New Structural Design and Simulation of Slotted Patch Antenna for Broadband Application

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Abstract—This design propose a new printed rectangular patch antenna for broadband applications.abroad-band design of a probe- fed patch antenna with two of a square and rectangular wide slots in the right and left of proposed patch respectively,also U-shaped slot located in the left of the radiating edge.the proposed antenna with an overall size of 25.6 × 36.8 mm,leading to broad bandwidths 1428.7MHZ covering 4.6951GHZ to 6.1238GHZ,these properties make the antenna suitable for 5.2 / 5.8 / 5.5 GHZ WLAN and WiMAX application.the results are simulated using (CST STudIo SUITE-2010) software package.

Index Terms—New design, Rectangular patch, Slotted antenna, Broadband application.

1. INTRDUCTION

Microstrip patch antennas are widely used because of their many merits,such as the low profile,light weight and conformity.however,patch antennas have amain disadvantage,narrow bandwidth.reserchers have made many efforts to overcome this problem and many configurations have been presented to extend the bandwidth[1-2].so to overcome their inherent limitation of narrow impedance bandwidth and low gain ,many techniques have been proposed and investigated,e.g.,for probe feed stacked antenna,microstrip patch antennas on electrically thick substrate,slotted patch antenna,the use of various impedance matching and feeding techniques,the use of multiple resonators[3-5].to reduce the size of antennas with achieving dualband or wide bandwidth,shorting pins or U-slot patch[6].the aim of introducing the U-slot on the rectangular patch is to produce four resonance frequencies[7].broadband operation is achieved when the second and third resonance frequencies are sufficiently close.

2. ANTENNA CONFIGURATION AND DESIGN

The configuration of the rectangular patch antenna with two of wide slots,and U-shaped slots is shown in figure 2.the rectangular patch dimensions are W X L . FR4 substrate with thickness 3.3 mm and dielectric constant ε_r =4.6 is used here with tangent loss 0.025.the dimensions square slot are Ws1 X Ws1,dimensions the rectangular slot are Ws X Ls and for U-shaped slots Ls1 X Ls2 X Ls3 X Ws2. Ls1 is equal in both arms of the slot. W2 is the distance between square and rectangular slot.the width and length of the patch are given by [8-9].

$$W = \frac{c}{2 f_o \sqrt{\frac{\varepsilon_r + 1}{2}}} \qquad (1)$$

$$L = L_{eff} - 2\Delta L \qquad (2)$$

And the effective dielectric constant ε_{eff} is given as:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \sqrt{\frac{1}{\left[1 + 12\frac{h}{w}\right]}} \qquad (3)$$

And a distance(Δ L),which is given by [10] :

$$\Delta L = 0.412h \frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{w}{h} + 0.813\right)} \qquad (4)$$

Where,c is the velocity of light, ε_r is the dielectric constant of substrate, (f_o) is the resonance frequency.the input impedance of 50 ohms,the final optimization process , the final optimum parameters for the slotted antenna were obtained where the width and length are found 36.8mm and 25.6mm respectively.

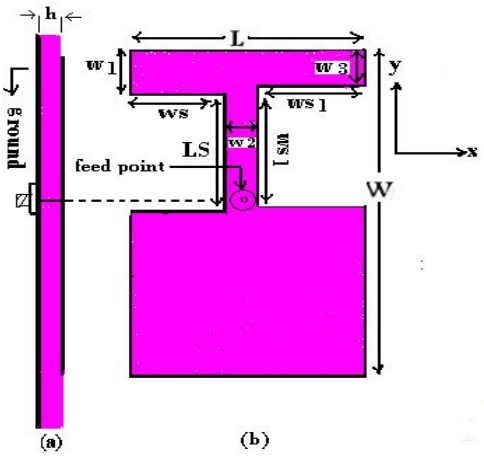


Figure1: patch antenna with wide slots
(a) side view(b) top view

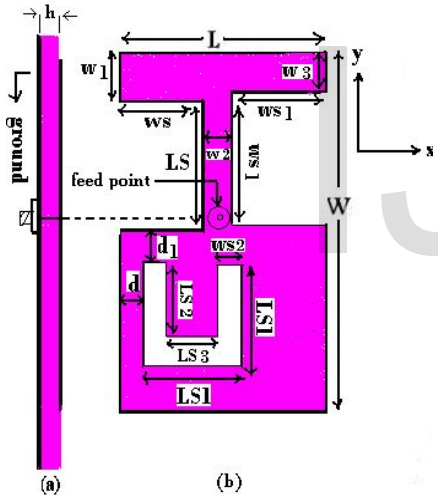


Figure 2: proposed antenna with U- shaped slot

3. SIMULATION RESULT

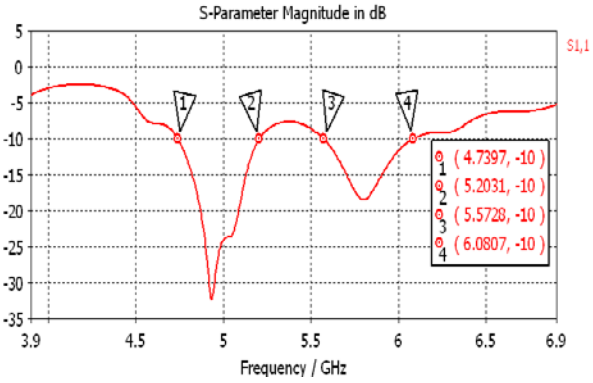


Figure 3: return loss for slotted antenna
Without U- shaped slot

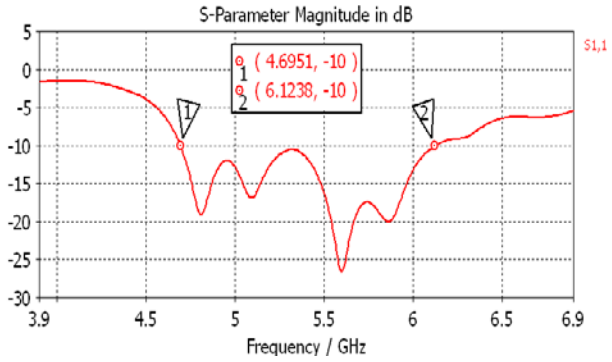


figure4: return loss for proposed antenna
with U- shaped slot

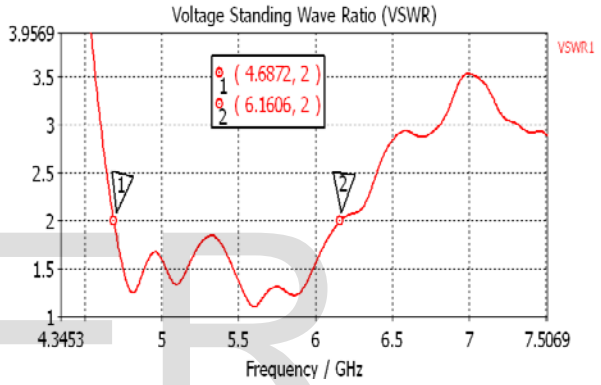


figure5: VSWR plot proposed antenna

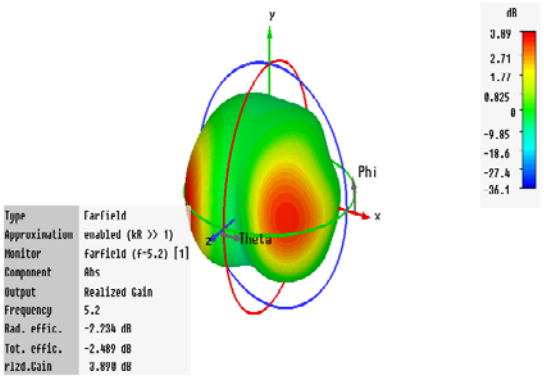
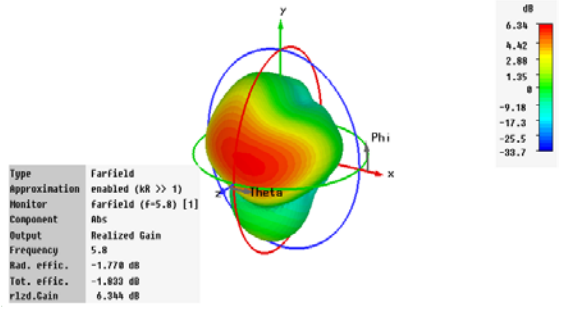


Figure6:-3D plot radiation pattern
For f=5.2GHz



(a) E-field

Figure7:-3D plot radiation patternfor f=5.8 GHz

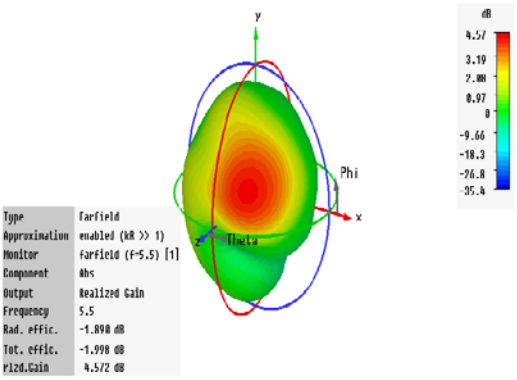
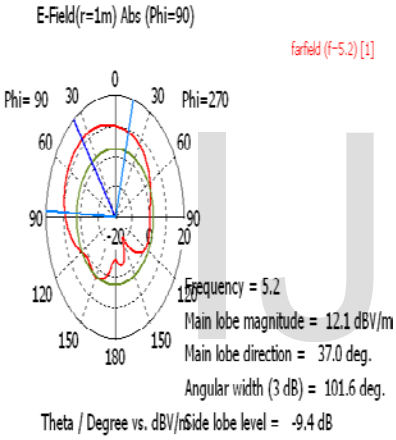
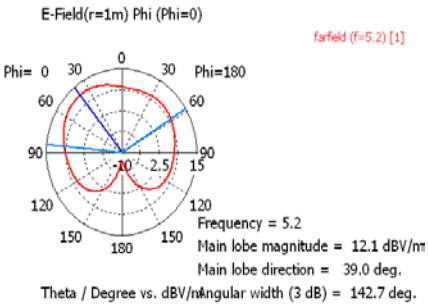
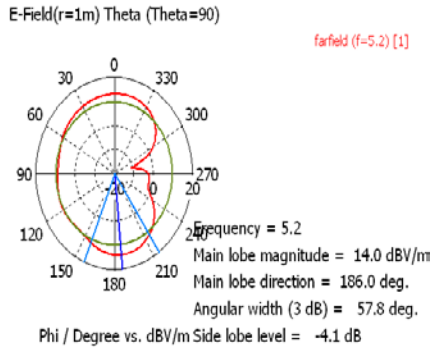
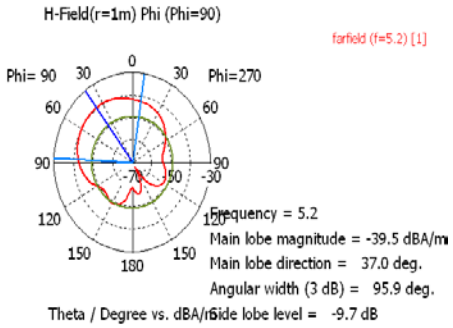


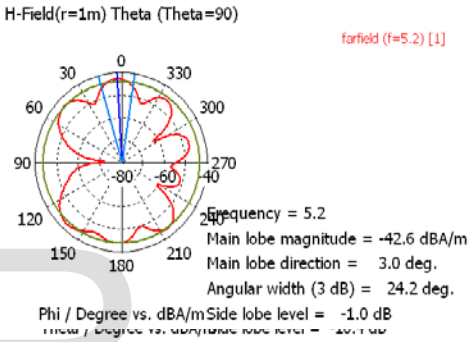
Figure8:-3D plot radiation patternfor f=5.5 GHz





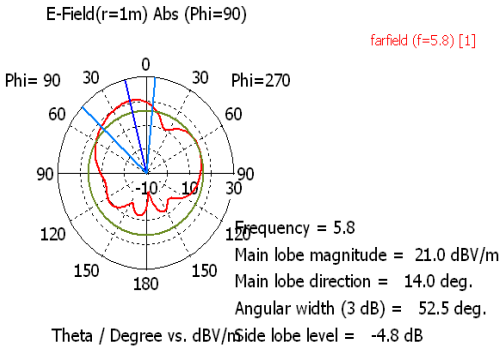


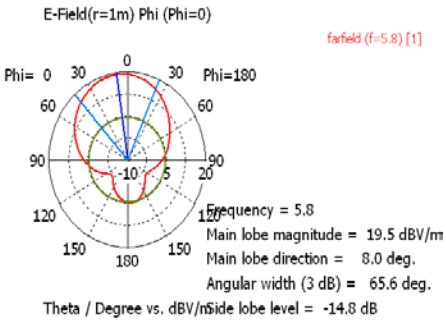


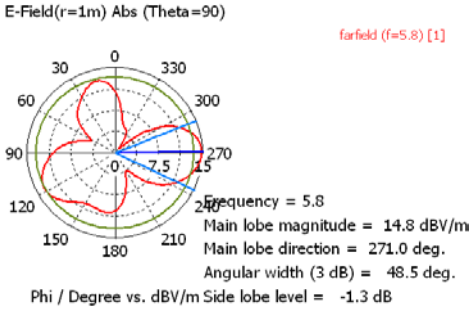


(b) H-field

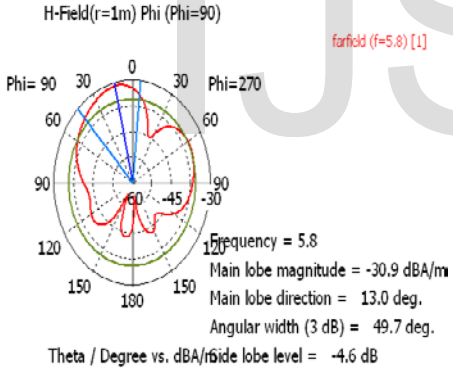
Figure9: radiation pattern for proposed antenna
At f=5.2 GHz(a) E-field (b) H-field

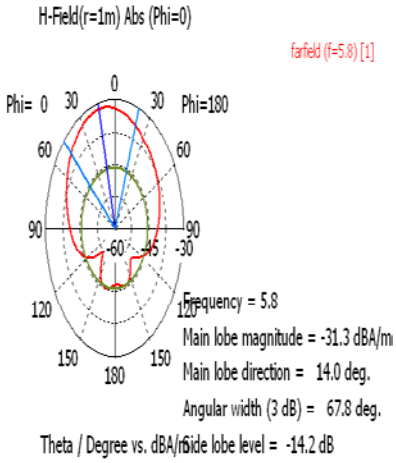


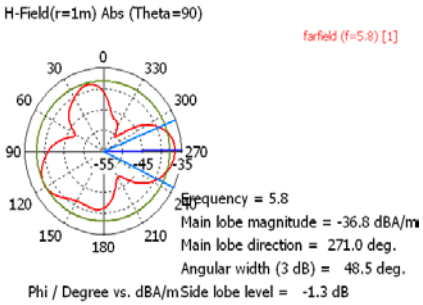




(a) E-field

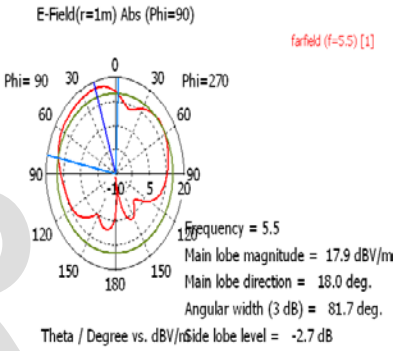


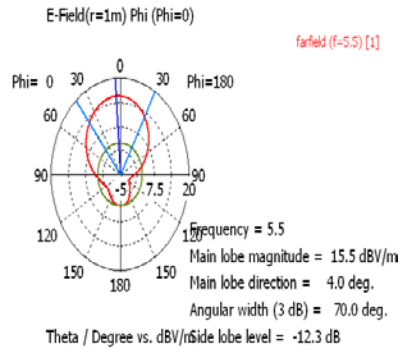


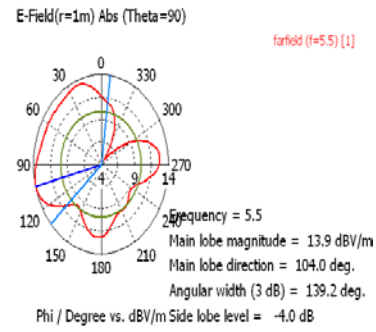


(a) H-field

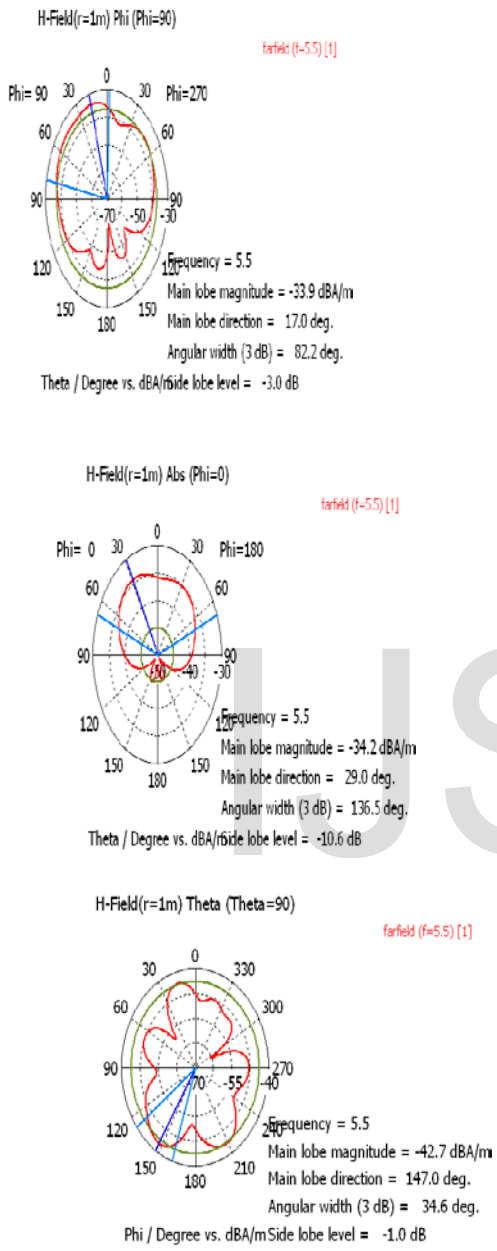
Figure10: radiation pattern for proposed antenna at f=5.8 GHz(a) E-field (b) H-field







(a) E-field



(b) H-field

Figure11: radiation pattern for proposed antenna at f=5.5 GHz(a) E-field (b) H-field

To design a new antenna ,and also in order to increase the bandwidth, U-shaped slot inserted in the patch of proposed antenna as displayed in figure.2.by properly tuning the length,width and location of these slots,the antenna can actully radiate broad frequency band.also the location of feed point is playing an important role in the broadband characteristics.figure.3show simulated frequency response of return loss for antenna without U-shaped slot,include of dual-band,but in figure .4 of proposed antenna with U-shaped slot (-10dB) return loss of broadband 1428.7 MHz (4.6951- 6.1238) GHz ,abroadband is achieved that covers the 5.2/5.8- GHz WLAN and 5.5 GHz WiMAX .figure.5 show the simulated VSWR characteristics of the proposed antenna with U-shaped slot.

TABLE 1:

BRAMETERES OF PROPOSED ANTENNA

parameter	value(mm)	parameter	value(mm)
L	25.6	W3	6.4
W	36.8	W1	8.4
LS	12	d	3
WS	10	d1	3.5
W2	3.6	LS1	7
WS1	12	WS2	1.5
LS2	5.5	LS3	4

TABLE II:

CHARACTERISTICS AND SLOTS LOCATION OF PROPOSED ANTENNA

parameters	value
The substrate thickness	h=3.3mm
Location of feed point(x,y)	(-1,3.3)
Location of left slot(x2,y2)	(-14,-2)
Location of right slot(x3,y3)	(2,0)
U-shaped slot location(x1,y1)	(-9.8,-12.5)
Bandwidth of proposed antenna	BW=1428.7 MHZ

4. Conclusion

In this design, broadband rectangular patch antenna for bandwidth enhancement is successfully developed.with use of probe-feed,the antenna has achieved 1428.7 MHz from 4.6951GHz to 6.1238GHzfor 5.2/5.8/5.5GHz WLAN and Wi-MAX application.

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