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A Compact Microstrip Patch Antenna with Triangular Snipped Slot for Wireless Applications

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Abstract: ***A compact microstrip patch antenna with a slot fed by coaxial probe is presented in this paper. The slot which is circular in shape with triangular truncations results three narrow bands. The patch is designed on FR4 substrate of thickness 1.6 mm and relative permittivity of 4.4. The size of the proposed antenna is 35mm x 45mm x 1.6mm. Return loss comparison is done for different feed locations. The proposed antenna is suitable for WiMax, Wi-Fi and WLAN applications. The simulations are carried out using Finite Element Method based Ansfot High Frequency Structure Simulator (HFSS).***

Index Terms: Microstrip patch, WLAN, Wi-Fi, WiMax.

I. INTRODUCTION

Microstip antennas are widely implemented in many applications, especially in wireless communication [1, 2]. This is due to attractive features such as low profile, light weight, conformal shaping, low cost, high efficiency, simplicity of manufacture and easy integration to circuits. However, the major disadvantage of the microstrip patch antenna is its narrow impedance bandwidth. Employing high dielectric constant substrates is the simplest solution, but it exhibits high loss and poor efficiency due to surface wave excitation. Modification of the basic patch shapes allows substantial size reduction [3, 4]. However, some of these shapes will cause the inefficient use of the available areas.

By inserting some specific slot in the radiating patch of microstrip antennas, compact or reduced size microstrip antennas can be obtained [5-8]. The loading of the slots in the radiating patch can cause meandering of the excited patch surface current paths and result in lowering of the antenna's fundamental resonant frequency, which corresponds to the reduced antenna size for such an antenna, compared to traditional microstrip antenna at same operating frequency[9]. In this paper, rectangular microstrip antenna which comprises of circular slot on the patch with triangular truncations is proposed. The patch is mounted on FR4 substrate (thickness=1.6 mm). The proposed antenna can be made suitable for wireless communication applications such as WiMax, Wi-Fi and WLAN.

II. ANTENNA CONFIGURATION

Figure 1 illustrates the geometry of presented antenna that is composed of rectangular patch whose length and width are 25 mm and 35 mm. The triangular slot is located on the upper end of the patch which makes the antenna to operate at desired application frequencies.

The dimensions of the substrate are 35 × 45 × 1.6 mm3. The whole system is fed by a coaxial probe into the substrate, with an input impedance of 50 Ω. Coaxial probe is used for good excitation of antenna over entire range. The probe feed is located at (-9, -18).

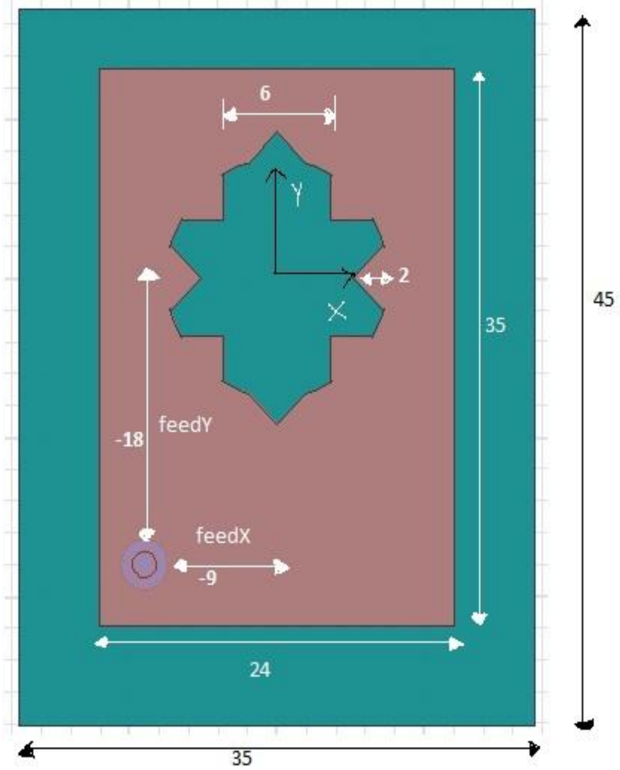

Fig 1: Geometry of the proposed antenna

III. SIMULATION RESULTS

The proposed antenna is simulated and analyzed using Commercial HFSS. From Figure 3, the return losses of the proposed antenna at 3.89 GHz, 5.51 GHz, 5.88 GHz are -19.82 dB, -35.26 dB and -27.05 dB respectively. The bandwidths of the three resonating frequencies are (3.85GHz - 3.93 GHz) 3.89 GHz, (5.43 GHz- 5.58 GHz) 5.51 GHz and (5.81GHz – 5.95 GHz) 5.88 GHz.

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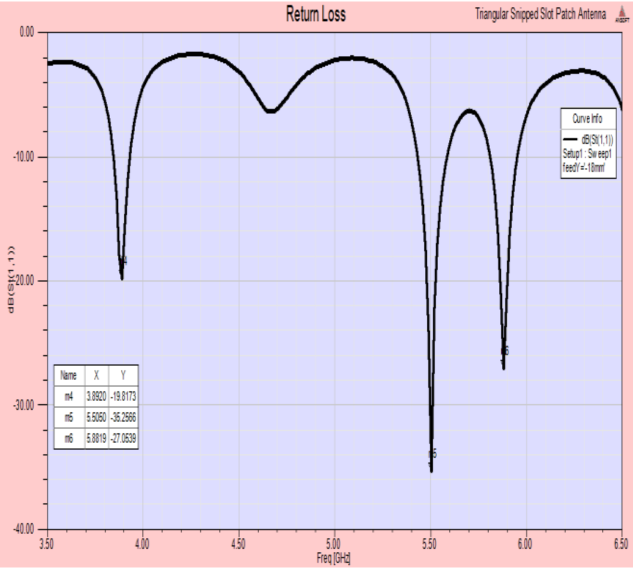

Fig 2: Return Loss vs Frequency

Comparison is done by varying the feed location along y-axis, which is shown in the Figure 3. The return loss is tested at four locations, namely, y= -18 mm, -15 mm, -10 mm and -9 mm respectively. When the feed location is y= -18 mm, the proposed antenna exhibits tri-band with good return losses when compared to other locations. It represents that the antenna operates more effectively at the feed location (-9, -18).

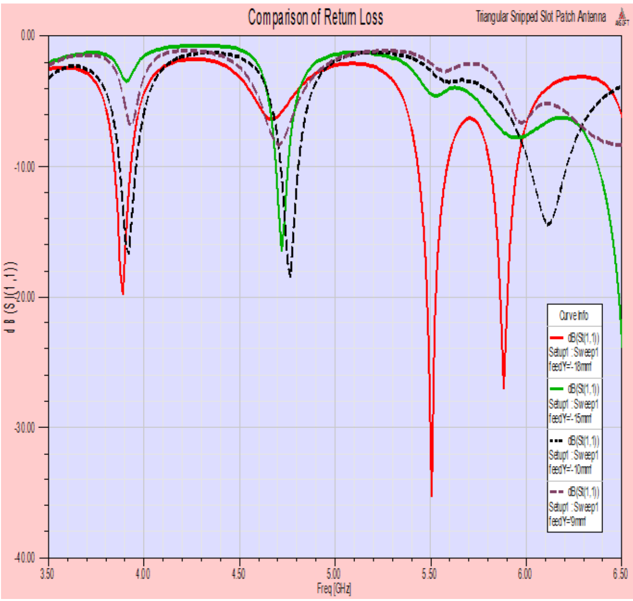

Fig 3: Comparison of Return Losses for different feed locations

Figure 4 shows the VSWR plot for the proposed antenna, which is less than 2 at all bands. The VSWR values at 3.89 GHz, 5.51 GHz and 5.88 GHz are 1.23, 1.03 and 1.09 respectively.

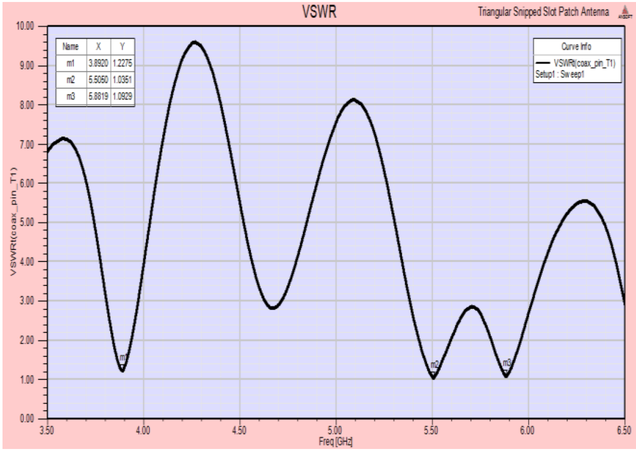

Fig 4: VSWR vs Frequency

Figure 5 shows the input impedance smith chart of the proposed antenna.

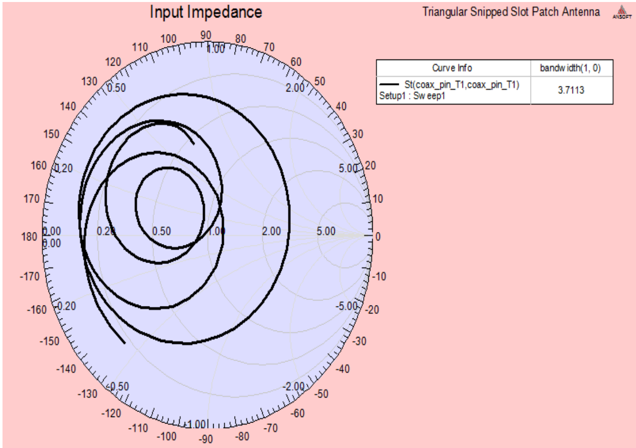

Fig 5: Input Impedance Smith Chart

Figure 6 shows the gain of the antenna versus frequency. The maximum gain of the proposed antenna is 2.93 dBi.

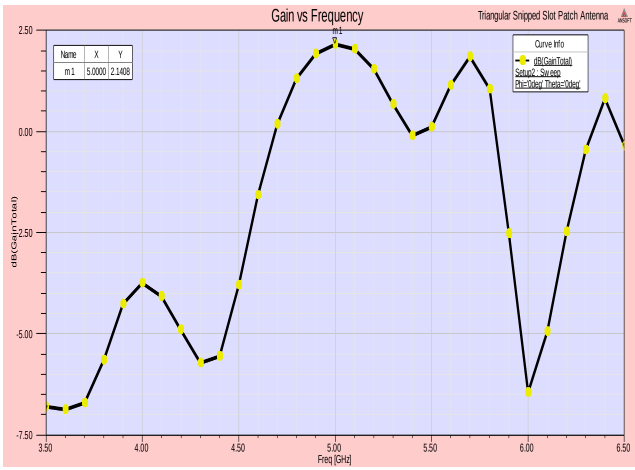

Fig 6: Gain vs Frequency

The radiation patterns for the proposed antenna for Phi and Theta at 0 deg and 90 deg is shown in the Figure 7 and Figure 8.

From the figures, the proposed antenna exhibit quasi omni and bi-directional radiation patterns.

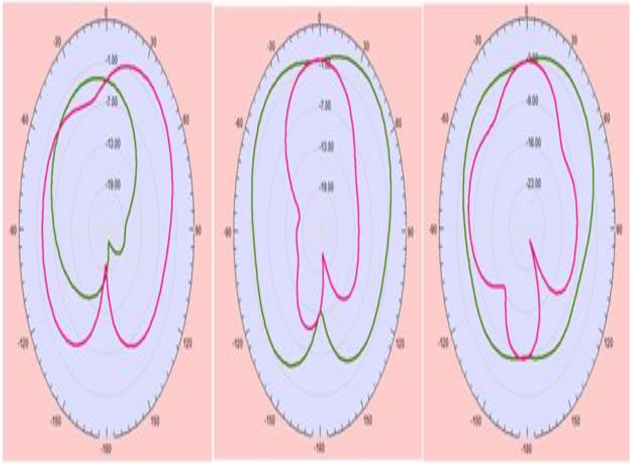

Fig 7: E-Plane Radiation Patterns at 3.89 GHz, 5.51 GHz and 5.88 GHz for Phi=0 deg and Phi=90 deg

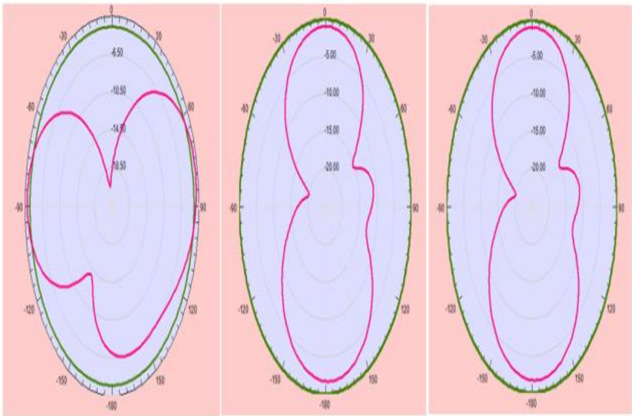

Fig 8: H-Plane Radiation Patterns at 3.89 GHz, 5.51 GHz and 5.88 GHz for Theta=0 deg and Theta=90 deg

The effect produced by an electric charge that exerts a force on charged objects is the E-field [10] and its distribution in the patch is as shown in the Figure 9. The E-field distribution at the three operating frequencies is shown.

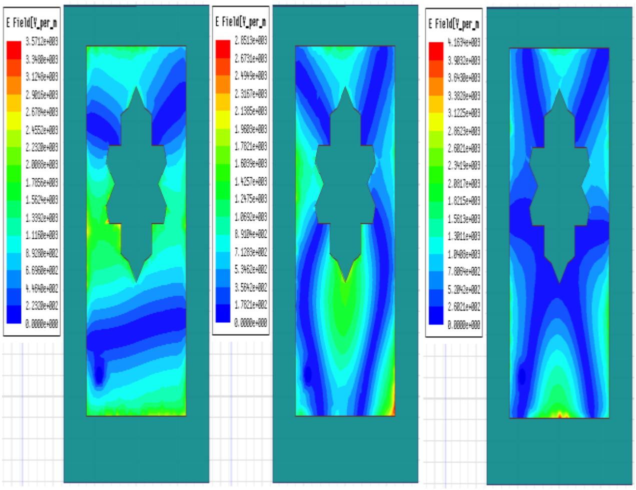

Fig 9: E-Field Distributions at 3.89 GHz, 5.51 GHz and 5.88 GHz

The measured intensity of a magnetic field in the patch is shown in Figure 10 at the three resonant frequencies.

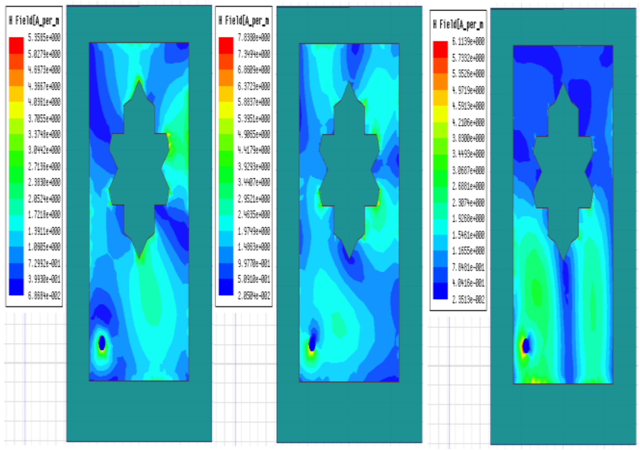

Fig 10: H-field Distributions

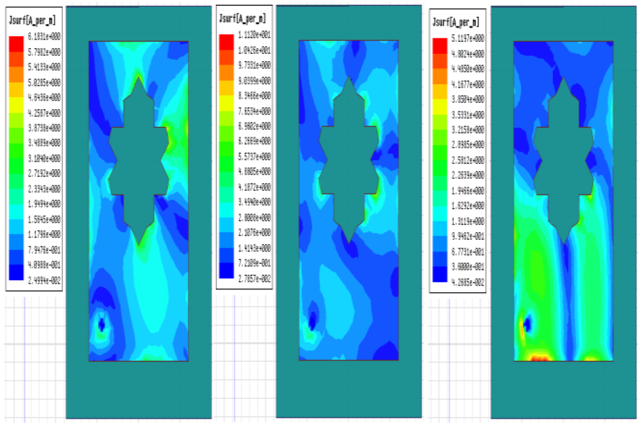

Fig 11: Surface Current Distributions

IV. CONCLUSION

A compact rectangular microstrip antenna with probe feed for tri band wireless communication systems is designed and simulational results are presented in the current work. The proposed antenna operates at three frequencies with bandwidths of (3.85 GHz-3.93 GHz) centered at 3.89 GHz, (5.43 GHz-5.58 GHz) centered at 5.51 GHz and (5.81 GHz-5.96 GHz) centered at 5.88 GHz respectively. The results demonstrate that the proposed antenna with triangular snipped slots and corner frilling at special angles can generate steady radiation patterns and is capable of wrapping the frequencies demanded by WiMax, Wi-Fi and WLAN.

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