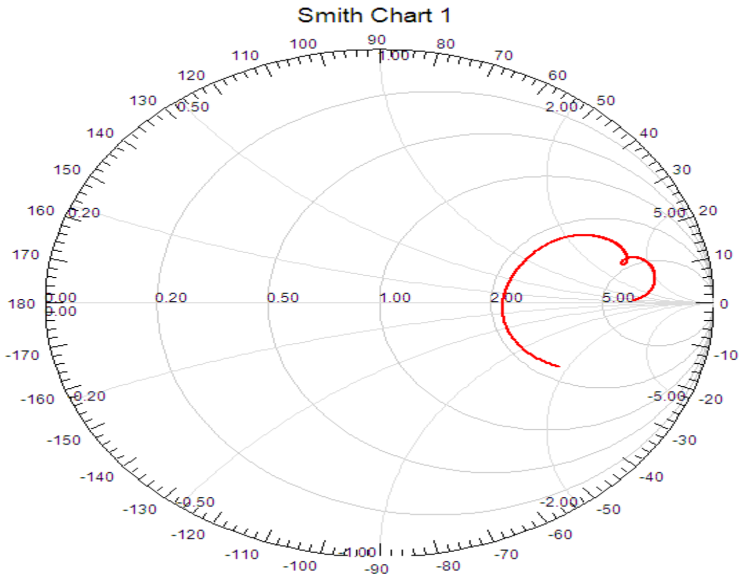

Figure 4: Smith Chart of Proposed Antenna(without slot)

Above Figure 4 shows the smith chart pattern for proposed antenna. The smith chart shows the poor matching since the smith plot is outside VSWR= 2 circle.

3D Polar Plot

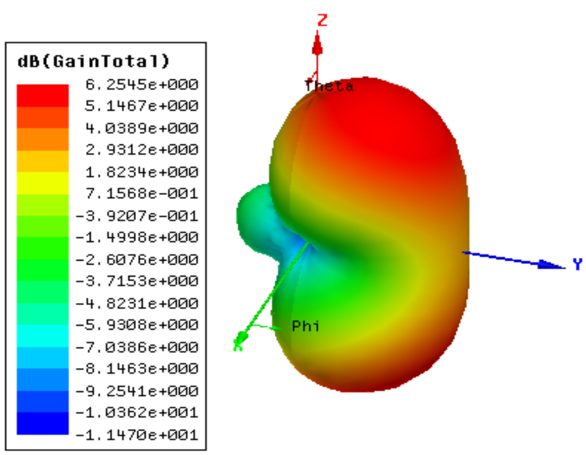

Figure 5: 3D-Polor Plot Proposed Antenna

Above figure 5 shows the gain of proposed antenna and the gain is varying form 1.8 to7.15 dB.

Return loss of antenna with slot

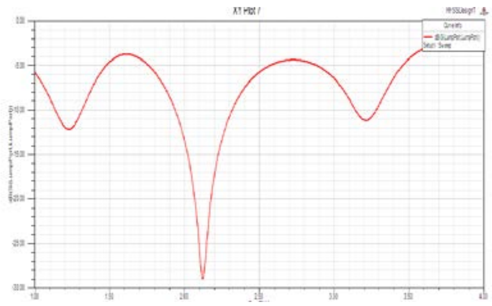

Figure 6: VSWR of Proposed Antenna

Above 6 figures shows simulated return loss $|s_{11}|$ response of antenna against frequency. The antenna resonates at 2.13 GHz with maximum return loss of nearly -29.5 dB, which makes it suitable for WLAN and ISM application.

3D Polar Plot

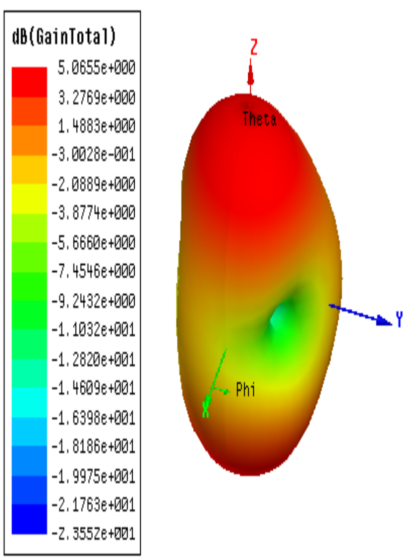

Figure 7: 3D-Polor Plot Proposed Antenna

Figure 7 shows the gain of proposed antenna and the gain is varying for 1.488 to 5.06dB which is finally well.

VSWR Proposed CPW Patch Antenna with slot

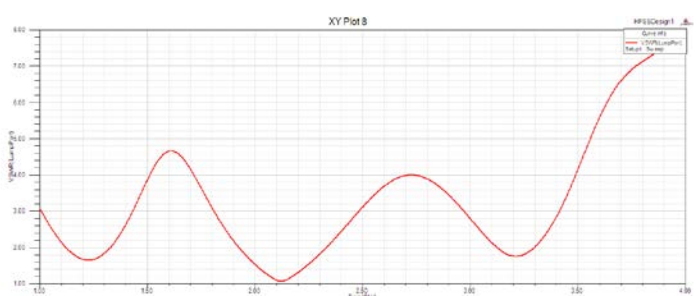

Figure 8: VSWR of Proposed Antenna

Above figure 8 shows the VSWR of proposed slotted MSA. The antenna has good matching at frequencies 2.13 GHz where VSWR <2.

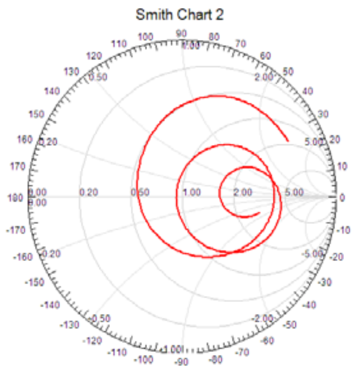

Figure 9: Smith Chart of Proposed Antenna(with slot)

Above figure 9 shows the smith chart pattern for proposed antenna. The smith chart shows the good matching is obtained at low frequency region at WLAN Application(1.92-2.4 GHz).

Conclusion

The wireless communication devices need antennas that are low profile, low cost, multiband and have wide bandwidth. To meet these requirements microstrip patch antenna are chosen under study. Three CPW fed microstrip antennas for various wireless applications have been proposed. The good matching is achieved by coplanar wave guide feed MSA. The return loss versus frequency characteristics indicates that proposed antenna are resonating at 2.13GHz and serve Bluetooth, WLAN, Wi-MAX applications .The antennas have good gain characteristics, they have advantage of compact size, ease of control. Due to their minimum size and high performance, proposed antennas can be useful for wireless communication.

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