Comparison of Microstrip Patch Antenna using Different substrate Material for Multiband Application

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Abstract:- In this article, the comparisons of parameters of S-shaped radiating patch using L-strip feeding for multiband operation. It is proposed that antenna fabricated on foam shows better performance than Bakelite substrate.The antenna is first analyzed using software simulation, and then fabricated on Foam and Bakelite substrates and their characteristics are compared. The resonating modes of S-shaped patch antenna are obtained between 6 GHz to 45 GHz for foam whereas 2 GHz to 20 GHz for Bakelite. The reflection coefficients and bandwidth of both antennas are compared and discussed. The geometry is simulated using commercially available IE3D software and the results are measured and tested. It is found that the agreement between the computed and experimental results was very good.

Keywords: *multiband antenna, L-strip feeding, Bakelite, foam.*

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1. INTRODUCTION

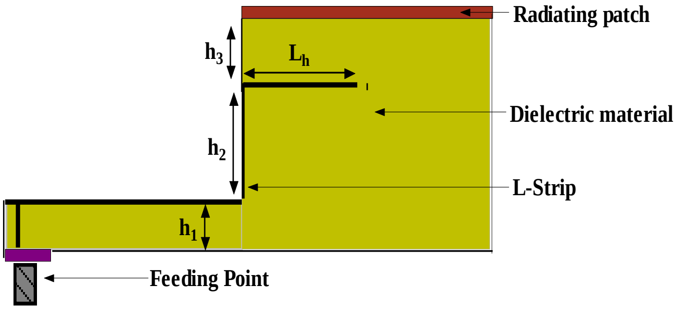
The Microstrip patch antenna (MSA) is most popular in wireless applications due to its various advantages in different fields. One of the major advantages is that these antennas are operated for multiband i.e. for tuning purpose.The multiband antennas are those antenna are operated to various wireless applications such as GSM (880MHz to 960MHz), UMTS (1920MHz to 2170MHz), Wi-MAX (2.5–2.69, 3.3– 3.7, and 5.25–5.85) GHz, WLAN (2.4–2.484 GHz, 5.15–5.35 GHz, and 5.725–5.85 GHz), PCS (1850–1990 MHz), IMT-2000 (1920–2170MHz), DCS (1710-1880MHz), GPSandCDMA [1,2].

Many techniques have been reported in literatures that obtain multiband behavior such as using Microstrip line feeds in orthogonal direction and excited by Y-shape like Microstrip feed [3-4] Several multiband antennas have been proposed by researchers such as slotted ground structure [5,6], by using folded patch structures [7,8], and by loading an active devices on the patch [9,10] etc.

In this paper, the L-strip fed S-shaped patch antenna for multiband operations is proposed. The proposed geometry is incorporated with L-strip feeding and notches loaded. The antenna characteristics are analyzed for different substrate materials such as Bakelite and Foam. The details of proposed antennas are discussed in the following sections.

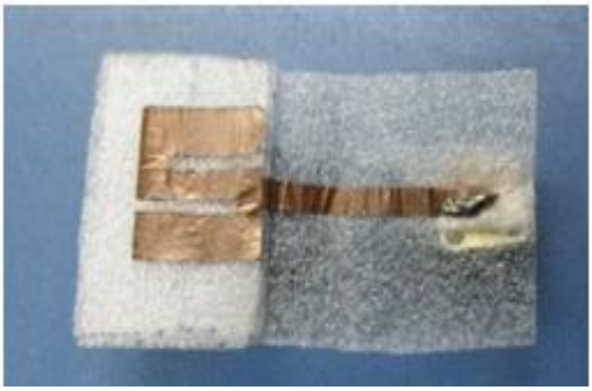
2. ANTENNA GEOMETRY AND DESIGN

The proposed prototype of the antenna is fabricated on foam and Bakelite substrate materials with relative permittivity of 1.07 and 3.3 as shown in Fig.1 and the fabricated photo of the antennas are shown in Fig 2. The both antennas are looked like similar in shape but having different characteristics.



(a)

Figure 1. Proposed Prototype of the antenna (a) side view (b) top view



(a)

(b)

Figure2. Photograph of the fabricated antennas (a) Antenna fabricated on a Foam substrate (b) Antenna fabricated on a Bakelite substrate

The design specifications of the antennas are given in Table 1 and Table 2.

Table1: Design specification of antenna fabricated on foam substrate (all dimensions are in mm)

PARAMETERS	DIMENSIONS
ε_r	**1.07**
L	**22.2**
W	**15.6**
L_n	**12.8**
L_h	**7.8**
L_S	**24.2**
h_1	**0.77**
h_2	**2.13**
h_3	**1.47**
(x_0, y_0)	**(23,0)**

Table 2: Design specification of antenna fabricated on Bakelite substrate (all dimensions are in mm)

PARAMETERS	DIMENSIONS
ε_r	**3.3**
L	**22.2**
W	**15.6**
L_n	**13.8**
L_h	**7.8**
L_S	**32.2**
h_1	**1.6**
h_2	**1.6**
h_3	**1.6**
(x_0, y_0)	**(31,0)**

3. Circuit Modal And Analysis Of The Proposed Antennas

The total input impedance of the proposed antennas with L-strip feeding is easily analyzed by using equivalent circuit model as shown in Fig3.

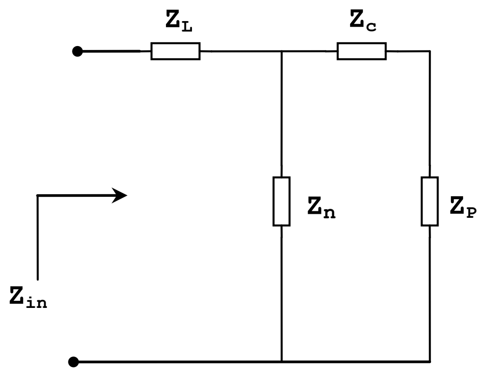


Figure 3. Equivalent circuit of the proposed antennas with L-strip feeding

The resultant input impedance (Z_{in}) of the antenna seen from the terminals is given by

$$Z_{in} = Z_L + \frac{Z_n(Z_C + Z_P)}{Z_n + Z_C + Z_P} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

whereas,

Z_L: Input impedance of L-strip feeding [9]
Z_n: Input impedance of notch loaded patch
Z_c: Input impedance of coupling capacitor
Z_p: Input impedance of patch

Now using equation (1), different antenna parameters such as reflection coefficient, VSWR and return loss are calculated.

4. Results And Discussion

The frequency versus return loss curve for proposed prototype is shown in Figs.4 and 5. Operating frequencies and bandwidth are compared for both antennas.The simulated results [11] are verified with experimental results. The reflection coefficient versus frequency of the proposed Antenna1 is shown in Fig4. In this figure simulated and measured results are plotted together and they are in close agreement. The proposed antenna is resonating at different

ISSN: 2321-8169
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operating frequencies, i.e., 6 to 45GHz. From the figure, it is observed that the measured resonating frequencies are noticed at 6.7GHz, 8.42GHz, 10.97GHz, 16.88GHz, 21.31GHz, 27.7GHz, 33.38GHz, 37.87GHz and 43.36GHz with corresponding bandwidth of 32.88%, 11.74%, 6.08%, 10.0%, 6.48%, 9.75 %, 7.09% and 5.41% respectively.

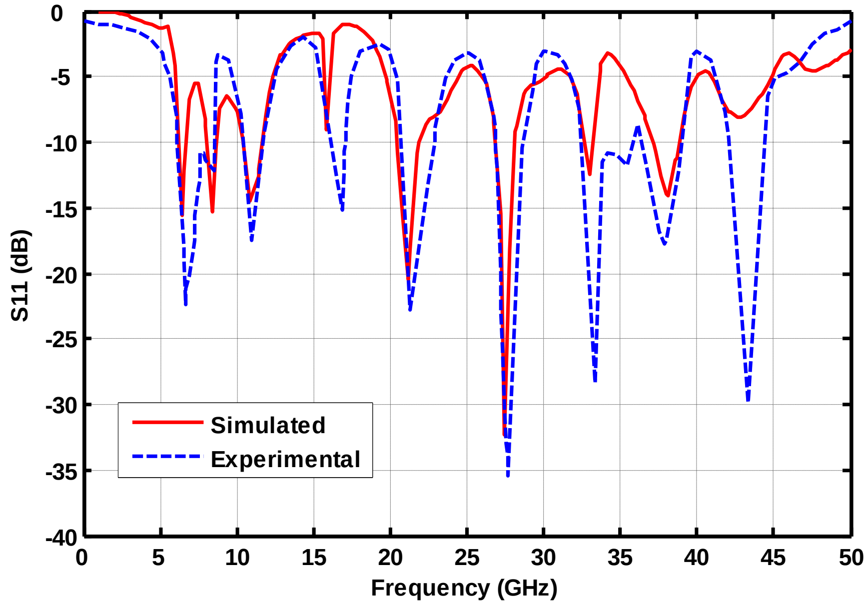

Figure 4. Plot of reflection coefficient versus frequency for proposed Antenna1

The simulated and measured reflection coefficient versus frequency of the proposed Antenna2 is shown in Fig.5. It provides multiband characteristics from 3 GHz to 20 GHz. The measured resonating frequencies are observed at 3.75 GHz, 4 .58 GHz, 5.89 GHz, 7.3 GHz, 9.83 GHz, 11.46 GHz, 13.39 GHz, 15.04 GHz, 16.97 GHz with corresponding bandwidth of 3.2%, 12.58%, 5.35 % , 7.27 % , 3.31 %, 3.13 % , 1.49%, 1.99 % and 2.06% respectively.

The E-plane and H-plane radiation patterns of the proposed Antenna1 at different resonating frequencies are shown in Fig.6 (a)–(i). The proposed antenna radiation patterns are observed for different operating frequencies such as 6.3 GHz and 8.42 GHz 10.97 GHz, 16.0 GHz, 21.2 GHz, 27.53 GHz, 33.03 GHz, 38.0 GHz and 43.0 GHz.

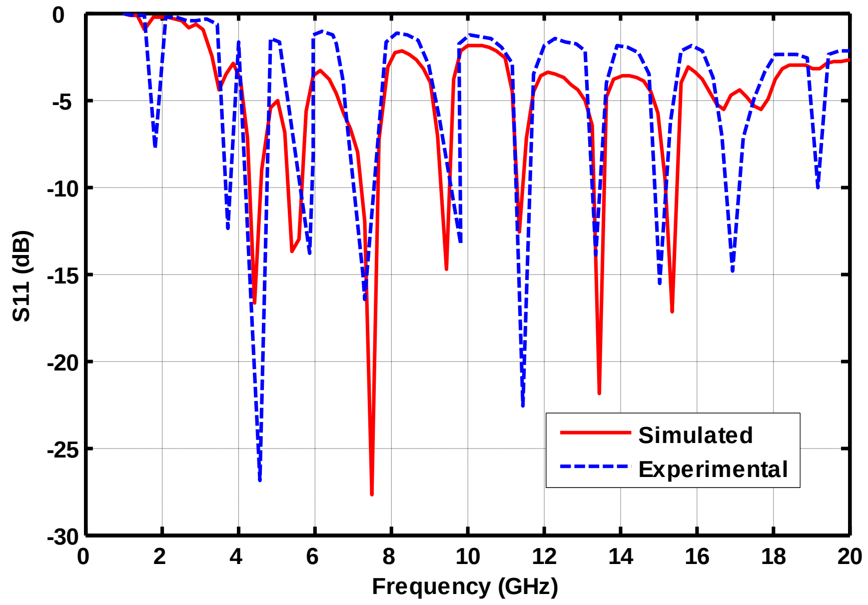

Figure 5. Plot of reflection coefficient versus frequency for proposed Antenna2

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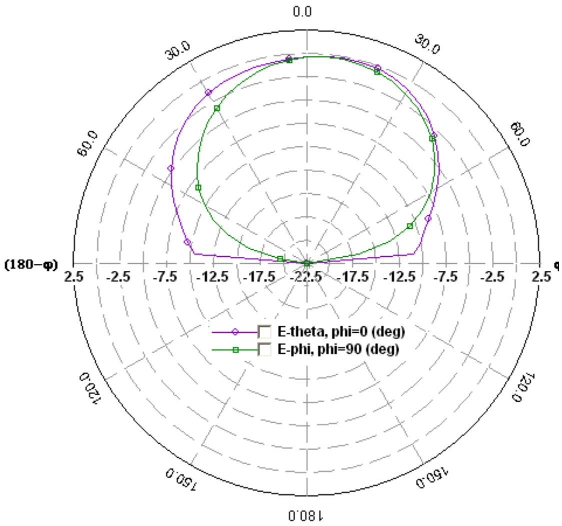
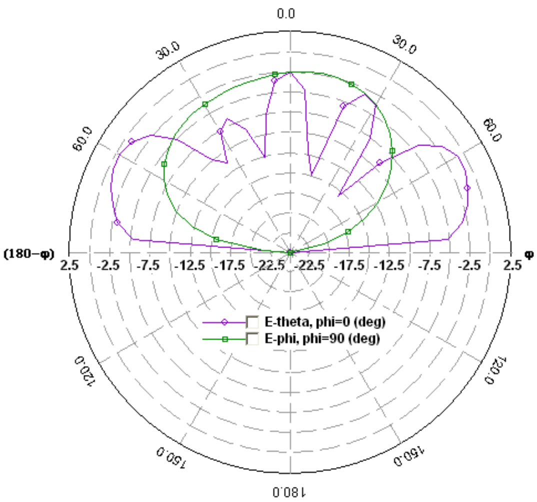
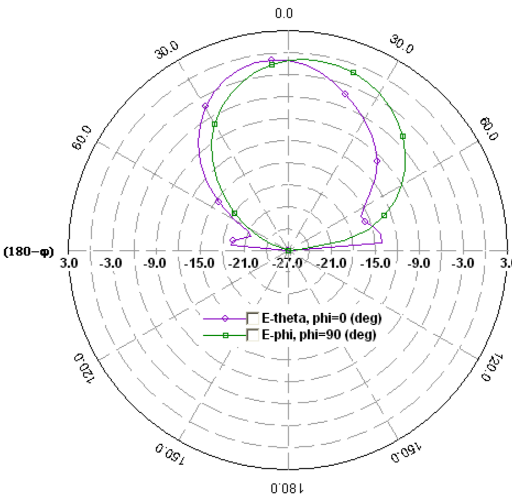


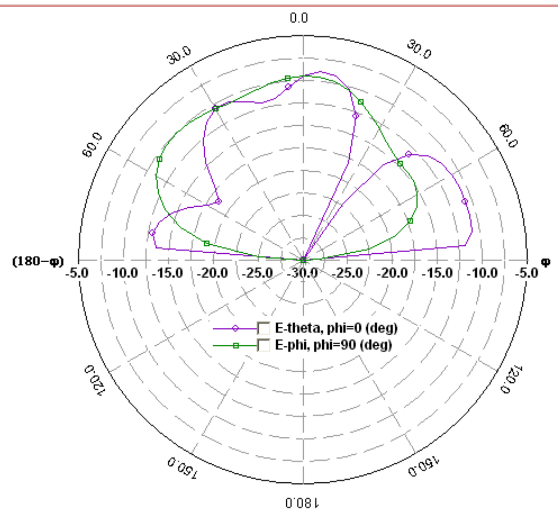
(a)



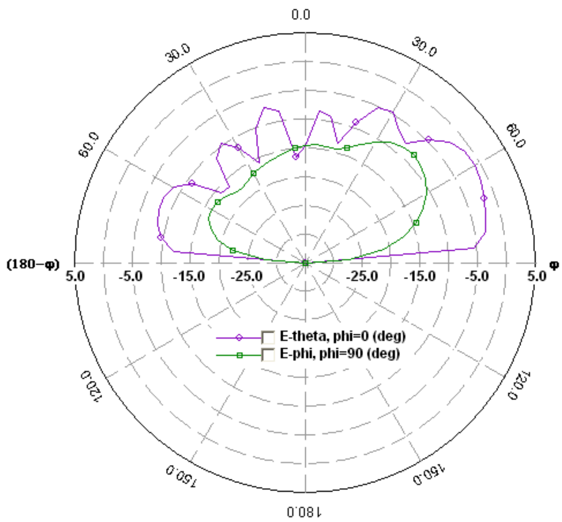
(b)



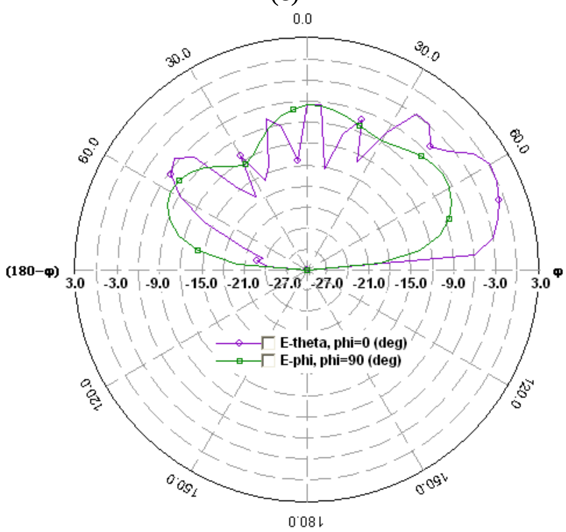
(c)



(d)



(e)



(f)

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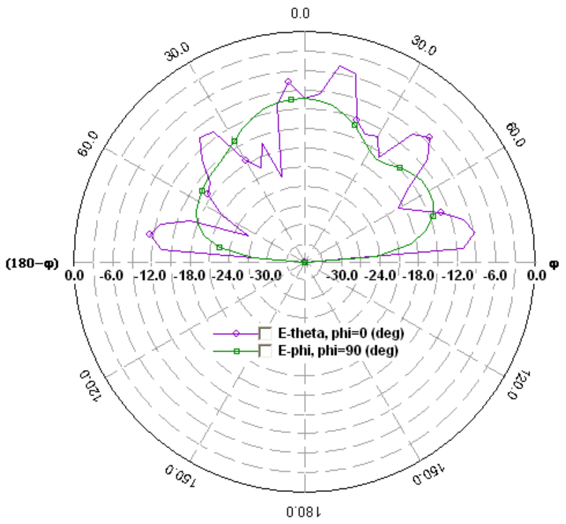
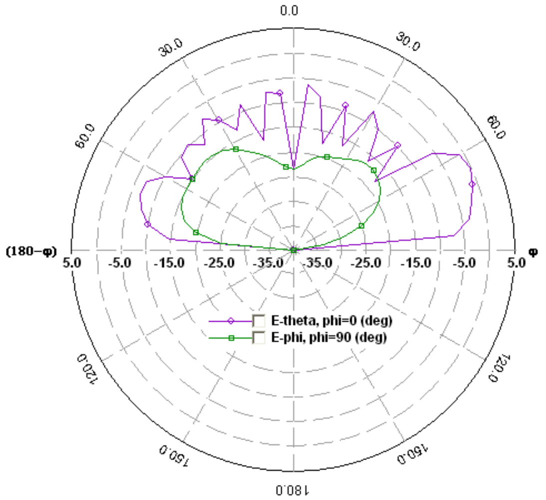
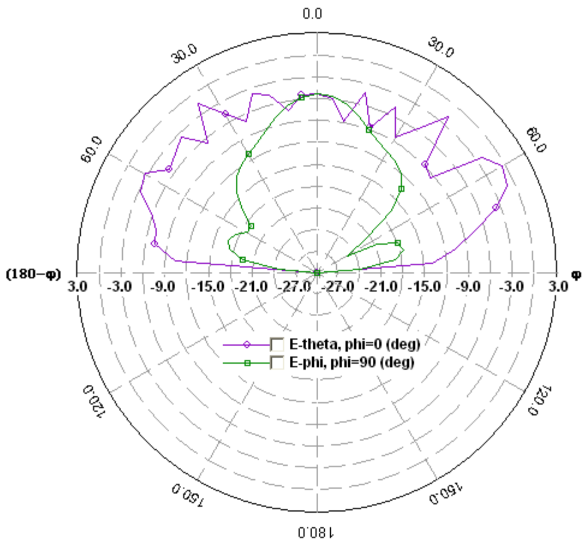


(g)



(h)



(i)

Figure 6. E and H plane radiation patterns at (a) 6.3GHz (b) 8.42GHz (c) 10.97GHz (d) 16.0GHz (e) 21.2GHz (f) 27.53GHz (g) 33.03GHz (h) 38.0GHz (i) 43.0GHz

5. CONCLUSION

Patch antenna for multiband operation have been successfully designed using different substrate material.The antenna fabricated on foam shows better performance than Bakelite substrate. The designed antennas have been simulated and results are verified experimentally. Furthermore, they show good radiation characteristics at different resonating frequencies.

REFERENCES

[1] Joong Han Yoon, Young Chul Rhee, and YeonKil Jang, “Compact monopole antenna design for WLAN/WiMAX triple-band operations,” Microwave and optical technology letters, Vol.54, pp.1838-1846, 2012.

[2] Won-GyuJang and Jae-Hoon Choi, (2007). Design of a wide and multiband aperture-stacked patch antenna with reflector.*Microwave and optical technology letters*, Vol. 49, pp.2822-2824, 2007.

[3] J. P. Thakur, J.-S. Park, B.-J. Jang, and H.-G. Cho, “Smallsize quad band microstrip antenna,” Microwave and OpticalTechnologyLetters ,vol.49,no.5,pp.997–1001,2007.

[4] J. Pei, A.-G. Wang, S. Gao, and W. Leng, “Miniaturized triple-bandantenna with a defected ground plane for WLAN/WiMAX applications,” IEEE Antennas and Wireless PropagationLetters, vol. 10, pp. 298–301, 2011.

[5] Dalia M.Elsheakh, Esmat A. Abdallah, “Different Feeding Techniques of Microstrip Patch Antennas with Spiral Defected Ground Structure for Size Reduction and Ultra-Wide Band Operation,”*Journal of Electromagnetic Analysis and Applications*, Vol.4, pp.410-418, 2012.

[6] Wen-Chung Liu, Chao-Ming Wu, and Yang Dai, “Design of Triple-Frequency Microstrip-Fed Monopole Antenna Using Defected Ground Structure,”*IEEE transactions on antennas and propagation*, Vol.59, pp.2457-2463, 2011.

[7] C.-W.Chiu and C.-H. Chang, Y.-J. Chi, “Multiband folded loop antenna for smart phones,”Progress In Electromagnetics Research, Vol.102, pp.213-226, 2010.

[8] Yun-Wen Chi and Kin-Lu Wong, “Compact Multiband Folded Loop Chip Antenna for Small-Size Mobile Phone,”IEEE Transactions on antennas and propagation, Vol.56, pp.3797-3803, 2008.

[9] MouKehn, Malcolm Ng, Oscar Quevedo-Teruel, and Eva Rajo-Iglesias, “Reconfigurable Loaded Planar Inverted-F Antenna Using Varactor

ISSN: 2321-8169
826 – 831

Diodes,"IEEE antennas and wireless propagation letters, Vol.10, pp.466-468, 2011.

[10] W. JayasingheJeevani, JaumeAnguera, and Disala N. Uduwawala, "A simple design of multi band microstrip patch antennas robust to fabrication tolerances for GSM, UMTS, LTE, and Bluetooth applications by using genetic algorithm optimization,"Progress in Electromagnetics Research M, Vol.27, pp.255-269, 2012.

[11] Amit Kumar Singh, Manoj Kumar Meshram, and Babau R. Vishvakarma, "L-strip proximity fed shorted rectangular microstrip antenna for mobile communication,"Microwave and optical technology letters, Vol.52, pp.1567-1571, 2010.

[12] IE3D simulation software, Zeland software Inc. USA, Version 14.05, 2008.