Design of Stub Loaded Wideband Antenna

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ABSTRACT

In this article a new wide band small size antenna with slotted ground plane integrated with stub has been proposed. To enhance the impedance bandwidth one stub is attached with the ground plane. Ansoft Designer v2 simulator is employed to analyze the proposed antenna, simulated return loss, E-plane radiation pattern, H-plane radiation pattern and gain for different frequencies within the band which is less than -10dB.The operating frequency range which is less than -10dB of the proposed antenna is 2.9GHz-7.6GHz. The impedance bandwidth is 89.5%. The proposed antenna finds its application in WIMAX (3.3GHz-3.7GHz), IEEE 802.11a WLAN (5.15GHz-5.35GHz), HIPERLAN (5.7GHz-5.825GHz), Satellite X-band (7.25GHz-7.75GHz) bands.

Keywords: Microstrip antenna, wideband, stub, slot.

1. INTRODUCTION

Microstrip patch antennas have been widely used in wireless communication due to its attractive features like light weight, low cost, easy of fabrications, small size, but the disadvantage of this microstrip patch antenna is very narrow bandwidth. In recent years, small size antenna design with wide bandwidth is very changeling task for researcher. Due to the increase of wireless communication application wide band antenna becomes attractive topics in this region. To increase the bandwidth different techniques have been adopted by different authors like feed modification [1], cutting slot on the ground plane [2], adding slot on the patch [3], chip loading [4], adding of air substrate [5] etc. Many researcher also used shorting pin between patch and ground plane to enhance the impedance bandwidth [6].
In this paper a 50 Ω microstrip line is used as a feeding line. The dimension of the ground slot, ground stub parameter values are optimized to get highest possible impedance bandwidth in the range of 2.9GHz to 7.8GHz.

2. ANTENNA GEOMETRY

A. Antenna Design

Figure-1 illustrates the detailed configuration of the proposed antenna. A Rogers RT/Duroid 5880(tm) dielectric substrate with relative permittivity 2.2 and loss tangent 0.0009 has been used. On the upper side of substrate a 50Ω microstrip line is used as a feeding line and the other side of the substrate is the ground plane. In this ground plane a slot with length Ls =24mm and width Ws=7.5mm has been taken. After introducing slot in the ground plane one inverted L-shaped stub has been taken to enhance the bandwidth. The optimized geometric parameters of the proposed antennas are shown in Table-I.

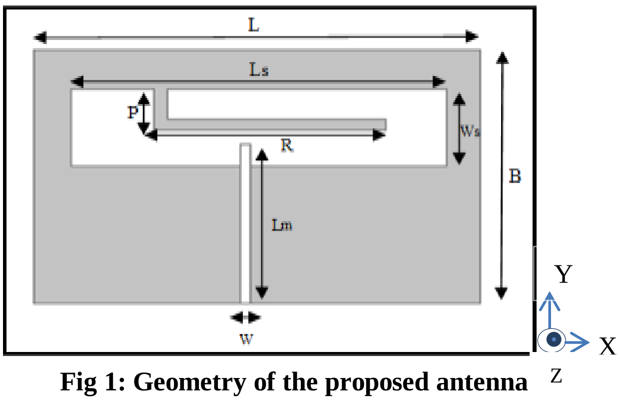


Fig 1: Geometry of the proposed antenna

Table 1: Dimension of the Proposed Antenna

Parameters	Values(mm)
B	23
L	30
W_S	7.5
L_S	24
P	4.5
R	18
M	16
W	0.6

B. Performance Evaluation of the Antenna

Absence of stub: To develop the proposed antenna two steps have been adopted and that are introducing slot in the first step and stub in the second step. In the first step when one slot is etched on the ground plane the range of band (return loss -10dB) is in between 2.96GHz to 6.7GHz that means the impedance bandwidth is 66.66%. From the Figure-2 it is clear that without adding stub in ground plane impedance bandwidth is reduced 22.84%.

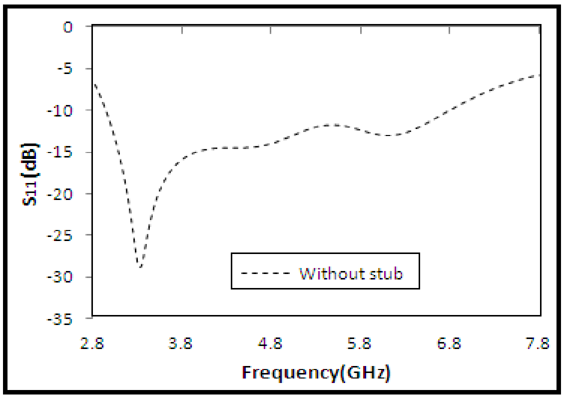


Figure-2: S_{11}characteristic in absence of stub

Variation of stub length: In the second stage of modification of the proposed antenna one stub with length 22.5mm is added in the ground plane. This stub plays a very important role for increasing impedance bandwidth. When the stub length is reduced to 21.5mm the impedance bandwidth becomes 80.4%. Similarly when the stub length is becomes 20.5mm the impedance bandwidth becomes 78.5%. the variation of stub length is shown in Figure-3.

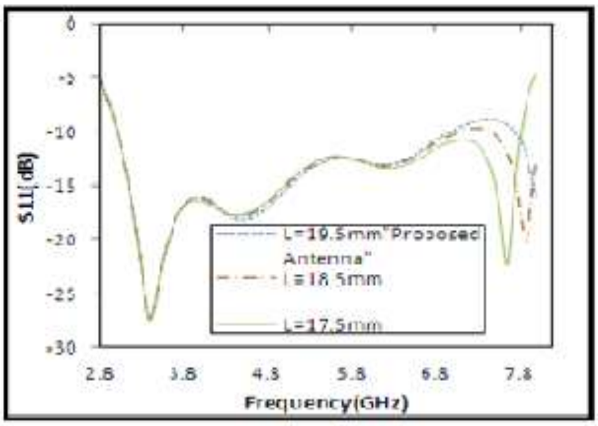


Figure 3: Variation of stub length

Variation of slot position: The position of slot in the ground plane is also very effective parameters for bandwidth variation. From the Figure-4.it is clear that when the slot is moving downwards in the vertical direction bandwidth is decreasing simultaneously and the operating band position is also changing.

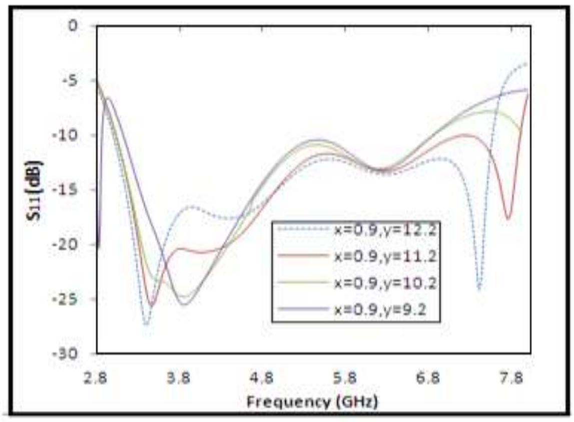


Figure 4: Variation of slot position

Variation of microstrip line length: The microstrip line which is used for feeding purposes also plays a significant role for enhancement of impedance bandwidth. From the Figure-5 it is clear that when the strip length is increased the bandwidth of the wideband proposed antenna is decreased. After optimizing the length of microstrip line we get maximum possible bandwidth for strip length L= 16mm.

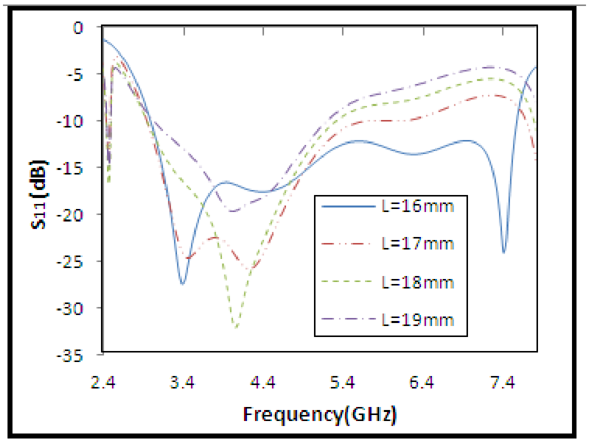


Figure 5: Variation of microstrip line length

3. RESULT AND DISCUSSIONS

The simulated return loss curve of developed wide band microstrip antenna is shown in Figure-6. The impedance bandwidth of this proposed antenna is 89.5%. The E-plane and H-plane radiation pattern for three different frequencies 2.9GHz, 5.4GHz and 7.7GHz are shown in Figure-7. The maximum peak gain in the operating band is 3.24dBi. The simulated gain of the proposed antenna over the entire frequency range is stable within the frequency range of 2.9GHz to 7.8GHz as shown in Figure-8.

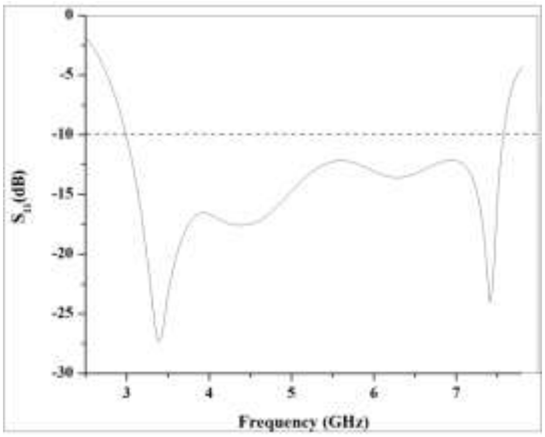
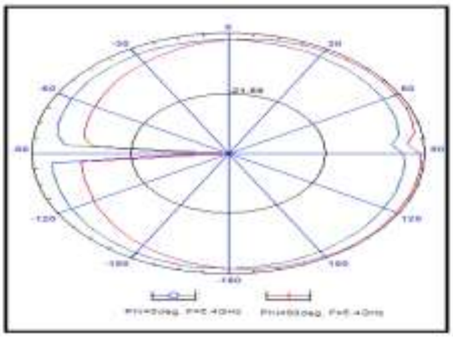
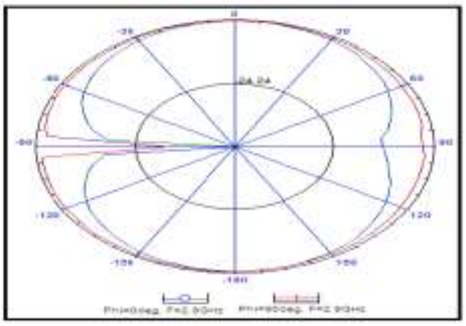


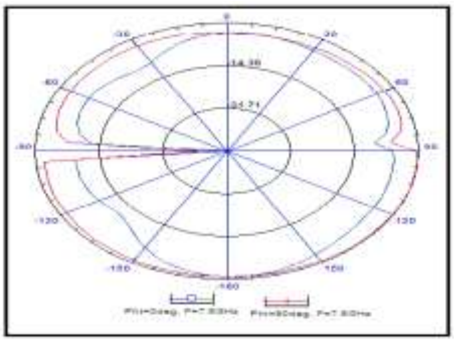
Fig 6: Simulated S_{11} curve of proposed antenna



(a)



(b)



(c)

Figure -7 Radiation pattern for three different frequencies (a) 2.9GHz, (b) 5.4GHz and (c) 7.7GHz

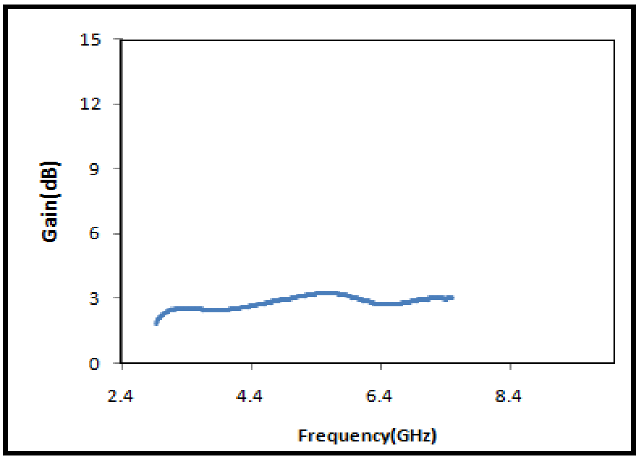


Figure 8: Gain of the proposed antenna over the entire frequency range from 2.9GHz to 7.8GHz

4. CONCLUSION

A wide band small size antenna including slot and stub in the ground plane is presented in this paper. The slot and stub in the ground plane main key factor for enhancing bandwidth of the proposed antenna. This proposed antenna has 89.5% bandwidth over the frequencies 2.99GHz to7.8GHz. This wide band antennafind applications in WIMAX (3.3GHz-3.7GHz), IEEE 802.11a WLAN (5.15GHz-5.35GHz), HIPERLAN (5.7GHz-5.825GHz), Satellite X-band (7.25GHz-7.75GHz).

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