Design of Microstrip Fed Antenna with E-Slot and Symmetrical L Slot for WLAN And Wi-Max Applications

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Abstract- *A small and compact micro strip fed antenna for Wireless Local Area Network (WLAN) and Worldwide Interoperability for Microwave Access (Wi-MAX) is presented. The proposed antenna consists of a rectangular radiating patch with L and E-shaped slots and ground plane. The required operational frequency bands—namely, WLAN (2.4/5.2/5.8 GHz) and Wi-MAX (2.5/3.5/5.5 GHz). The proposed antenna is small (15x15 x 1.6 mm3). Proposed antenna is designed using HFSS (High Frequency Structure Simulator).*

Keywords- Micro strip Antenna, dielectric, WLAN, Wi-Max.

I. INTRODUCTION

The study of micro strip patch antennas has made great progress in recent years. . In modern world, it is a challenge to reduce the size of an antenna and to make it operational for different frequency with acceptable efficiency and gain. This can be achieved by introducing the irregularities in the patch, which resist or change the flow of surface current. Micro strip patch antennas are becoming more and more useful because they can be printed directly onto a circuit board. Micro strip antennas are becoming common within the mobile phone market. Patch antennas are low price, have a low profile and are easy to fabricate. To meet this objective, small micro strip antennas have become an essential choice. Several techniques have been developed to minimize size of antennas. Micro strip patch antenna made up of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The patch is usually made of conducting material such as copper or gold and can take any possible shape. The patch is generally square, triangular, rectangular, circular, and elliptical or some other common shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Some patch antennas do not use a dielectric substrate and instead are made of a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rough but has a wider bandwidth. Such antennas have a very low profile, are mechanically rugged. They are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices. Micro strip patch antennas compared with conventional antennas have more advantages and better prospects. They are lighter in weight, low volume, low cost, low profile, smaller in size and ease of fabrication and conformity. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact Micro strip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance. Micro strip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure. Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. In this paper, the presented antenna is capable of working on two different applications, WLAN (2.4/5.2/5.8 GHz) and Wi-MAX (2.5/3.5/5.5 GHz). Different configurations of antenna are designed in order for proper working of antenna. Triple-band characteristic is designed by etching two narrow L-slots and E-slot with same lengths on a wideband patch antenna.

II. ANTENNA DESIGN AND SIMULATION APPROACH

The schematic configuration of the proposed micro strip-fed planar monopole antenna fixed with two L-slot and E-slot

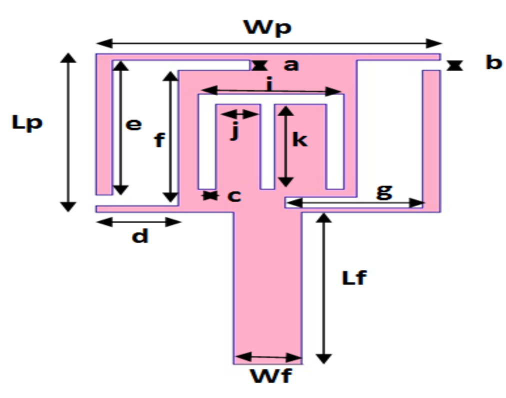

Figure1. Micro strip Antenna with 2L slots and E- slot on patch.

The proposed antenna is imprinted on FR4 substrate with permittivity of 4.4, a loss tangent of 0.024, and a thickness of 1.6 mm. The substrate dimension is only 15x 15 x 1.6 mm3. A10 x 7.5-mm2 rectangular patch is connected to a 2-mm-wide micro strip feed line.

Table I. Antenna Dimensions

Sr. No.	Parameter	Value
1.	Length and Width of Patch	10mm x7.5mm
2.	Length and Width of ground	3 mm x15 mm
3.	Thickness of Substrate (FR4)	1.6 mm
4.	Dielectric constant of substrate	4.4
5.	Length and width of feed line	7.2mmx 2mm
6.	Loss tangent of substrate	0.024

Micro strip Line feeding technique is used because it is easy to design and impedance matched. Conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position.

A compact Micro strip fed monopole antenna is designed without slots is shown in figure.2. A wide operating frequency band is obtained.

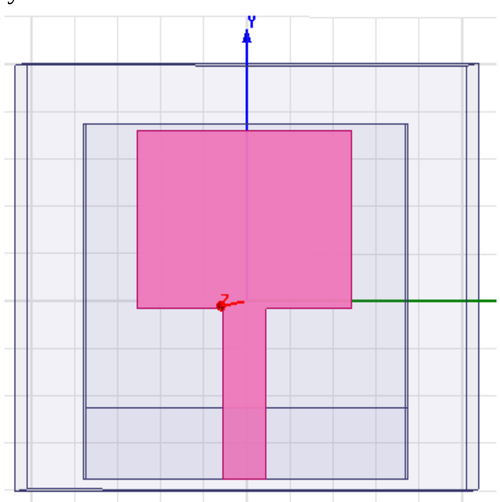

Figure 2. Simple Patch antenna without slot

Now, in Second phase two L-slots are cut on the patch of same dimension is shown in figure 3. The antenna with a pair of symmetrical L-shaped slots has three resonant frequency responses.

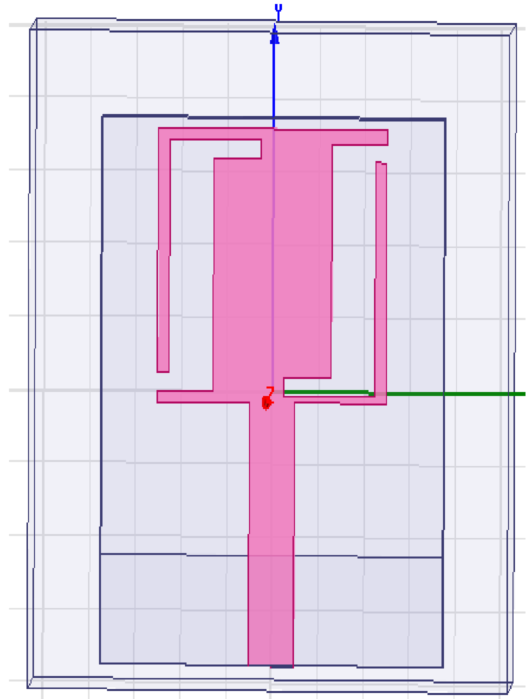

Figure 3. Micro strip antenna with 2L slots

Different antenna are designed and compared so as to obtain better bandwidth, return loss and gain.

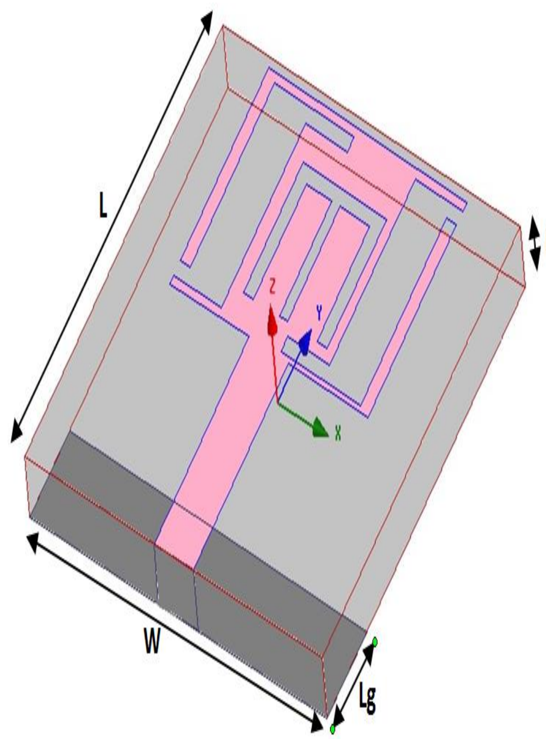

Figure 4. Micro strip antenna with two U slots along with L slots.

To improve return loss and bandwidth of proposed antenna, One E-Slot along with two L- slots are cut on the patch by taking same dimensions of patch, ground and substrate is shown in figure 4. Final dimensions of proposed antenna is given in table II.

Table II. Final Antenna Dimensions

Sr. No.	Parameter	Value
1.	Length and Width of Patch (Lp x Wp)	10mmx7.5mm
2.	Length and Width of ground (Lg x W)	3 mm x15 mm
3.	Thickness of Substrate (FR4)	1.6 mm
4.	Dielectric constant of substrate	4.4
5.	Length and width of feed line (LfxWf	7.2mmx 2mm
6.	Loss tangent of substrate	0.024

K=4mm, i=4.2mm, a=b=c=0.5mm, d=2.4mm, e=f=6.4mm, j= 1.3mm and g=4mm.

The design parameters of antenna:

Width of the substrate is given as

$$W = \frac{c}{2f\sqrt{\varepsilon_r}} \quad (1)$$

ε_{eff} the effective dielectric constant of a micro strip transmission line the same width as the patch. A suitable approximation for εeff is given by

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{10H}{W}\right)^{-1/2} \quad (2)$$

Where ε_r = Dielectric constant of substrate
H = Height of dielectric substrate
W = Width of the patch

The dimensions of the patch along its length have now been extended on each end by a distance ΔL.

$$\frac{\Delta}{H} = 0.412\frac{\varepsilon_{eff}+\frac{0.300W}{H}+0.262}{\varepsilon_{eff}-\frac{0.258W}{H}+0.813} \quad (3)$$

The effective length of the patch L_{eff}

Leff =L + 2ΔL (4)

The resonant length is

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta \quad (5)$$

Using above calculations the dimensions of antenna are calculated.

III. RESULTS AND DISCUSSION

This designed antenna satisfies the following operational bands: 2.4-GHz WLAN (2.4–2.484 GHz specified by IEEE 802.11b/g standards), mobile WiMAX (2.5–2.69 GHz specified by IEEE 802.16e standards), 3.5/5.5-GHz WiMAX (3.4–3.69, 5.25–5.85 GHz), and 5-GHz WLAN (5.15–5.35/5.725–5.825 GHz specified by IEEE 802.11a standards). The return loss plots of this antenna and its comparison with conventional a patch antenna is shown in Figure 5 and Figure 6.

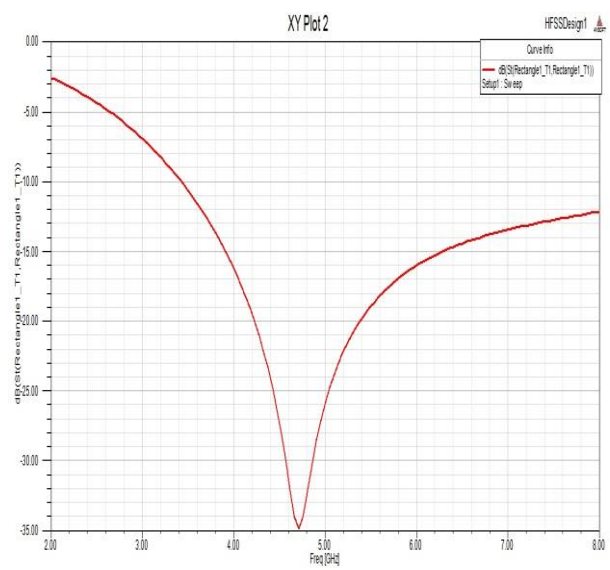

Figure 5.Return loss plot of the proposed antenna

The return loss characteristics of the proposed antenna are shown in Figure 6. It includes all the frequencies range of Wi-Max and WLAN. For getting the impedance bandwidth taking -10 dB as the reference return loss. It resonates at 4.1 GHz and 7.4GHz.

Sr. No.	Frequency	Return Loss
1.	4.1 GHz	–40 dB
2.	7.4 GHz	–24 dB

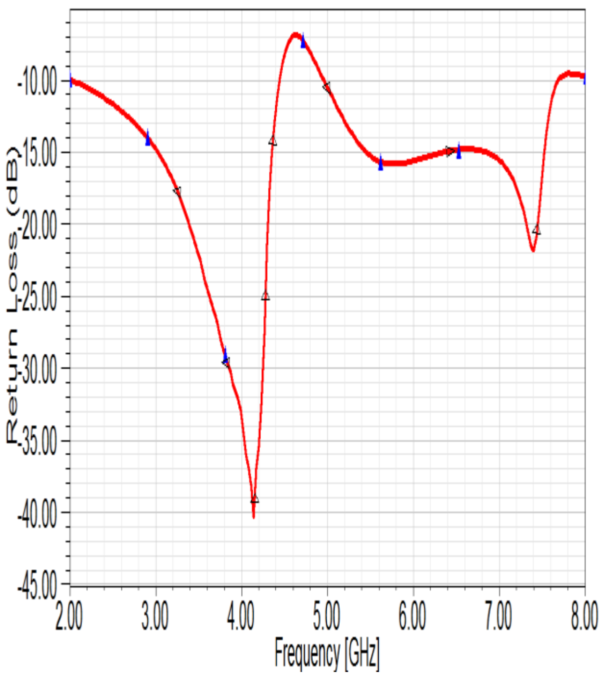

Figure 6.Return loss plot of the proposed antenna

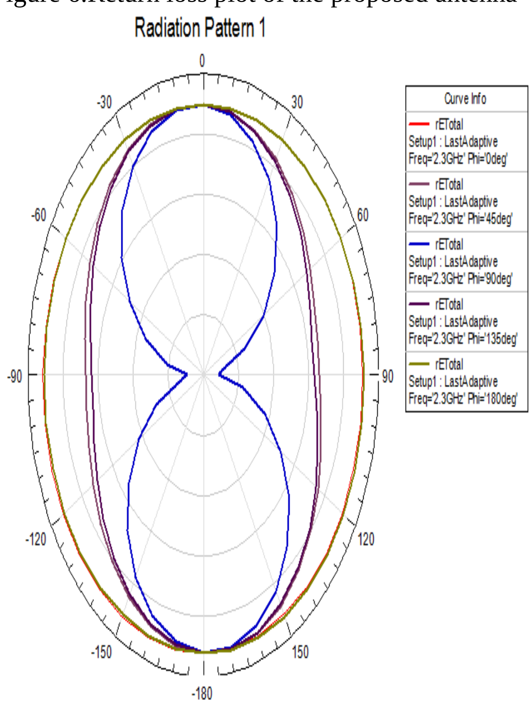

Figure 7. Radiation pattern

The 3D Radiation Pattern for the antenna with 2 L-slot and one E-slot on patch is shown in Figure 7. Basically radiation pattern of the antenna shows its radiation characteristic in the space in which it is radiating the signal. The 2D and 3D Polar and 3D rectangular radiation plot with the field magnitude for the proposed antenna is shown in Figure 8.

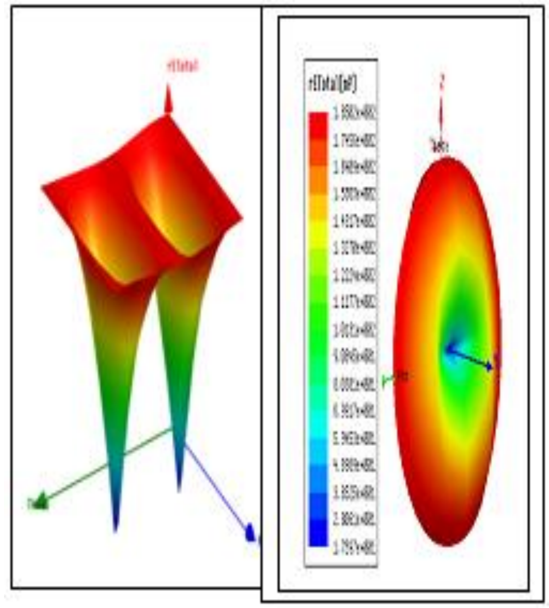

Figure 8. 3-D Radiation pattern

IV. CONCLUSION

Micro strip-fed antenna is designed for a wireless application. The proposed antenna is composed of a pair of symmetrical L- and E-shaped slots inside the rectangular patch that enables proper adjusting of the resonant bands. The proposed antenna can be an excellent choice for WLAN/Wi-MAX applications due to its small size, simple structure, good multi-band characteristics, and omni directional radiation pattern over the aforesaid bands.

Simulation and measured results are in good agreement, and they show that the desired operating bandwidths, gain, and radiation patterns for WLAN (2.4/5.2/5.8 GHz) and Wi-MAX (2.5/3.5/5.5 GHz) applications can be achieved.

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