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Bandwidth Enhancement Technique For Microstrip Patch Antenna For WLAN Application

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ABSTRACT
This communication presents a method to enhance the bandwidth of microstrip antenna by cutting a slot in the patch. Firstly, an antenna using inset microstrip line feed is designed for 5.2 GHz WLAN application. The bandwidth of antenna is found to be 170 MHz; which increases to 236 MHz when a rectangular slot is cut from the patch. The directivity of both the antennas resonating at 5.2 GHz is found to be 5.89 dB. CST studio is used as the software tool. Duroid substrate having a dimension of 28 mm ×36 mm×1.604 mm is used as the base of the antenna, giving the volume of the antenna to be 1.616cm^3. Thus, this volume makes the antenna suitable for WLAN application.
***Keywords**:* Directivity, Duroid, Microstrip, Resistance, Wireless Local Area Network (WLAN).

I. INTRODUCTION

Microstrip is probably the most successful and revolutionary antenna technology. Its success stems from very-well-known advantageous and distinctive properties, such as a low profile, light weight, planar structure (but also conformal to non-planar configurations), mechanical robustness, easy (simple and low-cost) fabrication, easy integration of passive and active components, easy incorporation in arrays, and notable versatility in terms of electromagnetic characteristics (resonant frequency, input impedance, radiation pattern, gain, polarization).

Primary barriers to implement patch antennas in modern broadband communication system applications are their narrow bandwidth. The microstrip antennas are often realized with bandwidth of the order of 1% to 5% [1] [2]. Bandwidth enhancement technique is one of the areas of research in the field of microstrip antennas. Basically the bandwidth is defined more concisely as a percentage (f/ f0) × 100%, where f and f0 respectively represent the width of the range of acceptable frequencies and the resonant frequency of the antenna. The parameters such as radiation efficiency, return loss, and voltage standing wave ratio (VSWR) are often used to define the bandwidth of a microstrip antenna [3]. This paper experimentally investigates an alternative approach in enhancing the bandwidth of microstrip antenna for the Wireless Local Area Network (WLAN) application operating at a frequency of 5.2 GHz. The result of this paper will show that enhancement of the original bandwidth can be achieved by using slot with proper position selection. The bandwidth, gain and radiation pattern are evaluated using CST software.

II. LITERATURE REVIEW

Microstrip patch antenna consists of a radiating patch which is generally made of conducting material such as gold or copper and can take any possible shape [9]. The radiating patch and the feed lines are usually photo etched on the dielectric substrate which has a ground plate as shown in Fig. 1. In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical in shape.

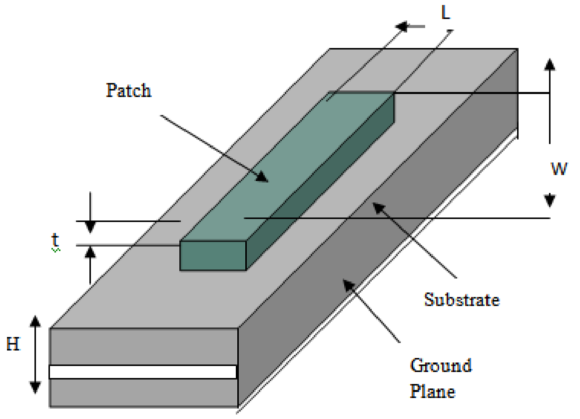

Figure 1: Structure of Microstrip patch antenna

For a rectangular patch, the length L of the patch is usually 0.333λo < L< 0.5λo, where λo is the free space wavelength. The patch is selected to be very thin such that the patch thickness t<<λo. The height h of the dielectric constant of the substrate (Ɛr) is typically in the range 2.2 ≤ Ɛr ≤ 12. The microstrip patch antenna radiates primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, the choice of substrate used is an important factor. There are numerous substrates that can be used for the design of microstrip antennas within the dielectric constants range of 2.2 ≤ Ɛr ≤ 12. The low dielectric constant Ɛr is about 2.2 to 3, the medium around 6.15 and the high approximately above 10.5 [4] [5]. 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 microstrip patch antenna, substrate with higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence, a trade-off must be realized between the antenna dimensions and antenna performance [6] [7] [8].

III. PROPOSED METHODOLOGY

Firstly, an antenna using inset microstrip line feed will be designed for 5.2 GHz WLAN application. The specifications of the antenna are calculated as per the requirement. The parameters then used are shown in Table 1. Further we cut a rectangular slot from the patch and analyse the return loss graph to measure the bandwidth difference between antenna without slots and the one with slots. Directivity will also be studied on the CST studio. CST studio will be used as the software tool.

Table 1: Microstrip antenna parameters used

Name	**Value**
Fi	4.5
Gpf (Gap between patch and feed)	1.49
L(Length of patch)	12
Lf (Length of feed)	11
Mt (Thickness of copper layer on FR4 substrate)	0.1
W(Width of patch)	17.7
Wf(Width of feed)	3
H (Thickness of substrate)	1.6

IV. ANTENNA GEOMETRY

4.1 Without Slot Geometry

Fig 2 shows a basic microstrip antenna. Ground plane is actually beneath the patch but it is shown above the substrate, as the figure depicts a 3D antenna.

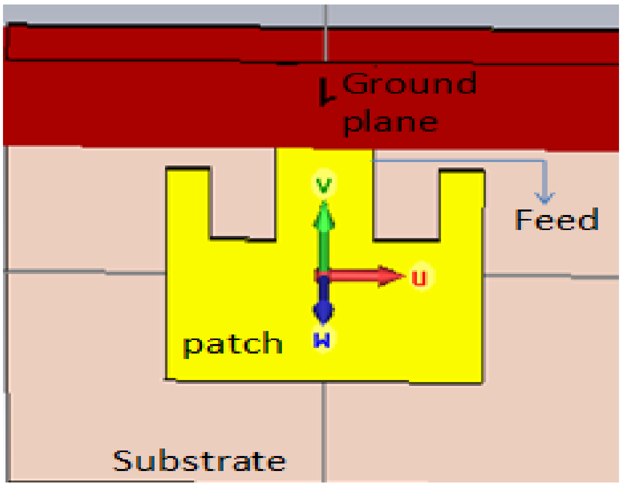

Figure 2: Microstrip antenna without slot

4.2 Slot Geometry

In Fig. 3, a rectangular microstrip antenna is shown after the introduction of slot. The dimensions of the slot are

U_{min} = -1
U_{max} = +1
V_{min} =-4
V_{max} =+4

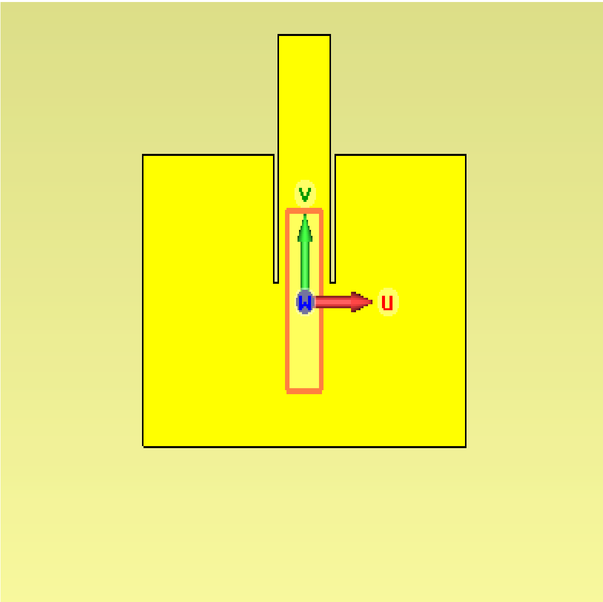

Figure 3: Microstrip antenna with slot

V. RESULT AND DISCUSSION

a. Return Loss

The return loss is a way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. The relationship between VSWR and return loss is as follows [7]. In Fig 4, we see the return loss graph, where the dip is greater in case of antenna with slot.

$$Return\ loss\ in\ dB = 20\log_{10}\frac{(VSWR)}{(VSWR-1)} \quad (1)$$

The bandwidth difference increases from d= 0.1684 to d=0.2303 on introducing the slots in microstrip patch antenna.

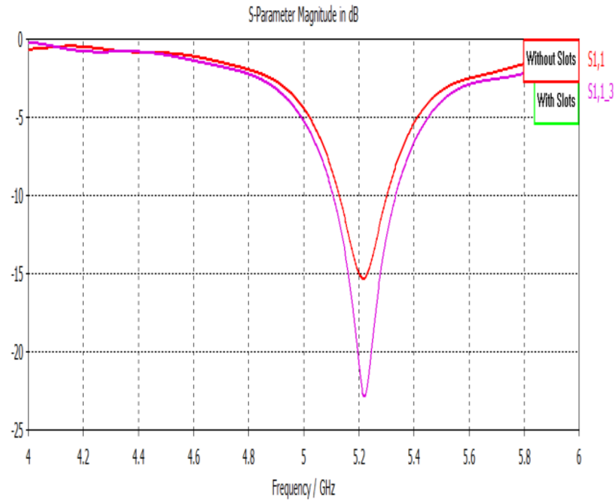

Figure 4: Simulated Return Loss Graph with and without slots.

5.2 Directivity

Directivity may be defined as the ratio of maximum radiation intensity of the test antenna to its average radiation intensity. Alternatively, Directivity is the ratio of maximum radiation intensity of the subject antenna to the radiation intensity of an isotropic antenna radiating the same total power. The directivity is fairly insensitive to the substrate thickness [8-9]. It is higher for lower permittivity, because the patch is larger.

The directivity plots with and without slots are shown in Fig. 5 and Fig. 6 respectively.

5.2.1 Antenna without slots

As in Fig. 5, at frequency 5.2 GHz, Main lobe magnitude comes out to be 6.9dBi. Main lobe direction and angular width are 1.0 degree and 97.4 degree respectively. The side lobe level is found to be -13.4dB.

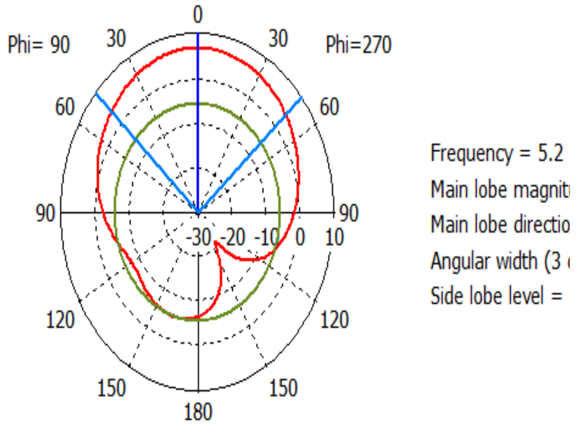

Figure 5: Plot of Theta/Degree vs. dBi

5.2.2 Antenna with slots

Now, in Fig. 6 we see that on the introduction of slots, at the same frequency, that is, 5.2 GHz, main lobe magnitude becomes 6.9dBi, main lobe direction 1.0 degree, angular width 97.1 degree and side lobe level 13.4dB.

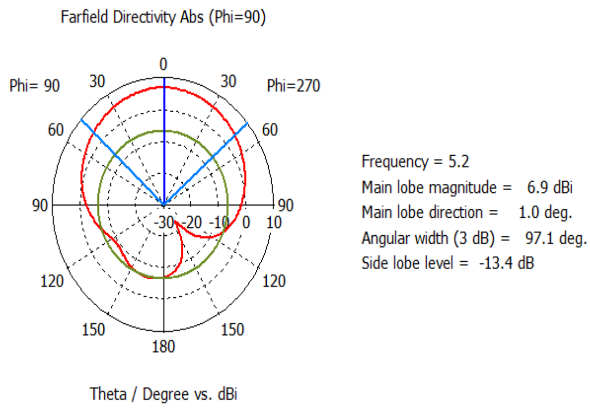

Figure 6: Plot of Theta/Degree vs. dBi

VI. CONCLUSION

The microstrip patch antenna has restricted and narrow bandwidth. We used slot cutting technique to increase the bandwidth. The results obtained clearly show that the bandwidth of the microstrip antenna increases on the introduction of slots and it can be used for WLAN applications. The advantage of this technique is that it does not increase the lateral size of the microstrip antenna. However, the height of microstrip antenna is increased.

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