Rectangular Ring Antenna Fed by Broadband Electric Probe above Elliptical Reflector for WiMAX Systems

[#]S. Kosulvit[1], S. Vongsack[2], S. Lamultree[3], K. Phaebua[2], T. Pumpoung[2], P. Keowsawat[4], K. Chawanonphithak[5], C. Phongcharoenpanich[2] and M. Krairiksh[2]

[1]Leo Technology and Marketing Co., Ltd and T.M. Metal Work Co., Ltd.
[2]Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Thailand.
[3]Faculty of Engineering and Technology, Asian University, Thailand.
[4]Faculty of Industrial Technology, Rajabhat Phetchaburi University, Thailand.
[5]Faculty of Industrial Technology, Nakhon Ratchasima Rajabhat University, Thailand.

1. Introduction

Low-profile antennas are especially suitable for modern mobile devices: for instance, handheld and laptop computers having a Wireless Local-Area Network (WLAN) module supporting a Worldwide Interoperability for Microwave Access (WiMAX) [1], [2] function. This can keep with the current trend and it is treated as an extension and upgrade to the WLAN module. For these devices, it is usually necessary for the antenna to have multiple impedance-matching bands, such as 2400–2484 MHz (specified by IEEE 802.11b/g) and 2500–2569 MHz (specified by IEEE 802.16e). Recently, antenna designs for WiMAX application have been proposed and studied in literature [3]. A large number of such antennas have been proposed and it is often with size that may be too large for practical installation. In literature, some ring antennas had also been proposed [4]-[6]. The rectangular ring antenna is one of good choices of the compact and simple structure. This paper proposes a rectangular ring antenna fed by broadband electric probe above an elliptical reflector for applying as an antenna at the base station of WiMAX systems. The basic configuration of the proposed antenna is first presented. The impedance bandwidth in terms of $|S_{11}|$ as well as gain, and radiation pattern at the selected frequency for WiMAX systems are investigated by using the CST Microwave Studio [7]. The prototype antenna was fabricated and measured to verify the simulation results. It is found that the simulated and measured results are in good agreement. The proposed antenna is a suitable candidate for WiMAX base station systems.

2. Antenna Design

The structure of a rectangular ring antenna fed by broadband probe above an elliptical reflector is shown in Fig. 1. It consists of an electric probe, of the length of l aligned along z axis, with coin-stub of radius a_c for impedance matching, surrounded by rectangular ring with the width of a, the height of b and the length of c, respectively. The thickness of rectangular ring is t. The rectangular ring is placed above an elliptical reflector with the distance d. The major and minor axes of the elliptical reflector are denoted by H and W, respectively. The antenna is fed via coaxial transmission line with characteristic impedance of 50 Ω. To investigate the appropriated antenna parameters for applying in WiMax system operating from 2 GHz to 3 GHz, the CST Microwave Studio is used as the simulation tool. The design parameters of the proposed antenna are shown in Table 1.

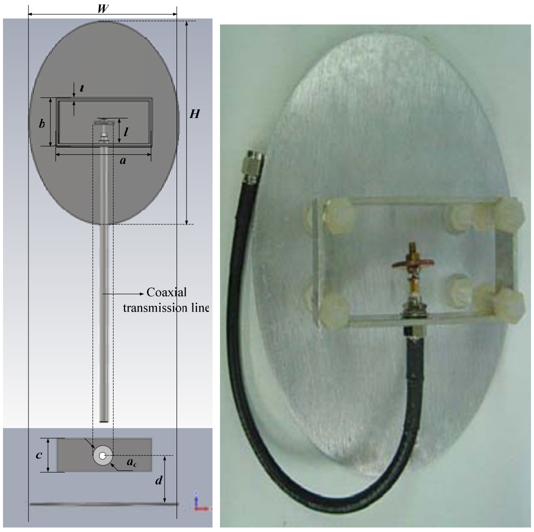


Figure 1. Antenna structure.

Table 1: Design parameters

Parameters	Physical size (mm)
a	76.0
b	38.5
c	16.0
t	2.0
l	26.0
a_c	16.0
W	120.0
H	163.0
d	38.0

3. Results

The simulated and measured results are reported in this section. Fig. 2 shows the impedance characteristics in term of $|S_{11}|$ versus frequency. It is found that the simulation and measurement provide impedance bandwidth for $|S_{11}| < -10$ dB covering the frequency from 2.0 GHz to 3.0 GHz. In addition, the curve of simulated and measured gains against frequency from 2.0 GHz to 3.0 GHz is shown in Fig. 3. Apparently, at the frequency 2.3 GHz, 2.4 GHz, 2.5 GHz, 2.69 GHz, the proposed antenna provides the maximum gain of 8.34 dBi, 8.47 dBi, 8.0 dBi, and 7.81 dBi, respectively. Furthermore, the radiation patterns of the antenna are shown in Figs. 4 to 5. It is found that the antenna provides the unidirectional beam with linear polarization, because the cross-polarization at each selected frequency is better than 20 dB at the broadside direction. The back lobe ratio at the selected frequency is better than 20 dB. Moreover, the simulated half-power beamwidth (HPBW) in yz -plane is 59.6º, 62.5º, 73.8º, and 73.8º at the frequency of 2.3 GHz, 2.4 GHz, 2.5 GHz, and 2.69 GHz, respectively. The simulated HPBW in xz -plane is 71.3º, 71.3º, 73.8º, and 85.7º at the frequency of 2.3 GHz, 2.4 GHz, 2.5 GHz, and 2.69 GHz, respectively. Therefore, from the results, it can be observed that the simulation is agreed with that measurement. Furthermore, both simulation and measurement provide a unidirectional pattern which in good agreement.

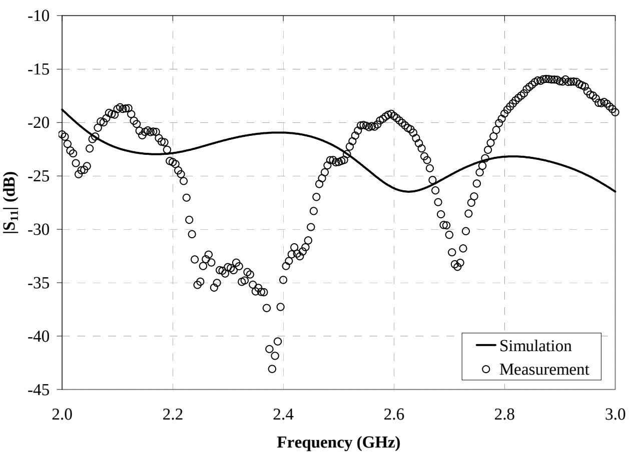


Figure 2. |S11| versus frequency

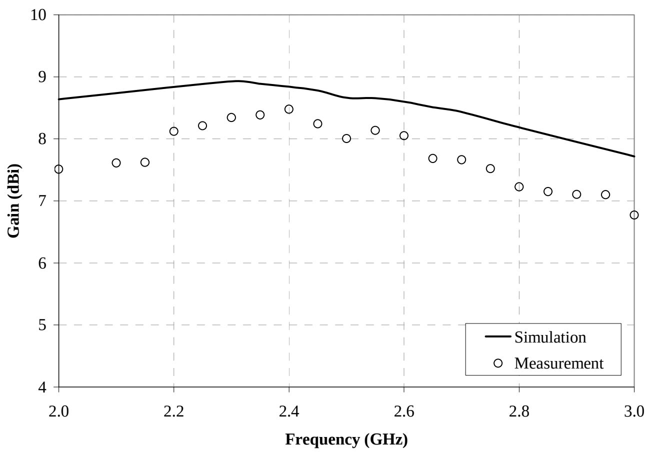
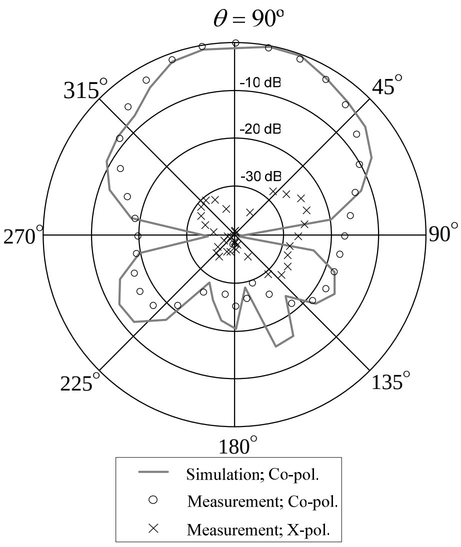
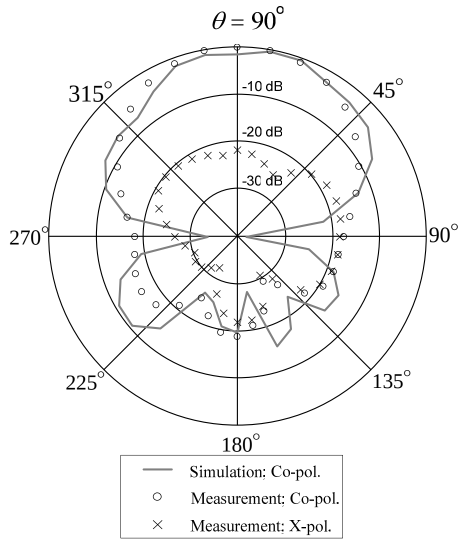


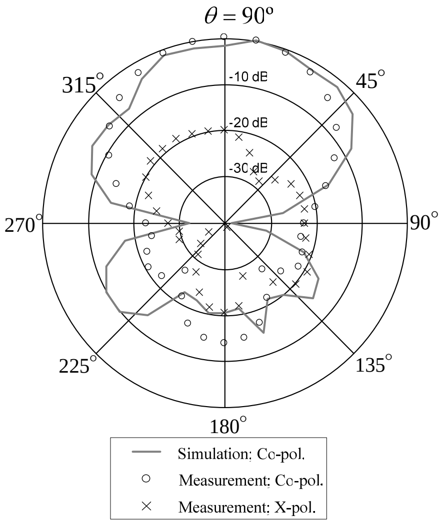
Figure 3. Gain versus frequency



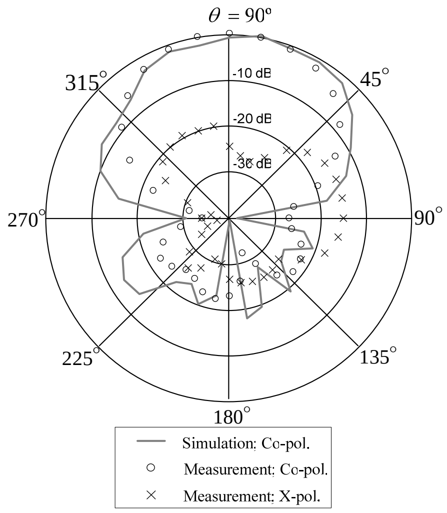
(a) 2.3 GHz



(b) 2.4 GHz

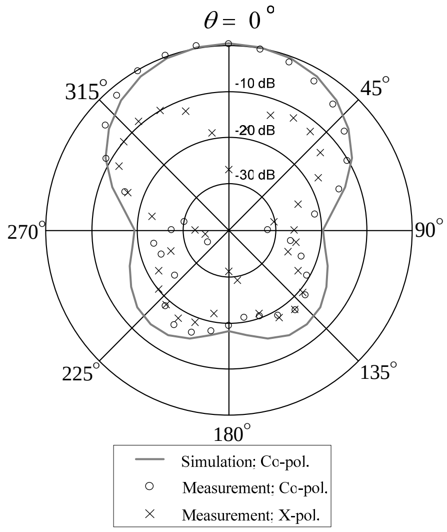


(c) 2.5 GHz

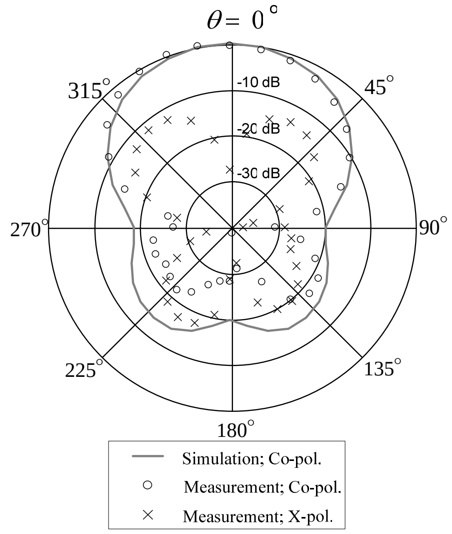


(d) 2.69 GHz

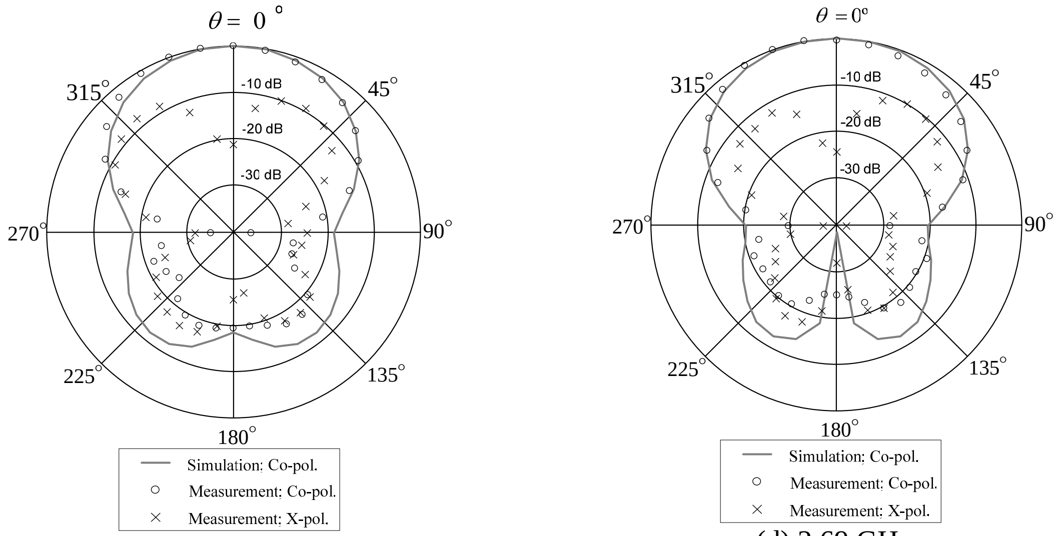
Figure 4. The simulated and measured patterns in YZ-plane



(a) 2.3 GHz



(b) 2.4 GHz



(c) 2.5 GHz (d) 2.69 GHz

Figure 5. The simulated and measured in XY-plane

4. Conclusion

A rectangular ring antenna fed by broadband electric probe above an elliptical reflector is proposed for applying for WiMAX application. It is found that the proposed antenna provides a unidirectional pattern with front-to-back ratio better than 20dB. Furthermore, the simulated and measured impedance bandwidths of 40% ($|S_{11}| < 10$ dB) ranging from 2.0 GHz to 3.0 GHz. The simulated and measured gains of 8.84 dBi and 8.47 dBi at the frequency of 2.4 GHz are yielded. From, the simulation and measurement, the results are in good agreement. Moreover, the proposed antenna with the advantages of compact size and good radiation performance can be promised for WiMAX application as well.

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