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Proximity Coupled Equilateral Triangular Microstrip Antenna for Mobile WiMax IEEE 802.16

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Abstract: **This Paper presents the proximity coupled equilateral triangular microstrip antenna. The proximity-coupled antenna is simpler in design with low fabrication cost. The main objective of this paper is to design microstrip antenna for WiMax application using equilateral triangular patch. The antenna consists of two substrates made up of glass epoxy material with different thickness h_1 and h_2 as 0.08 cms and 0.16 cms respectively. The experimentally measured and calculated antenna parameters such as return loss, VSWR, radiation pattern, gain and HPBW are presented.**

Key Words: **Microstrip patch antenna, Proximity coupled, Substrate thickness, HPBW, Gain and VSWR.**

1. INTRODUCTION:

In the recent years in modern communication, antennas are the most important components required to create a communication link. The Worldwide Interoperability for Microwave Access (WiMAX) technology is most rapidly growing area in the modern wireless communication.

Through the years, microstrip patch antenna structures are the most common option used to realize with monolithic integrated circuits for microwave, radar and communication purposes. The shape and operating mode of the patch are selected, designs become very versatile in terms of operating frequency, polarization pattern and impedance. [1]

A configuration of non-contacting non-coplanar microstrip line fed antenna uses a two layer substrate with the microstrip line on the lower layer and the patch antenna on the upper layer. The feed-line terminates underneath the patch. This feed is better known as an “electromagnetically coupled” microstrip feed. Coupling between the patch and microstrip is capacitive in nature. [2]

2. ANTENNA DESIGN:

The proposed antenna is designed for the frequency of 3.3 GHz using the relations presented in the literature for the design of equilateral triangular microstrip antenna.[1] A low cost glass epoxy substrate material of different thickness with same dielectric constant ε_r = 4.2 is used to fabricate the antenna. [3]

The geometry of proximity-coupled equilateral triangular microstrip antenna is shown in Fig. 1. An equilateral triangular radiating patch with length ‘a’ is etched on top surface of substrate 1. [4] The value of ‘a’ is obtained from the equation;

$$a = \frac{2C}{3 f_r \sqrt{\varepsilon_r}}$$

where C is the velocity of light and f_r is the resonating frequency. The microstripline feed of length L_f and width W_f is etched on the top surface of substrate 2. The substrate 2 is placed below substrate 1 such that the tip of the feedline and the center of the radiating patch coincide one over the other. The bottom surface of the substrate 2 acts as the ground plane. The dimensions of the ground plane L_g and W_g are calculated from equation;

$$Wg = Lg = 6h + a$$

The thicknesses ‘h’ of substrates 1 and 2 are different. The proposed antenna is sketched using the computer software AUTOCAD to achieve better accuracy. The antenna is fabricated using the photolithography process. The dimensions of the proposed antenna are shown in Table 1.

Fig-1: Geometry of proposed antenna

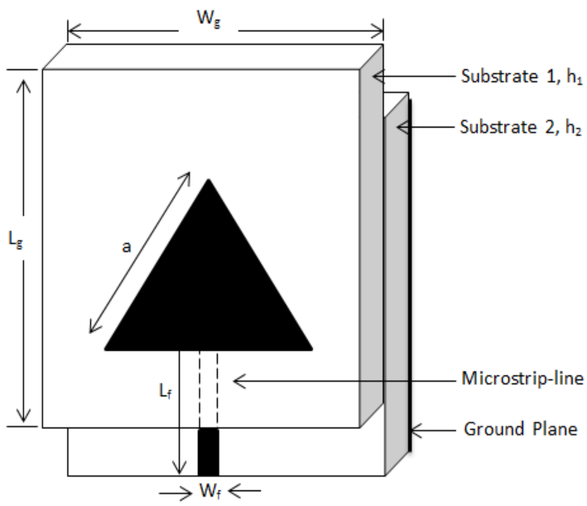

Table-1: Various dimensions of antenna

Dimensions	Value in cms.
Side length of equilateral triangle (a)	2.76
Length of the feed line (L_f)	1.24
Width of the feed line (W_f)	0.31
Length and width of the ground plane (L_g, W_g)	3.69
Thickness of substrate 1 (h_1)	0.08
Thickness of substrate 2 (h_2)	0.16

3. EXPERIMENTAL RESULTS AND DISCUSSION:

The reflection coefficient and input impedance are measured with the help of Vector network Analyzer (Rohde & Schwarz, German make ZVK Model No. 1127.8651).

The impedance bandwidth over return loss less than -10 dB for the proposed antenna is measured. The variation of return loss versus frequency of antenna is shown in Fig. 2.

From the graph it is observed that, the antenna resonates at 3.33 GHz with impedance bandwidth of 50 MHz (1.50%). The minimum return loss measured is found to be -16.44 dB.

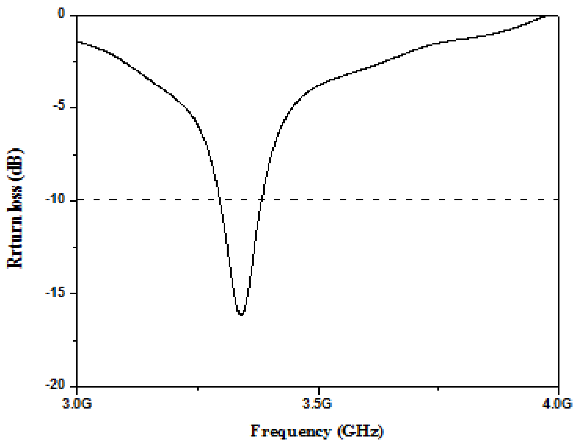

Fig-2: Measured Return loss Vs. Frequency graph

The VSWR of the proposed antenna is shown in Fig. 3 and is found to be 1.24.

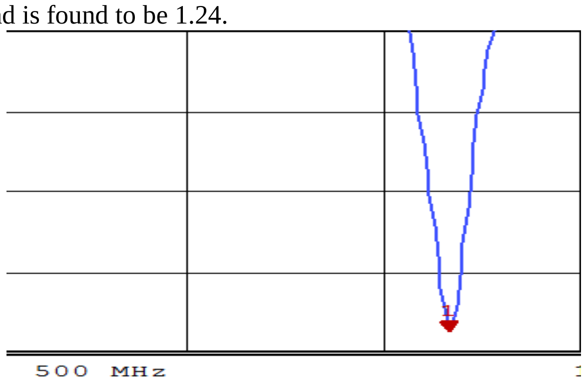

Fig-3: VSWR

The X-Y plane co-polar and cross-polar radiation pattern is measured at resonating frequency and is shown in Fig. 4. From the figure, it is clear that the antenna shows broad side radiation characteristics with cross-polarization level less than -11 dB. Further the calculated HPBW is found to be 99^0.

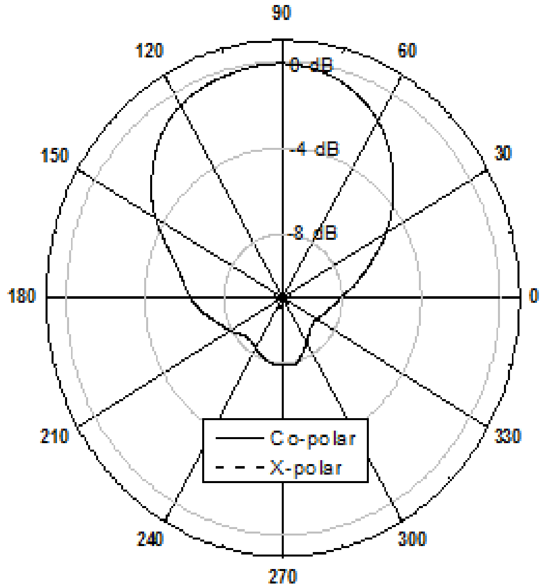

Fig-4: Radiation pattern at 3.33 GHz

The gain of proposed antenna is calculated using absolute gain method given by the equation, [5]

$$G(dB) = 10\log\left(\frac{P_r}{P_t}\right) - (Gt)dB - 20log\left(\frac{\lambda_0}{4\pi R}\right)dB$$

Where, P_t and P_r are transmitted and received powers respectively, G_t is the gain of the pyramidal horn antenna and R is the distance between transmitting antenna and antenna under test. The calculated gain of the antenna is 2.47 dB.

4. CONCLUSIONS:

The detailed experimental study shows that the antenna is quite simple in design and fabrication. The antenna gives required bandwidth and gain with broadside radiation pattern at the resonating frequency. The antenna is also superior as it uses low cost substrate material and finds applications in Worldwide Interoperability for Microwave Access (WiMAX) technology such as Mobile IEEE 802.16.

5. ACKNOWLEDGEMENT

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