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A Novel Design of Triple Band Arrow Slot Loaded HMA for GPS, WiMAX and X-band Communication Application

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ABSTRACT: A simple hybrid monopole antenna (HMA) with arrow shaped slot is proposed for Global Positioning System (GPS) and Worldwide interoperability for Microwave Access(Wi-MAX) applications. The antenna structure consist of hybrid triangular shape structure consisting ofarrow shaped slot on the patch. At the bottom surface a ground plane is partially placed to achieve triple band from 1.7 to 8.61GHz. The proposed antenna is fabricated using low cost FR4 substrate material. The antenna is excited through 50 Ω microstrip line. The simulated and experimental results are demonstrates that the proposed antenna satisfies the -10dB impedance bandwidth requirements while covering the GPS and Wi-MAX communications.

KEYWORDS: Hybrid Arrow shaped monopole antenna, triple band, GPS and Wi-MAX

I.INTRODUCTION

With the fast development of wireless communication system, such as Global Positioning System (GPS), Digital Communication System(DCS), Personal Communication System(PCS), International Mobile Telecommunication–2000(IMT-2000), Satellite Digital Audio Radio(SDAR), Wireless Local Area Network(WLAN) etc. therequirement is that the device should operate for specified bandof frequencies. Microstrip antenna with multiple band operation has attracted much attention towards this [1-3]. The microstrip antenna has the advantages of planar structure, wide impedance bandwidth, easy for impedance matching capability, small size, and light weight and easy to fabricate. For the requirement of GPS and Wi-MAX applications, some past studies using the microstripantenna have been reported with various structures [4-11].In this article, a novel design of hybrid semi-circular arrow slot antenna is proposed for GPS and Wi-MAX triple band applicationswhich is simpleand the proposed structure is found to berare in the literature. In addition, the slot loaded structure has the advantage to achieve desired radiation requirements by varying the dimension of slot inserted on the patch.Details of the antenna design both measured and experimental results are presented and discussed.

II. ANTENNA DESIGN

Figure 1.shows the geometry of proposed triple band arrow slot loaded hybrid microstrip antenna (TASHMA) along with its dimension.The geometrical parameters of the proposed antenna were obtained by using Ansoft high-frequency structure simulator (HFSS). The antenna is etched on FR4 substrate with dielectric constant of 4.2, thickness of 0.16cm.The length and width of the substrates is 4x6 cm. Loss tangent is 0.02. This antenna structure is named as hybrid because the rectangular and triangular geometry are combined together. The arrow type slots are inserted on the patch. The antenna is excitedthrough 50 Ω microstrip feed line having width of 3.017 mm and length of 24 mm. At the bottom surface of the ground plane a partially truncated groundplane is etched which is slightlybelow the radiating patch to get desired operating bands. The offset gap is 0.5 mmbetween the radiating patch and bottom ground plane.

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The proposedantenna is achieved triple bandscovering 1.55-1.85 GHz, 3.05-4.11 GHz and 8.46-8.77 GHz required for GPS and WiMAX. Final designed values of theantenna parameters are specified in Table1.

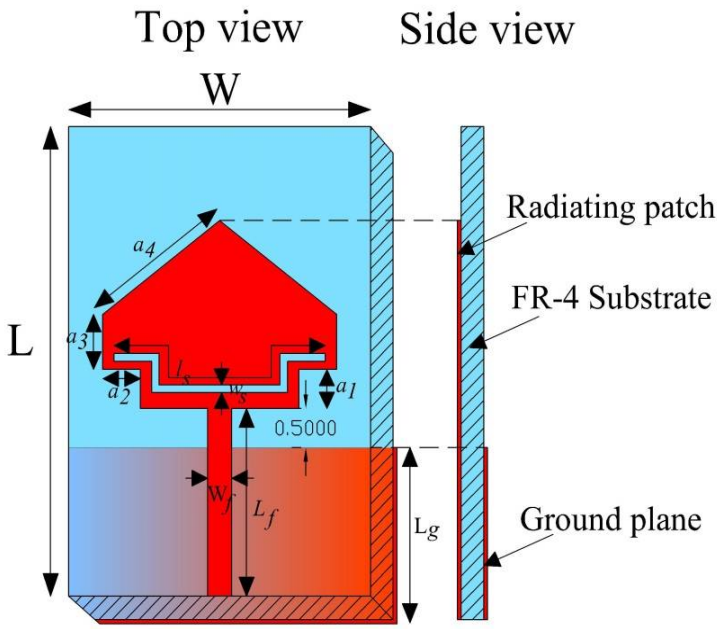
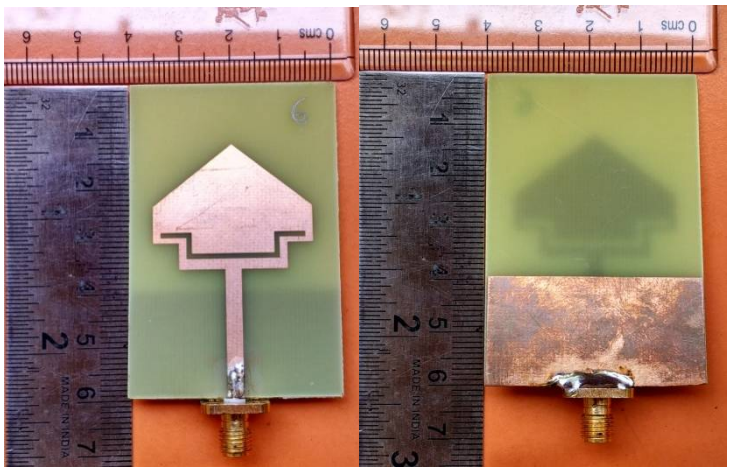


Fig. 1Geometry of TASHMA



(a) Top view (b) bottom view

Fig. 2 Photographs of TASHMA

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TABLE : 1 ANTENNA PARAMETERS

Parameters	Dimensions in mm
W	40
L	60
a_1	0.5
a_2	0.5
a_3	07
a_4	1.94
W_f	0.317
L_f	2.4
L_g	1.9
d	0.5

The top and bottom view of TASHMA is as shown in Figure 2 (a)and 2 (b) respectively. The antenna parameters are measured experimentally by using network analyser.

IV. RESULTS AND DISCUSSION

The simulated and measured return losses of the proposed antenna areas shown in Figure.3. The simulated and measured results demonstrate that there are three resonant frequencies excited at 1.7, 3.58 and 8.61 GHz. The proposed antenna exhibits triple band characteristics. The measured impedance bandwidth for the lower band is from 1.55 to 1.85 GHz which is 17%, for the middle band from 3.05 to 4.17 GHz which is 29.60% and for upper band from 8.46 to 8.77 GHz which is 3.59%. These operating bands cover the desired 1.6 GHz for GPS, 3.47 GHz for WiMAX and lower 8.52 GHz for X-band applications. Good agreement is observed between the simulation and measured results.

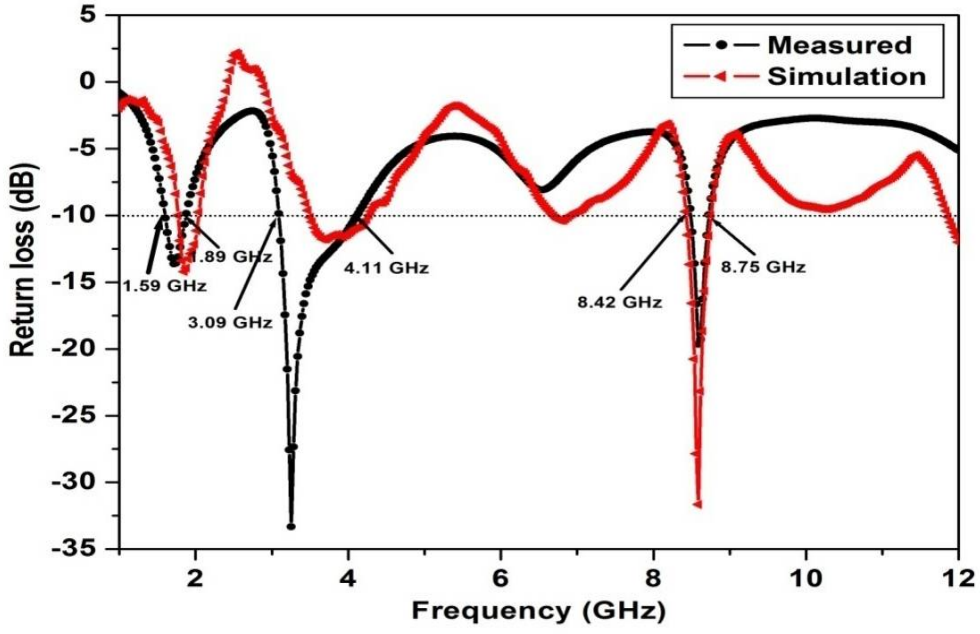

Fig.3 Return loss versus frequency of TASHMA

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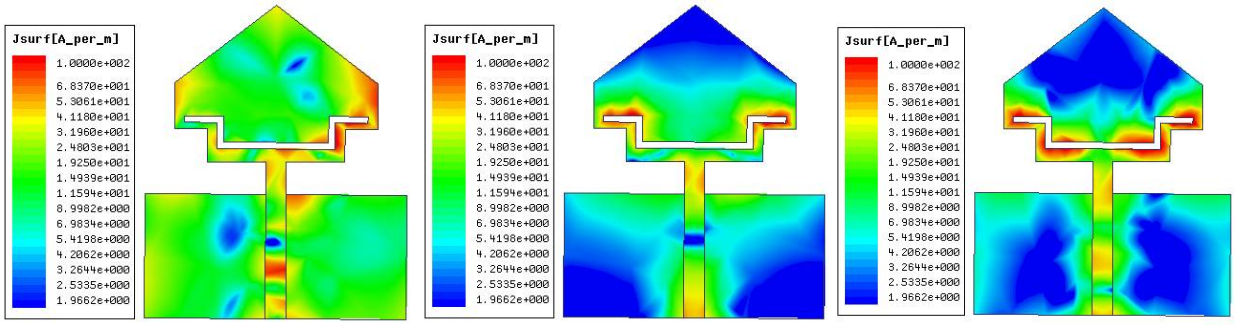
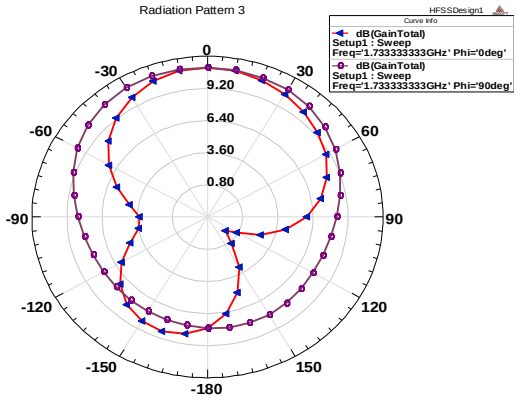
To illustrate the resonance mechanisms for the proposed antenna, the simulated current distribution at three resonant frequencies 1.7, 3.58 and 8.16 GHz are depicted in Figure 4 (a), (b) and (c) respectively. Current distribution in Figure 4. (a) appear at the left side of the ground plane. In Figure 4. (b),it appears on top of the radiating patch, feed line and ground plane whereas in Figure4. (c),it strongly appears on radiating patch and ground plane which indicates that the antenna is operating for three bands of frequencies.



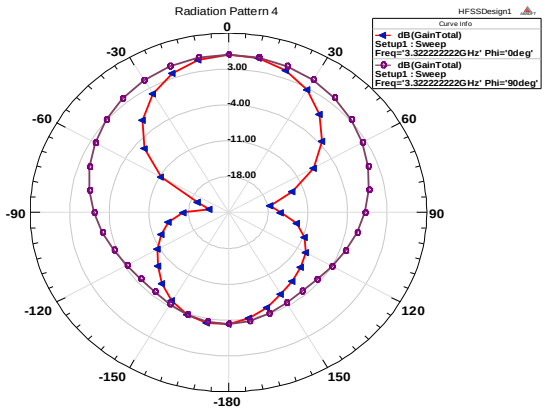
(a) (b) (c)

Fig. 4 Current distributions of TASHMA observed at (a) 1.7 GHz, (b) 3.2 GHz and (c) 8.57 GH

The E and H plane radiation pattern of the proposed antenna at 1.7, 3.58 and 8.16 GHz are measured and are shown in the Figure 5. The pattern is broad side andbidirectional in nature.



(a)



(b)

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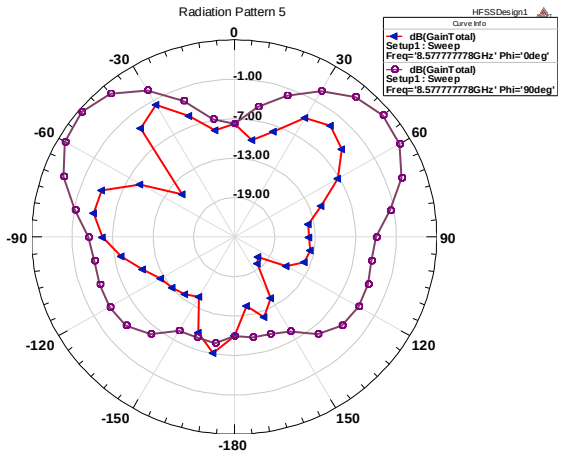

(c)

Fig. 5 Radiation pattern of TASHMA observed at (a) 1.7 GHz, (b) 3.2 GHz and (c) 8. 57 GHz

V.CONCLUSION

A novel design of TSHMA has been designed successfully for triple band operations which cover GPS and Wi-MAX applications. The structure of antenna is hybrid in nature and having slot inside it. By suitably varying the structure and dimension of the slot the designed radiation requirement is possible from this study. The-10 dB bandwidth of the proposed antenna is 17% for the lower frequency band, 29.60% for the middle frequency band and3.59% for the upper frequency band. The proposed antenna compact in its structure and designed using low cost FR4 substrate which is fed by a simple 50 Ω microstrip line feed. The antenna also shows a good broad side and bidirectional radiation pattern. The measured and simulated results are in good agreement with each other.

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