PROXIMITY COUPLED RECTANGULAR MICROSTRIP PATCH ANTENNA FOR S-BAND APPLICATIONS

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Abstract

Microstrip antennas have been one of the most featuring topic in antenna theory and design in recent years, and are progressively more finding application in a wide range of modern communication systems. In this study a microstrip antenna has been designed using proximity coupled feeding technique. The proposed antenna uses two layered substrate, such as the patch antenna on upper layer and the microstrip feedline on the lower layer. The study is made using the thickness of the substrate material. The experimental result shows that the Proximity coupled Rectangular Microstrip Antenna (PRMSA) gives an impedance bandwidth of 3.97% (110MHz) and 17.17% of gain. Also the other antenna parameters such as radiation pattern, reflection coefficient, VSWR and HPBW are calculated and discussed.

Keywords: *Rectangular microstrip patch, proximity feed, impedance bandwidth, gain.*

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1. INTRODUCTION

In the present day's communication, antennas cover a very large range of applications in various areas, like mobile communication, internet services, satellite navigation, automobiles and radars. Particularly, they are applied to microstrip antennas, due to its characteristics like low profile, lightweight and low power handling capacity [1-4]. Though, bandwidth and gain are sometimes low and not sufficient in most of applications. Alteration of shape and using special materials could be useful to solve such backlashes of this type of antennas. WiMAX (Wireless Interoperability for Microwave Access) is one of the latest wireless technologies. This technology can be used in numerous numbers of applications: the broadband services such as Voice over IP (VOIP), portable mobile connectivity, Digital Subscriber Line (DSL), etc [5].

Basically a microstrip antenna consists of a planar radiating design of desired geometrical shape on one side of a dielectric substrate material and a ground plane on the other. Generally preferred microstrip radiating geometries are rectangular and circular [6]. Still, other shapes are also considered depending upon the applications.

To connect power to a microstrip antenna is as important as the selection of a suitable geometry for a particular application. There are different types of feeding mechanisms are available and some vital among them are Microstrip feed, Co-axial feed, Aperture coupling feed and Proximity coupling feed. The Proximity coupling feed technique is used for the proposed microstrip antenna. It uses a two – layer substrate with the patch antenna on the upper layer and the microstripline feed on the lower layer. The feed line finishes in an open end underneath the patch [6].

2. ANTENNA DESIGN

The Proximity-coupled Rectangular Microstrip Antenna (PRMSA) is fabricated with a commercially obtainable low cost glass epoxy substrate material with relative permittivity εr= 4.2 and dielectric loss tangent tan δ = 0.02.

Figure 1 shows the top view geometry of PRMSA. It consists of a length L and width W is etched on upper top surface of substrate S_1. And the length L_f and width W_f of microstripline feed is etched on the upper top surface of substrate S_2. Thus the substrate S_2 is situated beneath substrate S_1 and the bottom surface of the substrate S_2 performs as the ground plane.

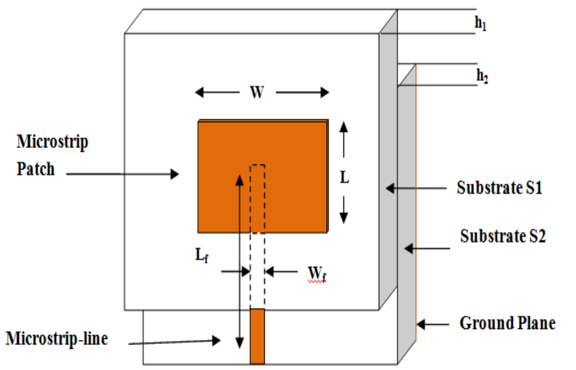

Fig -1: Geometry of PRMSA

The PRMSA has been designed for 3 GHz. The physical dimension of rectangular radiating patch and feedline are approximately determined from equations [1] and the dimensions are presented in the Table-1.

Table -1: Designed parameters of proposed antenna

Antenna Geometry Parameters	Dimensions
Length of the patch, L	24.34mm
Width of the patch, W	31.00mm
Length of feedline, L_f	12.86mm
Width of feedline, W_f	6.33mm
Thickness of the substrate	S1=3.2mm & S2=1.6mm

3. EXPERIMENTAL RESULTS

The measurements are taken on Vector Network Analyzer ({VNA} Rohde & Schwarz, German make ZVK Model No. 1127.8651). The deviation of return loss versus frequency of PRMSA with thickness of substrates S1=3.2mm & S2=1.6 mm by keeping the same permittivity which is shown in Figure 2. The impedance bandwidth over return loss less than -10dB is measured. The experimental impedance bandwidth is defined as,

$$\text{Impedance Bandwidth (\%)} = \left[\frac{f_H - f_L}{f_C}\right] \times 100 \text{ .... (1)}$$

Where, f_H is the higher cutoff frequency and f_L is the lower cutoff frequency and f_C is central frequency of the bands.

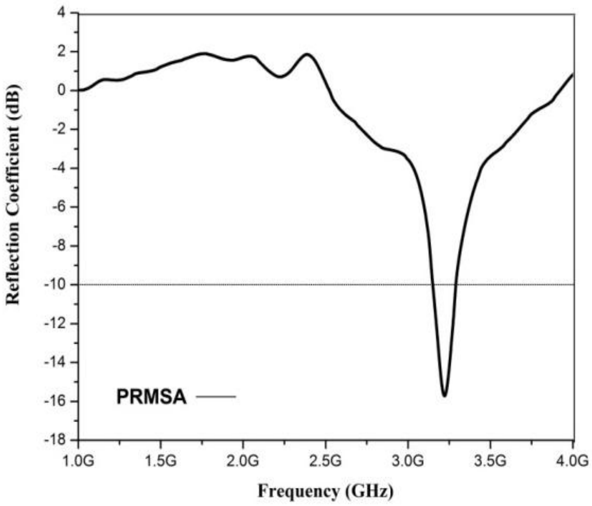

Fig -2: Deviation of Return loss Vs Frequency of PRMSA

As of the figure is observed, PRMSA with Substrate height (S1 = 3.2 mm & S2 = 1.6 mm) operates at 2.76 GHz and impedance bandwidth is found to be **110 MHz (3.97%),** which is 1.22 times more when compared with the antenna with Substrate height (S1 = 1.6 mm & S2 = 1.6 mm). Further, the minimum return loss measured in this antenna is -15.75 dB.

The co-polar and cross-polar radiation pattern of PRSMA is measured at X-Y plane at their resonating frequency and is depicted in Figure 3. The figure indicates that the antenna shows broader side radiation characteristic. The cross-polarization level of this antenna is found to be minimum which is below -11dB as shown.

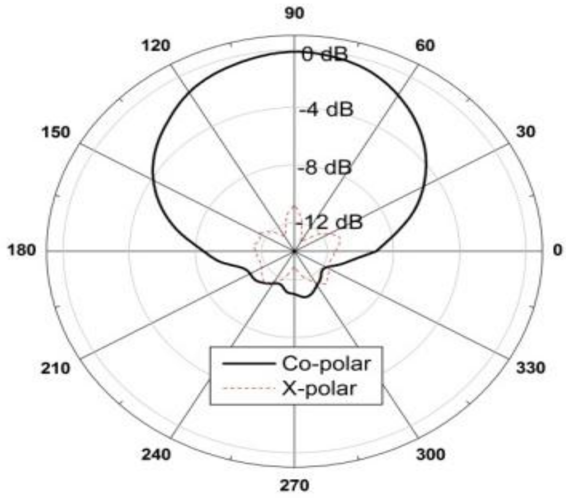

Fig -3: Radiation pattern at 2.76 GHz

The half power beam width (HPBW) for the proposed antenna is calculated for their resonating frequency and is also shown in Table 2.

The gain of proposed antenna is calculated with fixed gain method given by the equation, [6]

$$G(dB) = 10\log\left(\frac{P_r}{P_t}\right) - (Gt)dB - 20log\left(\frac{\lambda_0}{4\pi R}\right)dB \ldots (2)$$

Where, Pr and Pt are received and transmitted powers respectively, *Gt* is the gain of the pyramidal horn antenna and R is the distance between antenna under test and transmitting antenna. The gain of the antenna is tabulated in Table 2.

Table -2: Calculated Min. cross polar, Gain, HPBW and VSWR

Substrate Height	Freq. in GHz	Min. Cross polar in dB	Gain in dB	HPBW in degrees	VSWR
S1=3.2mm S2=1.6mm	2.76	-11	17.17	77^0	1.81

The antenna shows the input impedance which contains a loop at the middle of Smith chart which illustrates the matching of the feedline and radiating patch at 50Ω [7] which is shown in Figure 4.

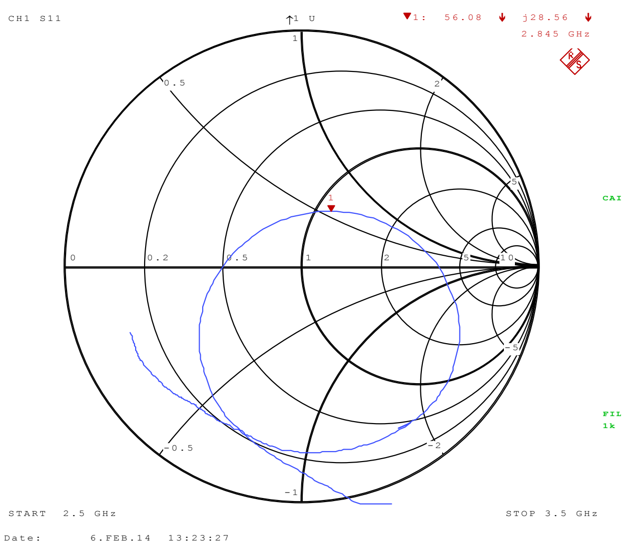

Fig -4: Smith chart profile

4. CONCLUSION

The entire experimental study illustrates that the antenna is relatively simple in design and fabrication and quite fine in enhancing the bandwidth and gives super broadside radiation pattern at the resonating frequency also the gain is found to be better as the thickness of antenna is increased. This antenna is also better as it uses low-priced substrate material and find the applications in S-band frequency range such as in modern wireless communication systems.

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