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Design of Cross-Shaped Slot Loaded Wideband Microstrip Patch Antenna for Mobile Communication

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Abstract: A very simple, constrict, cross-shaped slot loaded wideband rectangular microstrip patch antenna is demonstrated in this communication. Rectangular patch with a cross (+)shaped slot is radiating element. The probe feed technique is used for this shape. The selected antenna is simulated using IE3D simulator, 12.28 version of Zeland. Wideband characteristics of antenna are shown in simulated results. The impedance bandwidth (VSWR ≤ 2) at -10 dB returns loss comes out to be about 35.4%, ranging 1.946 GHz to 2.772 GHz.

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

I. INTRODUCTION

Microstrip antennas are becoming very widespread within the wireless and mobile communication because of their various advantages over the conventional antennas. 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 cross-shaped slot loaded 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 probe 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].

$$f \cong \frac{c}{2L\sqrt{\varepsilon_r}} \tag{1}$$

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

$$L = \frac{c}{2 f_r \sqrt{\varepsilon_r}} - 2\Delta l \tag{3}$$

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.

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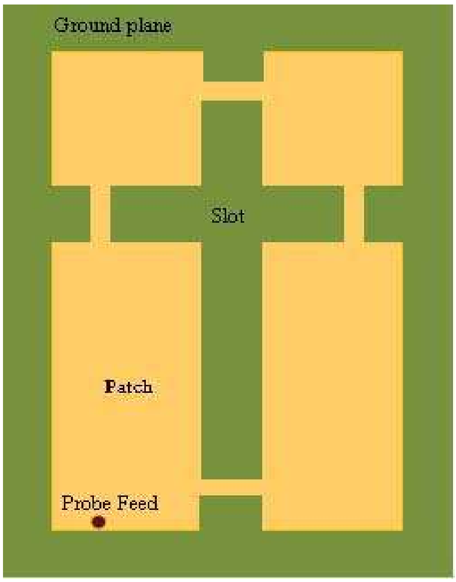
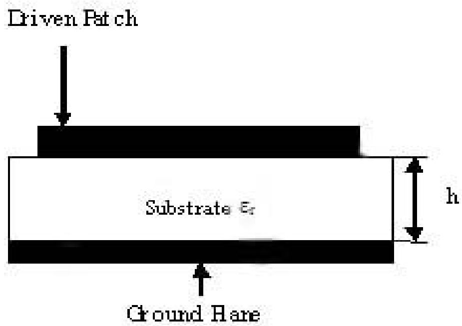
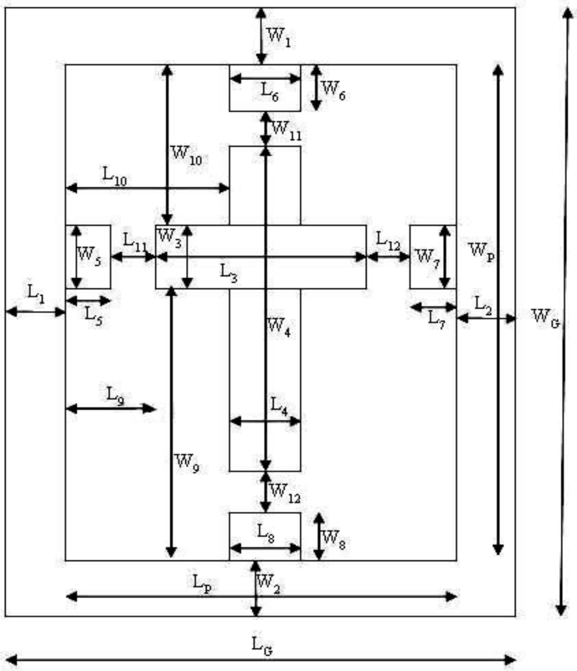


(a) Top View



(b) Side View



(b) Dimensions

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 ε_r = 4.2 and height h = 2 mm. Along with one cross-slot, also four rectangular slots are dug on the same 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:

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L_G	40 mm
W_G	50 mm
L_P	30 mm
W_P	40 mm
L_1	5 mm
W_1	5 mm
L_2	5 mm
W_2	5 mm
L_3	20 mm
W_3	5 mm
L_4	5 mm
W_4	30 mm
L_5	2.5 mm
W_5	5 mm
L_6	5 mm
W_6	2.5 mm
L_7	2.5 mm
W_7	5 mm
L_8	5 mm
W_8	2.5 mm
L_9	5 mm
W_9	25 mm
L_{10}	12.5 mm
W_{10}	10 mm
L_{11}	2.5 mm
W_{11}	2.5 mm
L_{12}	2.5 mm
W_{12}	2.5 mm

Table 1. Design parameters.

The patch is fed using probe feed with feed points x=9.914 mm and y=5.21 mm. The use of probe feeding technique and slotted configuration provides the bandwidth enhancement.

III. RESULTS AND DISCUSSIONS

The selected antenna is simulated using IE3D software, 12.28 version of Zeland. IE3D is based on Method of Moment analysis. 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 35.5% at center frequency 2.19 GHz. The VSWR of the selected antenna is shown in figure 3. The simulated radiation patterns of the elevation and azimuth of the proposed antenna are shown in figure 4. Figure 5 and figure 6 shows the smith chart and pattern view respectively. It can be observed that the selected antenna have the same radiation patterns over the entire frequency band.

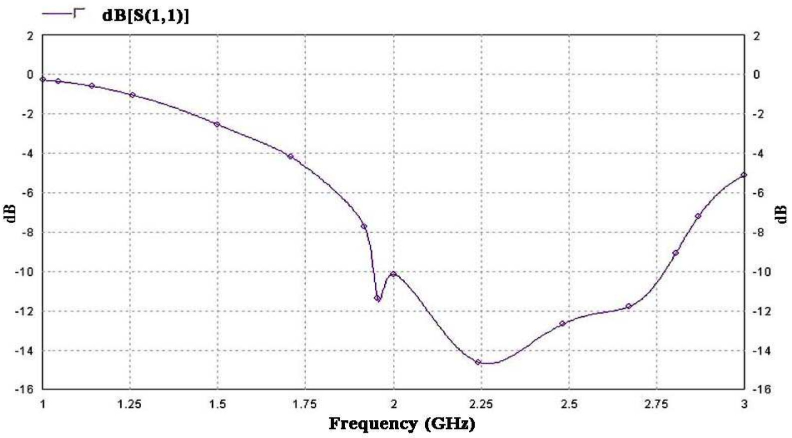


Fig: 2. Simulated return loss (impedance bandwidth)

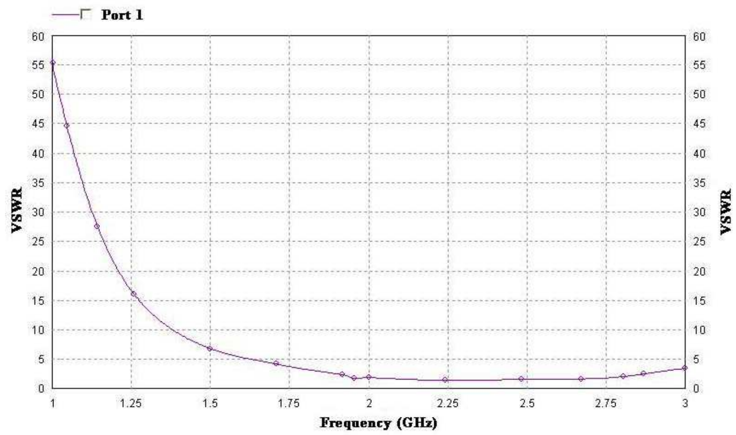
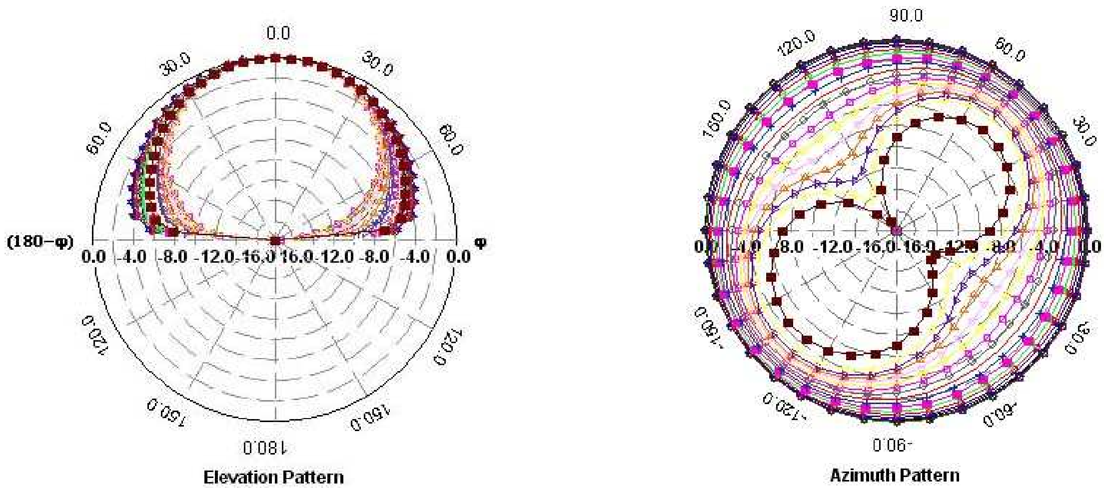


Fig: 3. Simulated VSWR



(a) Elevation (b) Azimuth

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

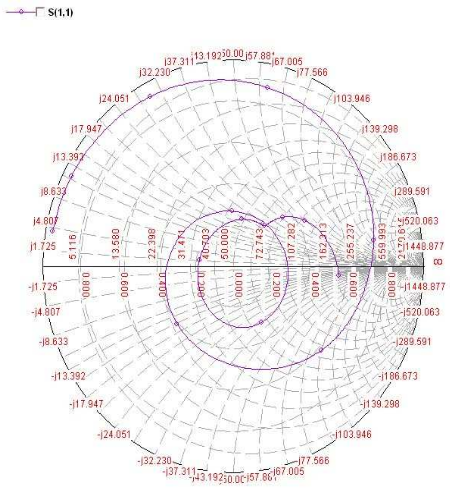


Fig.5. Smith Chart

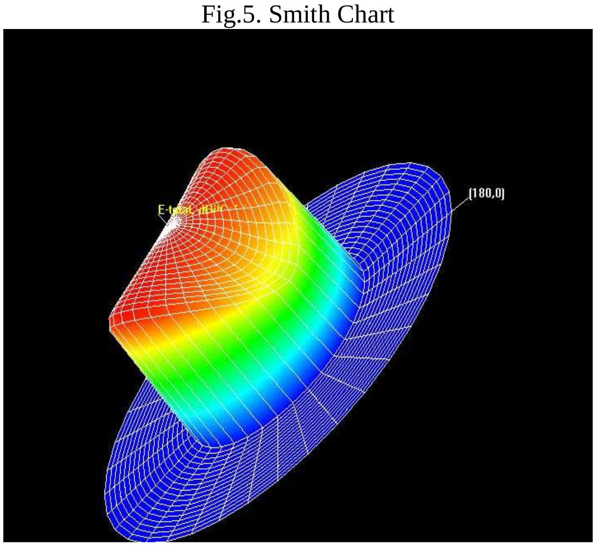


Fig.6. Pattern view

IV. CONCLUSION

A novel wideband, slotted microstrip antenna for 1.946-2.772 GHz is presented. The selected antenna has a very compact size of (40 mm x 50 mm x 2 mm). The impedance bandwidth of the proposed antenna at -10 dB return loss is about 35.5% which can easily cover the frequency bands of UMTS, Wi Max, WLAN (2.40–2.48GHz), and UMTS II (2.50–2.69GHz). The minimum return loss for proposed antenna is -14.69 dB at 2.27 GHz. The antenna is simulated using IE3D, 12.28 version of Zealand. Good antenna performance and impedance matching can be realized by adjusting the probe feed coordinates.

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