PRINTED UWB ANTENNA FOR WIMAX /WLAN

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ABSTRACT

Strong subscriber growth over the past year has demonstrated the appeal of WiMAX technology (WiMAX-1 & WiMAX-2) . The IEEE 802.16 working group has been established a new operating band name as Worldwide Interoperability for Microwave access (WiMax). WiMax has three allocated frequency bands. The low band (2.5-2.69 GHz), the middle band (3.2-3.8 GHz) and the upper band (5.2-5.8 GHz). Printed antennas are attractive because their uniplanar architecture which helps to integrated with active devices or MMIC easily. In this paper, a printed small antenna fed by a microstrip line with a rotated square for bandwidth enhancement is proposed and discussed. Field distribution, gain and Impedance characteristics of this antenna are presented and discussed. A simple 50 ohm microstrip line is used to excite the slot. A rotated square slot resonator is considered as reference geometry. By embedding a parasitic patch into the center of the rotated square slot, the lower resonant frequency is decreased and the higher resonant frequency is increased. The measured results demonstrate that this structure exhibits a wide impedance bandwidth, s_{11} < -10 which is over ranging from 2.84 to 6.19 GHz. The parametric analysis of the antenna is done by using Method of Moment based available electromagnetic solver IE3D.

Index Terms: Parasitic Patch, CPW Feed, UWB, Wimax Antenna, Slot Antenna.

I.INTRODUCTION

After the release of Ultra Wideband (UWB) for unlicensed applications by the FCC, it receives much attention by the industries and academia due to its properties of low power consumption, support of high secured data rate and simple configuration [1].WiMAX antennas, just like the antennas for car radio, cell phone, FM radio, or TV, are designed to optimize performance for a given application. Strong subscriber growth over the past year has demonstrated the appeal of WiMAX technology. Now operators are aggressively expanding their networks to keep up with the growth in demand. Operators have moved from the slide deck and vendor selection stage to the more demanding jobs of building networks and signing up customers. A couple of years ago, the focus of operators' attention was on the fundamentals - which type of equipment worked best and how fast the price of subscriber units would decrease. Today operators are asking vendors for a wider variety of devices that will enable them to increase the capacity and reach of their networks, and new base station form factors that will give them the flexibility they need as they expand their networks. They are also experimenting with new services and new ways to reach their subscribers and to make the services more attractive. The fast growth in subscribership and traffic per user demonstrates that WiMAX operators / device manufacturer have got the attention of subscribers in their markets.

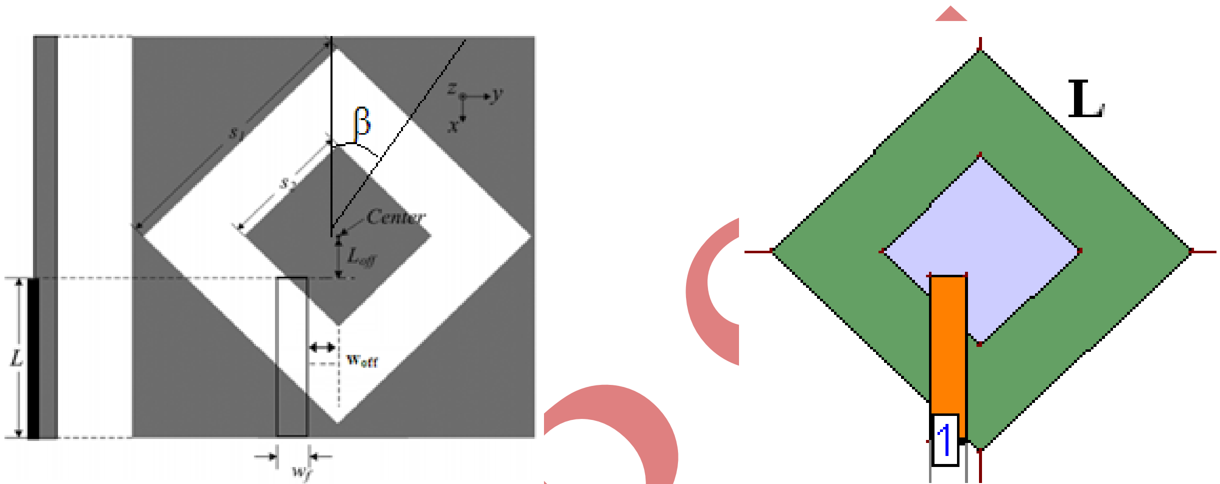

Fig. Geometry and dimensions of line-fed printed square antenna with a rotated slot

Printed antennas are attractive because their uniplanar architecture which helps to integrated with active devices or MMIC easily. Therefore a great interest in various antennas with different feed methods can be seen in the literature [2]–[4]. In recent years, there has been a growing research activity on many microstrip-line-fed printed slot antennas, especially printed wide-slot antennas [5], [6] because of their favorable impedance characteristics. A wide-slot is a slot with an aspect-radio significantly smaller than that of the usual narrow slots, sometimes quite close to 1. B Characteristics of printed wide-slot antennas fed by a microstrip line with different tuning stubs have also been widely studied. In the reported literature [5], a printed wide-slot antenna fed by a microstrip line with a fork-like tuning stub is good for bandwidth enhancement. However, it makes the configuration of the wide-slot antenna more complicated in the design on the feed line. In this paper, a new design of microstrip-line-fed printed wide-slot antennas with a simply rotated slot for bandwidth enhancement is pro-posed and investigated. The rotated slot used in this new design is different from the various microstrip feed lines used in previous research [5]. By choosing a proper rotation angle with respect to the center of square wide slot, it can be expected that the other resonant mode operating near one of the conventional wide-slot antenna can be obtained. Hence within the operating bandwidth, two resonant modes having similar slot radiation patterns and the same polarization planes makes significant bandwidth enhancement of the proposed wide-slot antenna possible. From the experimental results, the obtained impedance band- width (determined from 10 dB return loss) of the proposed antenna can reach about four times that of a conventional microstrip-line-fed printed wide-slot antenna.

II. ANTENNA CONFIGURATION

Fig. 1 shows the geometry and dimensions of the proposed microstrip-line-fed wide-slot antenna. The printed wide slot is chosen to be a square in order to excite two modes with close resonant frequencies. For exciting the operating frequencies at around 4.5 GHz, this printed square slot rotated with a angle has dimensions of 27.4 x 27.4 mm^2 and is printed on an FR4 substrate of thickness 1.6 mm and relative permittivity 4.4. The ground plane is also chosen to be square with a side length of 27.4 mm. In this geometry to enhance the bandwidth we use a parasitic patch and its height is optimized to 2.4 mm.

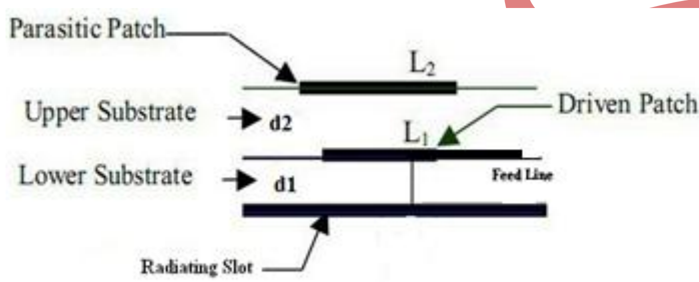

Fig.2. Layered Architecture of Proposed geometry

This square slot is fed by a 50- microstrip line with a simple tuning stub having a straight length of L mm, which is printed on the opposite side of the microwave substrate. For design simplicity, the width of the tuning stub is chosen to be the same as that of the 50 ohm microstrip line. Simulated results show that square slot antennas with various rotated angles need different tuning-stub length (L in Fig. 1) to be matched. The correct values can

III. EXPERIMENTAL RESULTS AND DISCUSSION

In this study, experimental results of gain, impedance and field distribution characteristics of the proposed antenna are simulated by using Method of Moment based available electromagnetic solver IE3D.

3.1 Impedance Characteristics of the Proposed Antenna

The proposed microstrip-line-fed square slot has been constructed and studied by IE3D. By varying the parameters of β and L in Fig. 1, the measured return loss results of several design examples are shown in Fig. 3. This paper uses the structure proposed in [6]-[7] as a reference antenna.

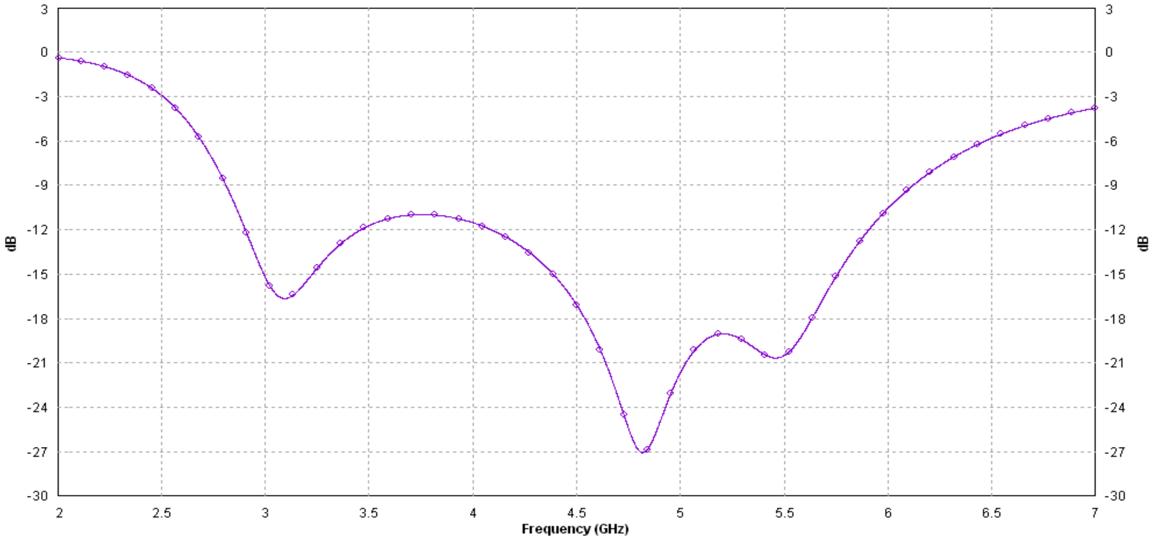

Fig.3. Return Loss of Proposed Geometry with β=45° and L=15

In this section, a parameter study is carried out to understand the effects of various parameters and to optimize the performance of the final design. Fig.3 shows the simulated reflection coefficient for the reference antenna with different ground plane sizes. As proposed in [6]-[7], the same FR4 substrates are used, and the antenna parameters are set identically. The dimensions of the proposed antenna are as follows: s_1= 26.4 mm and feed width w= 3 mm. However, the length of the feed line, L, cannot remain constant as it changes by the size of the ground plane. According to [6]-[7], the rotated square-slot antenna, where rotated G=27.4 mm, has an optimized bandwidth when L= 15 mm and w_{eff} = 3.5 mm. All these values suggest that L_{off} is 3.5 mm and therefore this paper maintains L_{off} , instead of the variable L, at a constant value of 3.5 mm.

3.2 Radiation Characteristics of the Proposed Antenna

The proposed antenna with various parameters of β and L shows the same radiation characteristics, and thus only those of the proposed antenna with β =45 and L =15 mm are plotted by E- and H-planes here. Fig.8. show typical measured radiation patterns of this antenna at the operating frequencies 3250, 4500, 5800 MHz respectively. Note that a printed antenna without a reflecting plate is a bi-directional radiator, so the radiation patterns on both sides of this antenna are similar. From these results, it can be seen that the operating frequencies across the impedance bandwidth of this antenna within 3000–6000 MHz have same polarization planes and similar broadside radiation patterns.

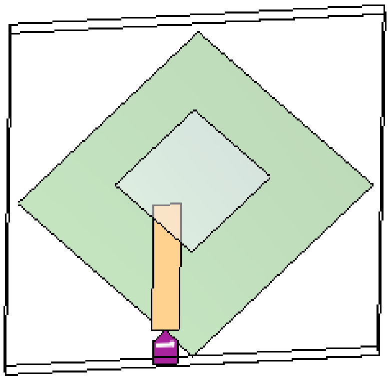

Fig.4. Proposed Geometry (3D View)

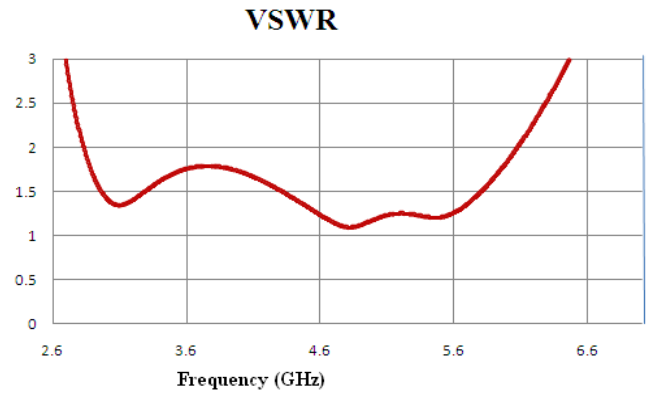

Fig.5. VSWR of proposed Geometry

From the obtained results, it can be seen that the proposed antenna with β = 45 and L =15 mm has an large impedance bandwidth. Generally, the bandwidth of the wideband antenna decreases as the ground plane size decreases. Therefore, the overall size of the antenna, including the ground, will likely be fairly large in order to have broadband characteristics; this serves as an obstacle in making compact antennas with broadband characteristics. The proposed structure may be used as a compact-sized broadband antenna, as its bandwidth increases even though the size of the ground is smaller. However, it is reasonable to infer that the antenna performances are influenced by the mounting support as well as the antenna surroundings. Thus, there may be some limitation for the proposed design.

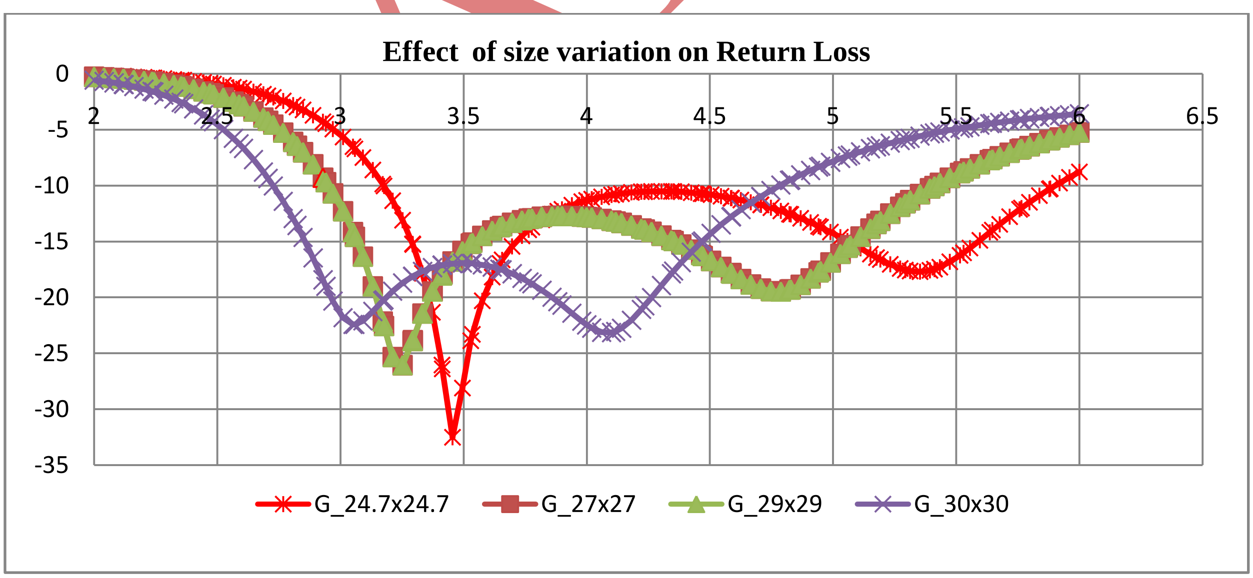

Fig.6. Effect of size variation on Impedance bandwidth

3.3 Gain Characteristics of the Proposed Antenna

A wide-band antenna can usually provide larger operating impedance bandwidth than other types. For example, the proposed printed wide-slot antenna with β=45 and L =15 mm in Fig. 1 has an impedance bandwidth as large as 3000 MHz. In the broadside direction, it is possible that the gain drop across the whole impedance bandwidth from 3000 to 6000 MHz cannot maintain the same level.

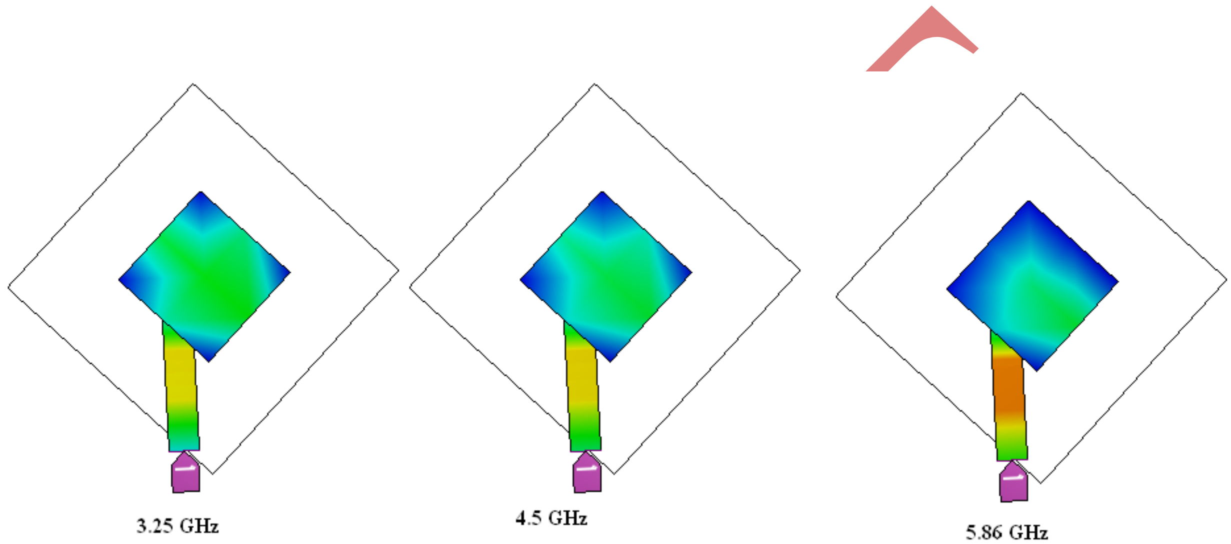

Fig.7. Current distribution over Patch

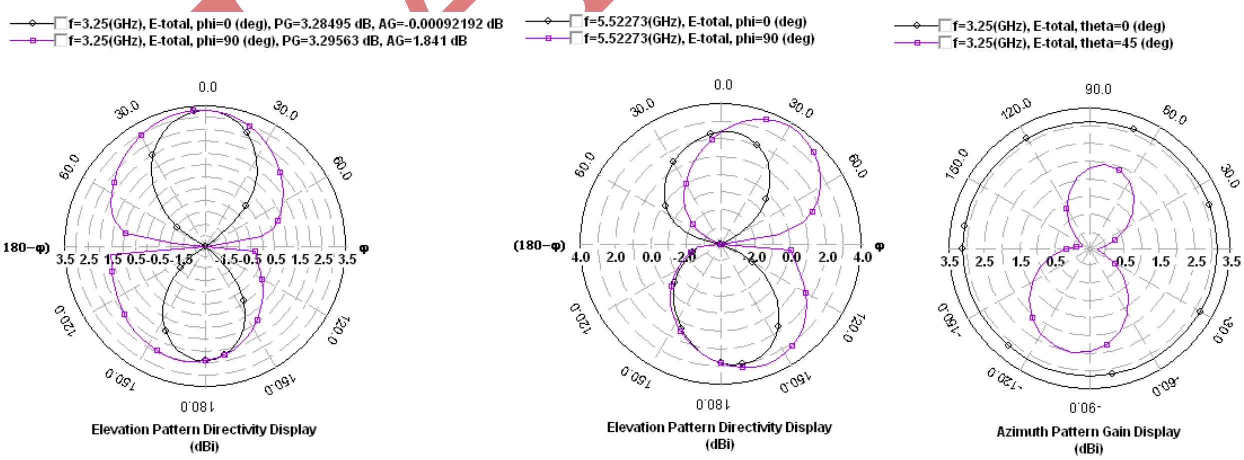

Fig.8. Simulated H-plane and E-plane radiation patterns for the antenna with β =45 and L =15 mm at different frequency

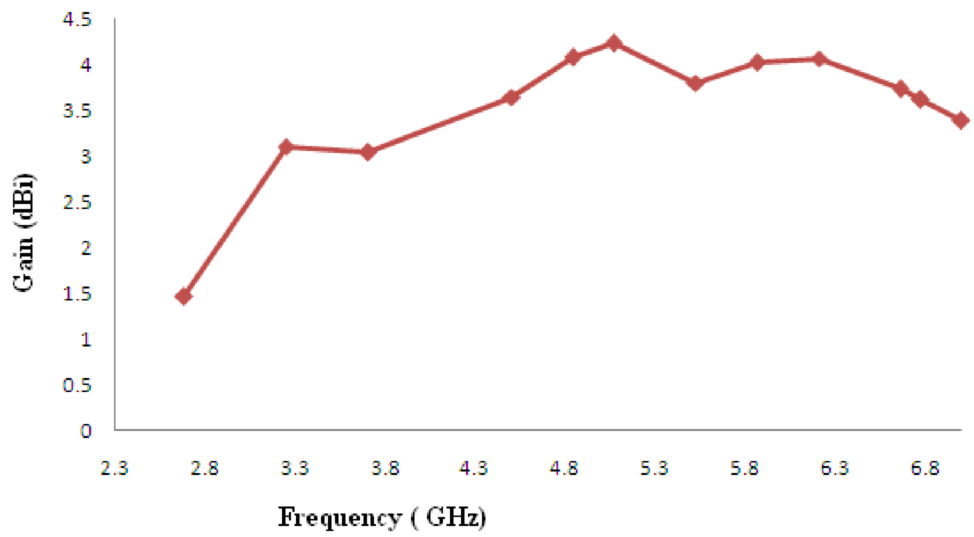

Fig.9. Gain of the proposed antenna with =45 and L= 15 mm at different frequency

IV. CONCLUSION

A printed wide rotated slot antenna fed by a 50- microstrip line with a rotated square wide parasitic patch for bandwidth enhancement has been demonstrated. Several design examples have also been implemented. Experimental results show that the impedance bandwidth of a proposed antenna can be improved by rotating a suitable angle of the square slot. For the optimized antenna parameters β is selected from 40^0 to 50^0 and L =14 to 17mm mm in this study, the impedance bandwidth determined by 10 dB return loss can reach nearly 2.84 GHz for the proposed antenna with designed operating frequencies around 4.5 GHz, which is about four times that of the corresponding conventional printed microstrip-line-fed wide-slot antenna. Within this wide impedance bandwidth gain is greater than 2 dBi. In addition, the proposed printed wide-slot antenna shows a very wide 10-dB return-loss impedance bandwidth of about 3 GHz (about 2840–6000 MHz).

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