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# Design of CPW-fed 'E-G' shaped Microstrip antenna for WLAN and WiMAX Applications

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## ABSTRACT

This paper, presents a triple band Microstrip Patch Antenna for WiMax application.This antenna can achieve triple band performance to simultaneously cover the most commonly used 2.4 GHz/5.8 GHz WLAN bands and 3.5 GHz/5.5 GHz Wi-MAX bands. CST MWS simulator has been used to model and simulate the 'E-G' shaped microstrip antenna. The designed antenna resonates at 2.20 GHz, 3.37 GHz and 5.84 GHz respectively. The return loss for 2.2 GHz, 3.37 GHz and 5.84 GHz is -20.48 dB, -18.56 dB and -35.93 dB respectively. The bandwidth of the proposed patch antenna is 567 MHz (1.98 GHz-2.54 GHz) for 2.2 GHz frequency and 439 MHz (3.19 GHz-3.63 GHz) for 3.37 GHz frequency and 1.17 GHz (5.35 GHz-6.52 GHz) for 5.84 GHz respectively.

## General Terms

Microstrip Patch Antenna, Simulation, Antenna Geometry.

## Keywords

CST Software, E-G shaped Microstrip Patch Antenna, CPW feed line, Triple frequency bands.

## 1. INTRODUCTION

Microstrip antennas is a simplest form of antenna configuration. It consists of a radiating patch on one side of dielectric substrate (Єr≤10) and it has a ground plane on other side. A microstrip patch antenna consists of a many conducting patch of any planar or nonplanar geometry. The rectangular and circular patches are the basic and mostly common used for microstrip antennas because of ease of fabrication system. The microstrip antenna have various advantages such as small size, low-cost of fabrication process, low profile of antenna, light in weight, ease of installation process and integration with many feed types. The applications of these type of antennas in various fields such as in the medical applications, satellite and of course even in the military systems just like in the rockets, aircrafts missiles [1]. However, the microstrip antenna has a low gain and a narrow bandwidth. To overcome its limitation of narrow impedance bandwidth and low gain, many techniques have been proposed. In this proposed antenna CPW feeding has been used.. A patch antenna planned to operate at a centre resonance frequency mounted on a substrate having dielectric constant $\varepsilon_r$ would have length L and width W of the patch as calculaed from equations [2]. The radiation characteristics of antennas (current distribution, pattern, impedance) mounted on finite size ground planes can be some modification considerably, especially in regions of very low intensity, by the effects of the edges [3]. In microstrip patch antenna there are some well-known methods to increase the bandwidth of patch antennas, such as, cutting a resonant slot in the patch, reduced ground plane, the use of thick substrate, the use of a low dielectric substrate, the use of a low dielectric substrate, the use of various impedance matching feeding techniques, the use of slot antenna geometry and multi-resonator stack configurations. However, the bandwidth and the size of an antenna are generally reciprocal conflicting properties that are improvement of one of the characteristics normally results in degradation of the other one [4]. Various shapes of cutting slots and slits have been designed on patch antennas to reduce their size. These shapes of slots that are embedded on the antenna are used to increase the surface current path. To decrease the resonant frequency of an antenna for a given surface area, the current path must be maximized within the area [5]. For efficient radiation, the size of Microstrip antenna should be λ/2. If the size reduces less than λ/2, the radiation efficiency of antenna decreases along with other antenna parameters. The miniaturization of antenna and improvement in bandwidth can be achieved by etching the slot in ground and patch of Microstrip antenna of proper length and width value [6].

## 2. DESIGN ANTENNA GEOMETRY

Figure 1 shows the geometrical configuration of the proposed CPW-fed planar monopole. The antenna is printed on only one side of an FR4 microwave substrate with the substrate thickness of 1.6 mm and the dielectric constant of 4.4. The main structure of the proposed antenna comprise of three folded strips. A 50 Ω CPW feeding line with a fixed signal strip thickness of '$W_f$' and a gap distance of 'g' between the signal strip and ground is used for centrally feeding the 'E-G'-shaped antenna from its bottom edge. Two equal finite ground planes, each with dimensions of width '$W_g$' and length '$L_g$', are situated symmetrically on each side of the CPW feeding line.

| L | $L_1$ | W | $L_2$ | $W_1$ | $W_2$ | $W_3$ |
|---|---|---|---|---|---|---|
| 46.32 | 28.4 | 25 | 19.8 | 20.8 | 9.9 | 7.9 |

| $W_4$ | S | G | $L_f$ | $W_f$ | $L_g$ | $W_g$ |
|---|---|---|---|---|---|---|
| 15.8 | 2 | 1.09 | 16.32 | 6.26 | 12.82 | 8.275 |

**Table 1: Geometry parameters of the antenna and CPW-line (all dimensions in mm)**

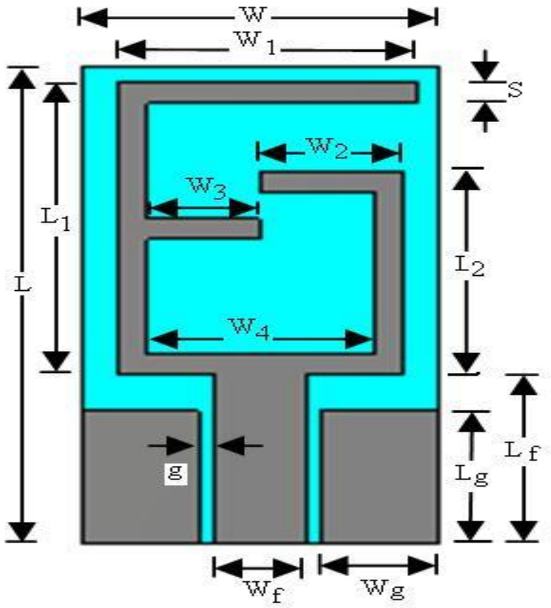


**Figure1: Geometrical configuration of CPW-fed 'E-G' Shaped MPA**

## 3. DESIGN PARAMETER

The CST view of the designed antenna is shown in Figure2. CST Microwave Studio software view of designed CPW fed patch antenna with E-G shaped for triple band operation for WiMax & WLAN.

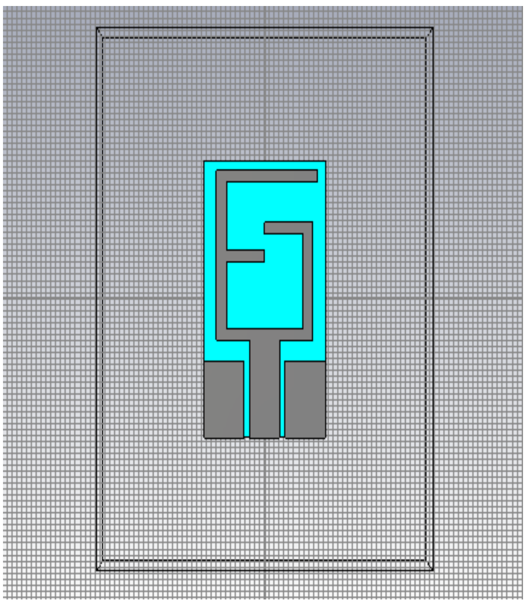

**Figure 2: Front view of proposed antenna**

The front view of the designed proposed antenna is shown in Figure 2.

## 4. SIMULATED RESULTS

The geometrical parameters of the antenna were changed one by one and after several cycle of changes, the optimized values for these parameters were obtained. Table 1 lists the values of optimized parameters of the antenna and CPW-line.

The designed antenna resonates at 2.20 GHz, 3.37 GHz and 5.84 GHz respectively. The return loss for 2.2 GHz, 3.37 GHz and 5.84 GHz is -20.48 dB, -18.56 dB and -35.93 dB respectively. The return loss versus frequency curve is shown in Figure 3. The bandwidth of the proposed patch antenna is 567 MHz (1.98 GHz-2.54 GHz) for 2.2 GHz frequency and 439 MHz (3.19 GHz-3.63 GHz) for 3.37 GHz frequency and 1.17 GHz (5.35 GHz-6.52 GHz) for 5.84 GHz respectively.

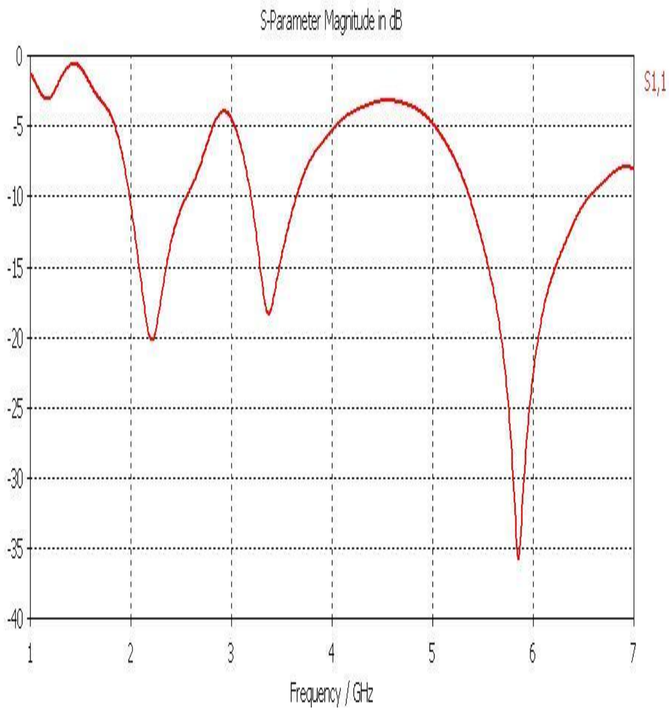


**Figure 3: Return Loss of proposed antenna**

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The Smith Chart plot represents that how the antenna impedence varies with frequency. The achieved antenna impedance is 50 ohm as shown in Figure 4, which is equal to the required impedance of 50 ohm.

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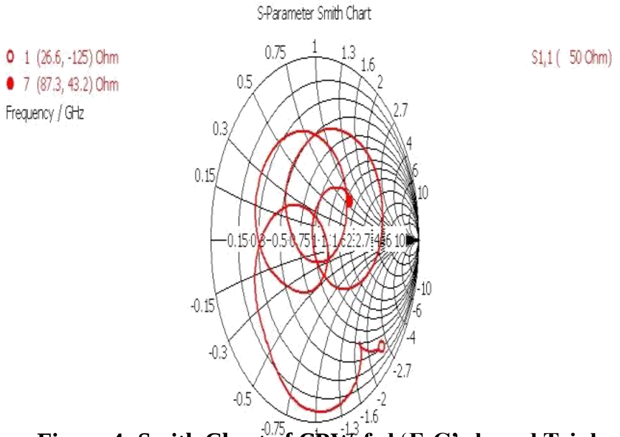


**Figure 4: Smith Chart of CPW-fed 'E-G' shaped Triple Band MPA**

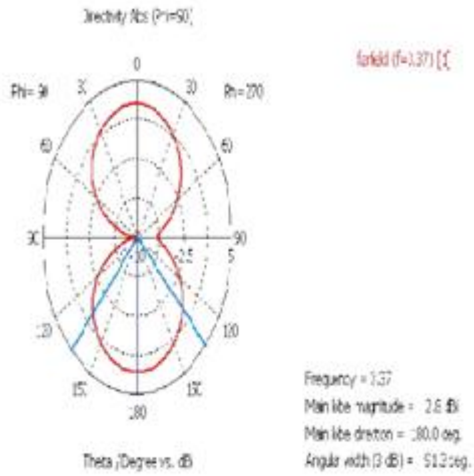


**Figure 5(b): 4.25 Directivity at 3.37 GHz**

The radiation patterns showing the directivity for the designed antenna for 2.2 GHz, 3.37 GHz and 5.84 GHz have been shown in Figure 5(a), Figure 5(b) and Figure 5(c) respectively. The radiation pattern shows directivity (polar view) is 2.287 dBi, main lobe direction is 178 degree and angular beam width is 83.6 degree for 2.2 GHz frequency. The radiation pattern obtained for 3.37 GHz frequency shows directivity is 2.796 dBi and main lobe direction is 180 degree having angular beam width of 91.3 degree and for 5.84 GHz frequency directivity is 3.582 dBi with main lobe direction 152 degree and having angular beam width of 54.2 degree.

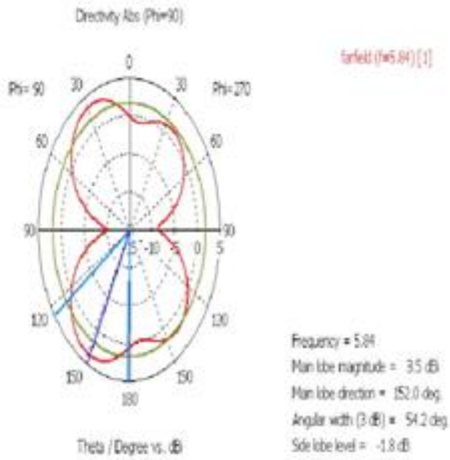


**Figure 5(c): Directivity at 5.84 GHz**

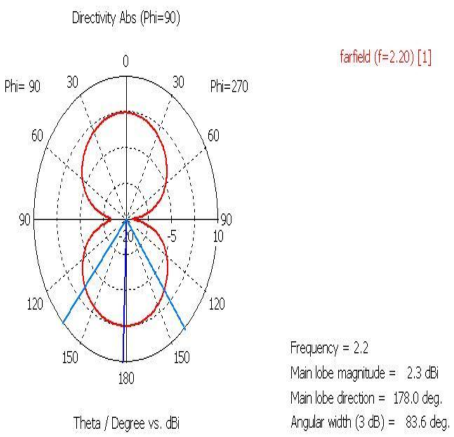


**Figure. 5(a): Directivity at 2.2 GHz**

Ideally, VSWR must lie in the range of 1-2 which has been achieved for 2.20 GHz, 3.37 GHz and 5.84 GHz frequency, near the operating frequency value. The VSWR ratio at 2.20 GHz, 3.37 GHz and 5.84 GHz frequencies is 1:1.217, 1:1.276 and 1:1.033 respectively

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The average antenna gain of proposed antenna for frequencies across the triple band is measured and is shown in Figure 6. The ranges of antenna gain at the first lower frequency band (1.98 GHz-2.54 GHz) is about 2.48-2.9 dB and the average gain is 2.63 GHz around 2.2 GHz. The ranges of antenna gain for second lower frequency band (3.19 GHz-3.63 GHz) is about 2.56-3.5 dB and the average gain is 3.02 dB around 3.37 GHz and for higher frequency band (5.35 GHz-6.52 GHz) is about 3.85-3.39 dB respectively. The average gain is 3.57 around 5.84 GHz.

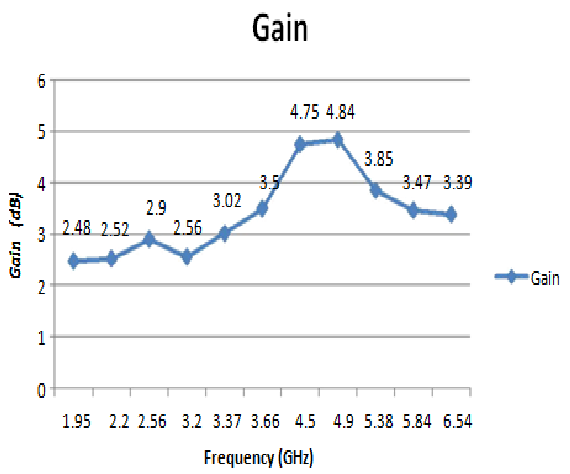


**Figure 6: Gain versus frequency curve**

## 5. CONCLUSIONS

The proposed antenna simulated on CST microwave studio. CPW-fed 'E-G' shaped triple band microstrip patch antenna has been designed which covers 2.4/5.8 GHz WLAN standard and 3.5/5.5 GHz WiMAX standard. The obtained -10 dB impedance bandwidth for CPW-fed 'E-G' shaped triple band antenna is 25.45%, 13.05% and 20.03% at the bands of 2.20 GHz, 3.37 GHz and 5.84 GHz respectively. The return loss for 2.2 GHz, 3.37 GHz and 5.84 GHz is -20.48 dB, -18.56 dB and -35.93 dB respectively.

## 6. ACKNOWLEDGEMENTS

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