

Design of Slot Loaded Stacked Wideband Microstrip Patch Antenna for Wireless Communications

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Abstract: A simple, compact, slot loaded stacked wideband microstrip patch antenna is presented in this communication. The radiating element consists of a rectangular patch with a T-shaped slot and is fed by a 50 Ω microstrip line. The proposed antenna is simulated using IE3D software, 12.32 version of Zealand. The simulated results show that the antenna can exhibit wideband characteristics. The impedance bandwidth (VSWR \leq 2) at -10 dB return loss comes out to be about 54%, ranging from 1.533 GHz to 2.679 GHz.

Keywords: Microstrip antenna, Rectangular, T-shaped slot, stacked, wideband, IE3D.

I. INTRODUCTION

Microstrip antennas have many advantages over the conventional antennas because of light weight and low volume, low profile planar configuration which can be easily made conformal to host surface, low fabrication cost, capable of dual and triple frequency operations, mechanically robust when mounted on rigid surfaces [1] rectangular microstrip antenna exhibits several limitations such as low bandwidth, low efficiency, low gain and directivity owing to the excitation of surface waves. There are numerous and well-known methods to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, slotted patch antenna, the use of various impedance matching and feeding techniques [2-15].

This paper presents a new T-shaped slot loaded stacked rectangular patch antenna that is investigating for enhancing the impedance bandwidth. By choosing the suitable slot shape, selecting a proper feed and tuning their dimensions, a large operating bandwidth is obtained. The design employs 50 Ω microstrip line feeding. The antenna is simulated using IE3D software package of Zealand. The results show that the impedance bandwidth has achieved a good match.

II. ANTENNA DESIGN

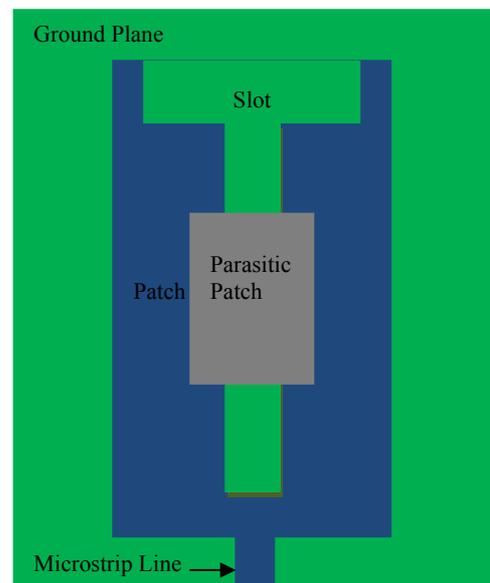
The resonant frequency of microstrip antenna and the size of the radiation patch can be similar to the following formulas [16].

$$f \cong \frac{c}{2L\sqrt{\epsilon_r}} \quad (1)$$

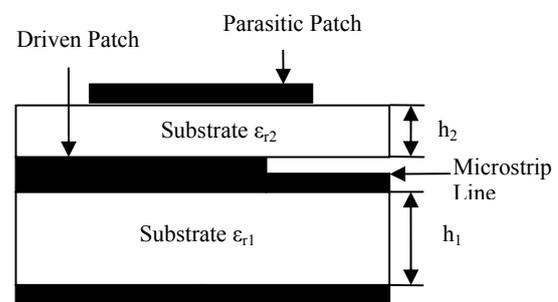
$$W = \frac{2}{f_r} \left(\frac{\epsilon_r + 1}{2} \right)^{\frac{1}{2}} \quad (2)$$

$$L = \frac{c}{2f_r\sqrt{\epsilon_r}} - 2\Delta l \quad (3)$$

Where f is the resonant frequency of the antenna, c is the free space velocity of the light, L is the actual length of the current, ϵ_r is the effective dielectric constant of the substrate and Δl is the length of equivalent radiation gap.



(a) Top View



(b) Side View

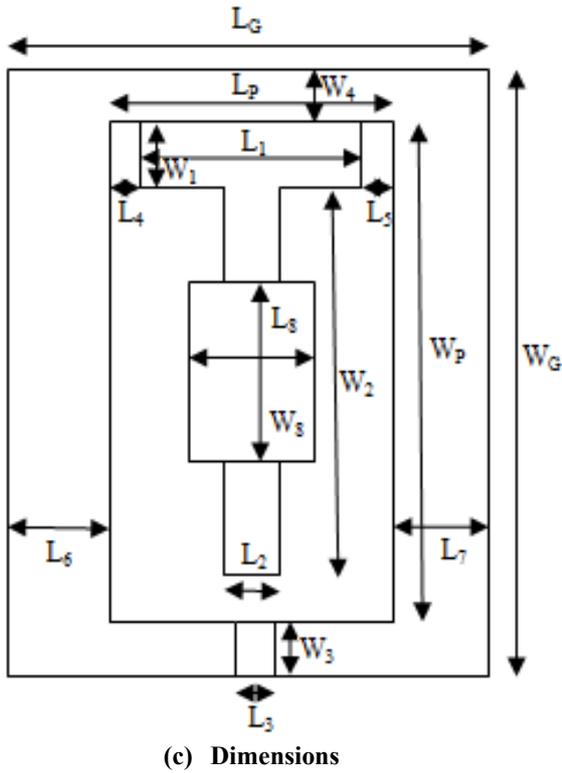


Fig. 1. Geometry of the proposed antenna.

The geometry of the proposed antenna is shown in figure 1. The antenna is built on a glass epoxy substrate with dielectric constant $\epsilon_{r1} = 4.2$ and height $h_1 = 1.6$ mm. Further a square patch of dielectric constant $\epsilon_{r2} = 4.2$ and height $h_2 = 1.6$ mm is stacked with the slotted patch. The top view and side view of the patch antenna is shown in figures (a) and (b) respectively. The dimensions of the proposed antenna are shown in figure (c). The optimized design parameters of the proposed antenna are as follows: $W_G = 50$ mm, $L_G = 40$ mm, $W_P = 40$ mm, $L_P = 30$ mm, $W_1 = 5$ mm, $L_1 = 25$ mm, $W_2 = 30$ mm, $L_2 = 5$ mm, $W_3 = 5$ mm, $L_3 = 3$ mm, $W_4 = 5$ mm, $L_4 = 2.5$ mm, $L_5 = 2.5$ mm, $L_6 = 5$ mm, $L_7 = 5$ mm, $W_8 = 10$ mm, $L_8 = 10$ mm. The patch is fed by a 50Ω microstrip line. The use of microstrip line feeding technique and stacking configuration provides the bandwidth enhancement.

III. RESULTS AND DISCUSSIONS

The proposed antenna is simulated using IE3D software, 12.32 version of Zeland. The simulated return loss of the proposed antenna is shown in figure 2. The impedance bandwidth at -10 dB return loss comes out to be 54% at center frequency 2.319 GHz. The VSWR of the proposed antenna is shown in figure 3. The simulated radiation patterns of the elevation and azimuth of the proposed antenna are shown in figure 4. It can be observed that the proposed antenna have the same radiation patterns over the entire frequency band.

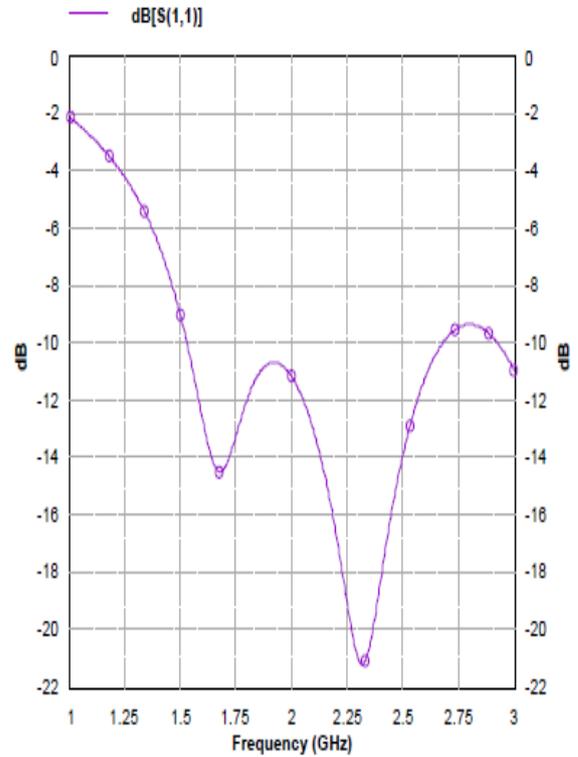


Fig: 2. Simulated return loss

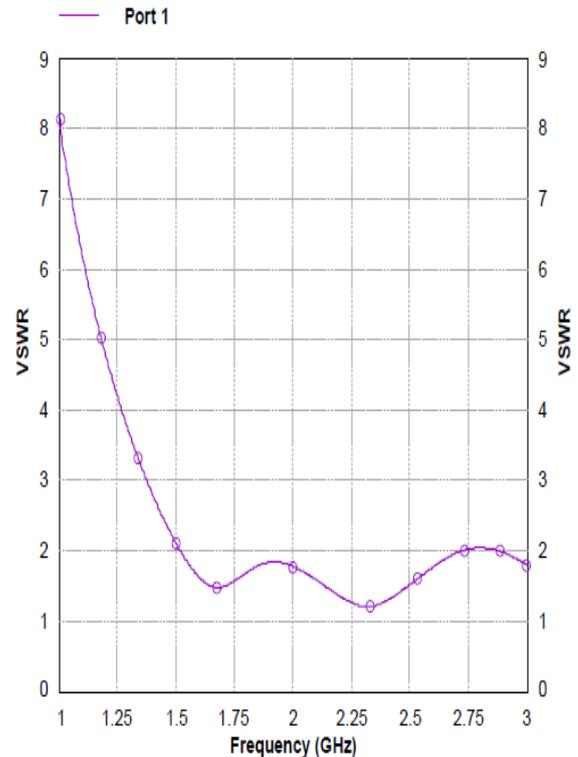


Fig: 3. Simulated VSWR

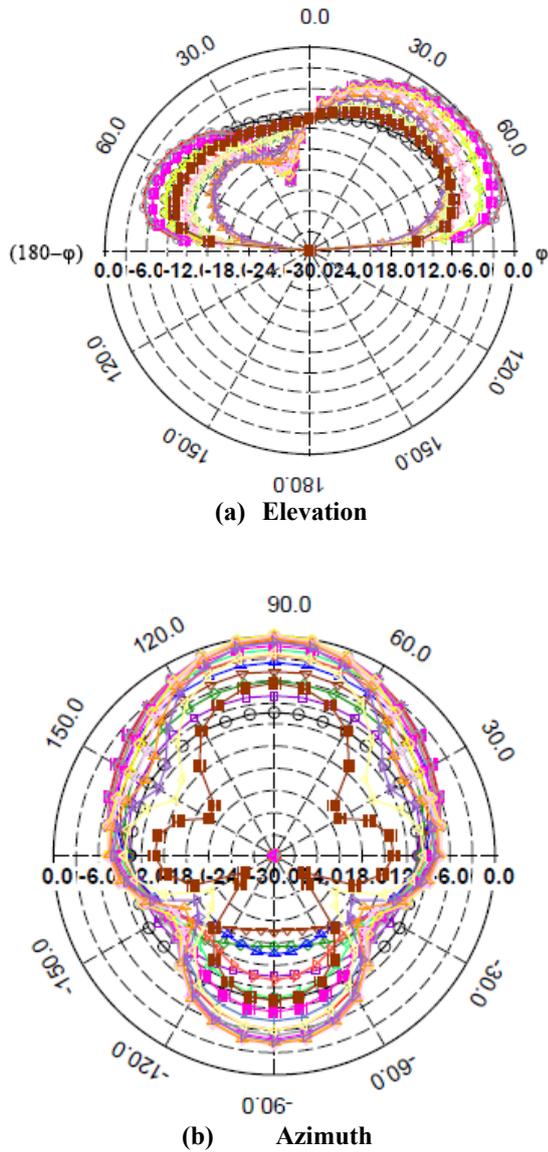


Fig.4. Radiation pattern of the proposed antenna. (a) Elevation and (b) Azimuth.

IV. CONCLUSION

A novel wideband, stacked, slotted microstrip antenna for 1.533/2.679 GHz is presented. The proposed antenna has a very compact size of (40 mm x 50 mm x 1.6 mm). The impedance bandwidth of the proposed antenna at -10 dB return loss is about 54% which can easily cover the frequency bands of UMTS, Wi Max, WLAN (2.40–2.48GHz), and UMTS II (2.50–2.69GHz). The antenna is simulated using IE3D, 12.32 version of Zealand. Good antenna performance and impedance matching can be realized by adjusting the length and width of microstrip line.

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