Bandwidth Enhancement of Rectangular Patch Microstrip Antenna

Prof. Ahmad H. Al-Shaheen (Ph. D.) and Yahiea Al-naiemy

Physics Department
College of Science, Misan University
Misan, Iraq
prof.dr.ahmad@uomisan.edu.iq

Computer Science Deptartment
College of Science, Diyala University
Diyala, Iraq
yahiea_1971@yahoo.com

Abstract-

The microstrip antennas are often realized with bandwidth (BW) of the order of 1% to 5%. For broadband antenna design the following considerations are necessary in antenna geometry, first Larger substrate thickness or lower permittivity of the dielectric to obtain low Q, second, feed impedance must be matched, third, optimization of patch geometry, final suppression of surface waves in a thick substrate. In this paper third and fourth considerations are used here to enhance the bandwidth. Rectangular patch antenna of RF4 substrate of 4.4 permittivity is used, with 40x40x1.575 mm^3 dimensions. The patch shape is fan-like to enhance the BW rather than the traditional rectangular patch antenna. The simulated result shows the significant enhancement in the bandwidth.

Index: **Bandwidth, Microstrip Antenna, Probe Feed**

1. INTRODUCTION:

Wireless communications have been developed widely and rapidly in the modern world, especially during the last two decades. The future development of the personal communication devices will aim to provide image, speech and data communications at any time, and anywhere around the world. This indicates that the future communication terminal antennas must meet the requirements of multi-band or wideband to sufficiently cover the possible operating bands [1].

Enhancement of some microwave frequency bands is investigated by many researchers such as Banuprakash R. et. al. For X band, they find that the proposed antennas increases in the frequency band to 16.39% by using the coplanar waveguide instead of coaxial probe feed [2]. Using the technique of Electronic Band Gap EBG is the one method used to enhance the bandwidth of a rectangular microstrip antenna, Savita M. Shaka and his co-researchers were getting "The proposed design helps to achieve multiband and enhancement in the bandwidth of 60.64% after loading UC-EBG cells on the ground plane, which makes the antenna useful for wireless applications"[3].

The slot antenna is the one type of bandwidth enhancement methods, so by reconfigurable the patch or ground plane of the microstrip antenna one can get increasing in the bandwidth to use the antenna in the wide range of wireless communications applications such as Bluetooth, Wi-Fi, WLAN, WiMax [4]. The size of the microstrip antennas can be reduced by the concept of loading a microstrip antenna with shorting pin. Microstrip antenna with slotted patch and defected ground plane offers a huge bandwidth of about 38.67% of the center frequency suitable for WLAN application in C band which is very much encouraging. By using the shorting pin, antenna size has also been reduced about 82.4% of its original size. Avisankar Roy *et. al.* with their proposed antenna resonates at dual band S and C band with remarkable return loss which may be used in dual band operation[5].

New types of fabricated structures or composite materials that mimic media with non-natural environmental management properties were introduced in the microwave and optical fields. These new types of materials are known as metamaterials. With the flexibility and new properties provided by metamaterials, new types of antennas have been conceived [6-8], so making their designs more straightforward, improved metamaterial rectangular patch antenna with UWB and high-gain patch antenna is successfully designed, fabricated and tested. The average gain of the proposed antenna and unique radiation characteristics make this antenna would be a good choice for UWB wireless communications in the future [9].

2. PROBLEM OF RESEARCH:

In this paper a new design is used to enhance the bandwidth, by using the reconfigurable rectangular patch antenna, rather than the traditional rectangular patch antenna. The patch is simulating using RF4_epoxy dielectric martial as a substrate of relative dielectric constant of ε_r=4.4 and a tangent loss of $\tan\delta$ = 0.0025 is used, with 40x40x1.575 mm^3 hole dimensions. The patch shape is fan-like to enhance the BW rather than the traditional rectangular patch antenna.

3. ANTENNA DESIGN

The traditional rectangular patch microstrip antenna is designed and simulates with dimension L_{sub}, W_{sub} and hub are 40 mm, 40 mm, and 1.575 mm, respectively, with substrate parameters ε_r=4.4 and tangent loss of 0.0025. Rectangular patch dimension L_p and W_p are 29.18 mm to both of them with a coaxial feed probe, with feed position to get 50 Ω (0, -0.4 mm, 0) as shown in Fig.(1). The proposed antenna to enhanced bandwidth is reconfigurable patch antenna of fan-like shape as shown in Fig.(2) with the same parameters and dimensions for the substrate and feed location, the dimensions of patch are listed in Table 1.

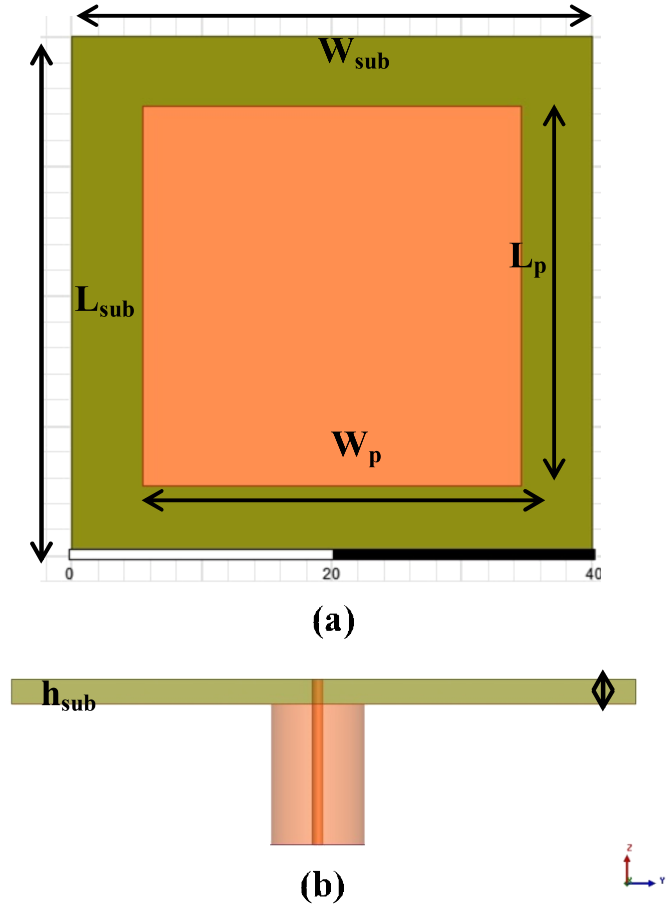

Fig. 1 Traditional microstrip antenna (a): top view and (b) cross section view.

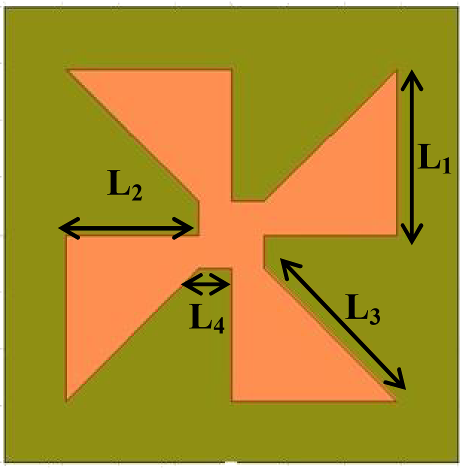

Fig. 2 Proposed reconfigurable patch microstrip antenna

TABLE 1

DIMENSIONS OF RECTANGULAR PATCH OF PROPOSED ANTENNA

L_1(mm)	L_2(mm)	L_3(mm)	L_4(mm)
14.59	11.67	16.50	2.92

4. SIMULATION RESULTS:

First of all traditional rectangular patch microstrip antenna was simulated with central frequency 4.75 GHz (C band) using HFSS software to the design and simulation results. Fig. (3) and Fig.(4) shows the return loss and VSWR of the rectangular patch antenna.

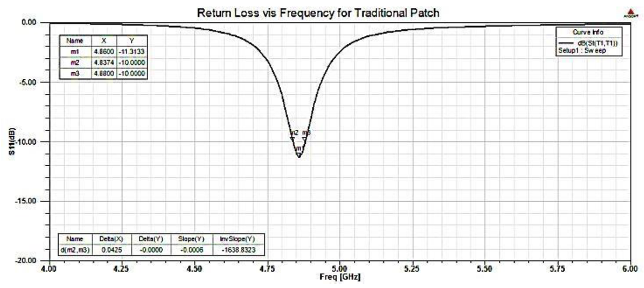

Fig. 3 Return loss of traditional patch microstrip antenna

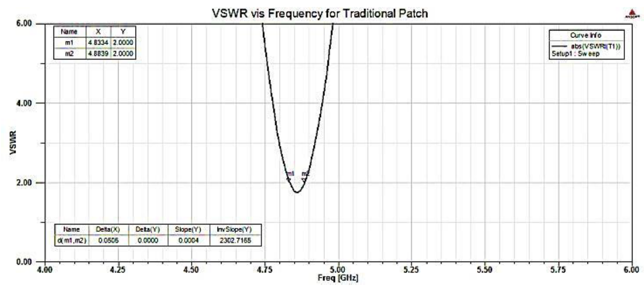

Fig. 4 VSWR of traditional patch microstrip antenna

As shown from figures 3 and 4 the operating bandwidth is about 50.5 MHz (f_u-f_l) the ratio is 1.03% ($\frac{f_u-f_l}{f_o} \times 100\%$). From Fig. (5) one can see the radiation pattern is omnidirectional in tow principles E and H at the resonance frequency 4.86 GHz.

To enhance bandwidth reconfigurable patch antenna is done to make a patch is fan-like as shown in Fig (2). A parametric study was done to determine the best value for L2 and L3, as shown in Fig.(6). It is shown that the base value of L2 and L3 is 11.67 and 16.5 mm respectively to get bandwidth wider compared with the other values.

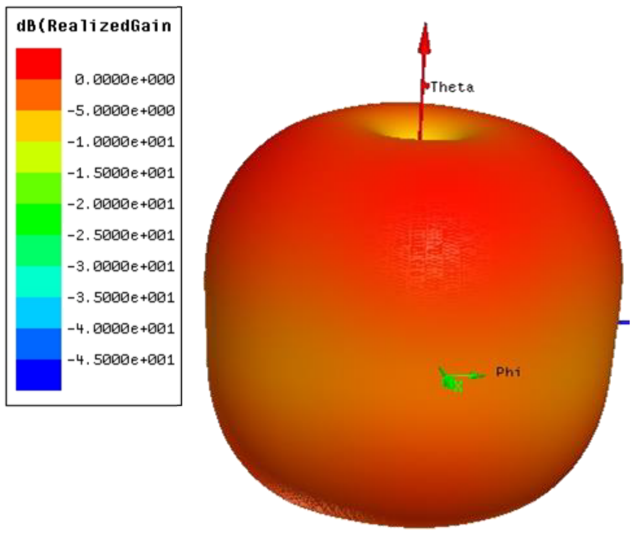

Fig. 5 3D radiation pattern of the rectangular patch antenna

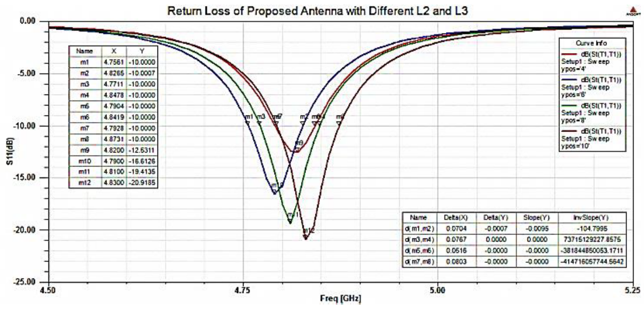

Fig. 6 Return loss of parametric study microstrip antenna

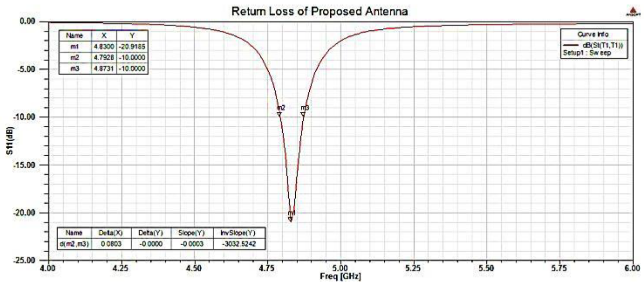

Fig. 7 Return loss of proposed microstrip antenna

Table 2 shows the parametric study values and the bandwidth frequency.

TABLE 2

THE PARAMETRIC STUDY VALUES AND THE BANDWIDTH FREQUENCY

y_{pos}	L_2(mm)	L_3(mm)	BW(MHz)
$L_p/4$	7.30	13.76	51.6
$L_p/6$	9.73	15.19	70.4
$L_p/8$	10.97	16.00	76.7
$L_p/10$	11.67	16.50	80.3

The results of optimum parameters of the proposed reconfigurable rectangular patch antenna are demonstrated in the figures 7, 8 and 9 for return loss, radiation pattern and 3D polar radiation pattern respectively at the resonance frequency. Fig.(10) illustrate the current distribution on the patch at 4.83 GHz.

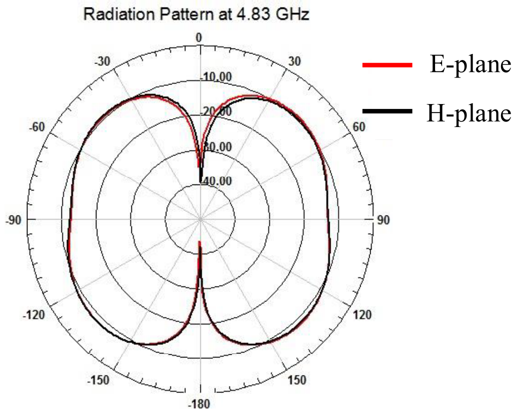

Fig. 8 Radiation pattern of the proposed patch antenna.

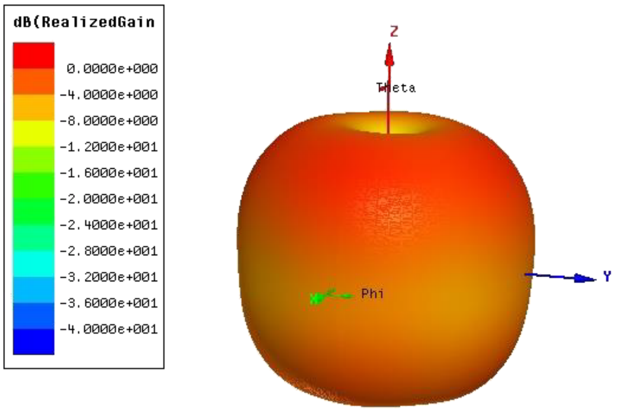

Fig. 9 3D radiation pattern of the reconfigurable rectangular patch antenna.

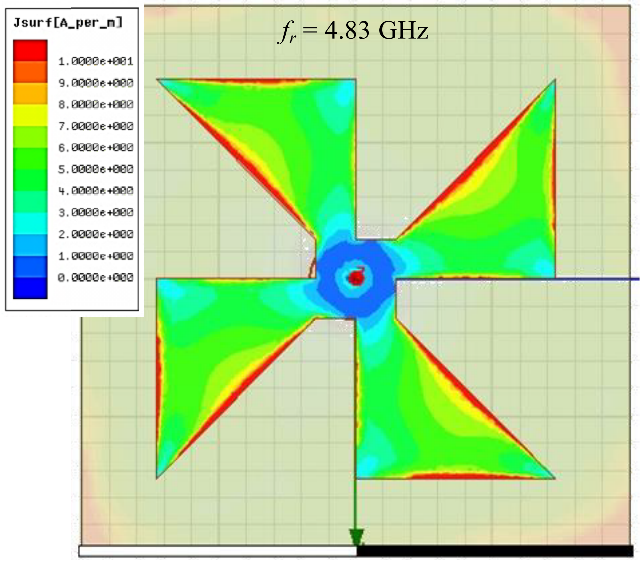

Fig. 10 Current density J_{sur} distribution on the reconfigurable rectangular patch antenna at 4.83 GHz.

5. CONCLUSION

In this paper the enhancement of bandwidth is accomplished by reconfigure the patch of the rectangular microstrip antenna, the simulation results shows the significant increasing in the bandwidth of the proposed antenna rather than the traditional rectangular patch microstrip antenna as shown in Fig. (11). The radiation pattern do not effect and still omnidirectional. The new antenna can be used in the C band of microwave frequency.

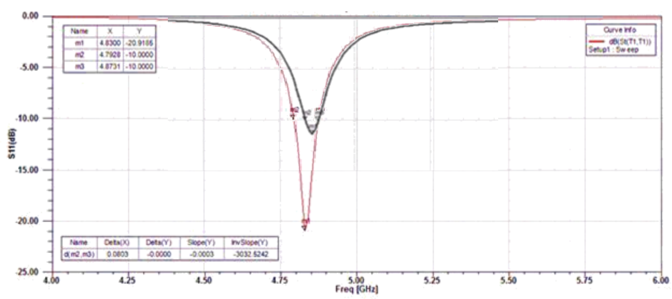

Fig. 11 Comparatives results of return loss of the rectangular and reconfigurable patch antennas.

6. REFERENCES

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