Triple Band Notch Loaded Hexagonal Patch Stacked Antenna

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***Abstract*-The proposed antenna is a novel structure of stacked micro strip hexagonal patch antenna (SMHPA) operable in 2-6GHz range of frequency with resonant frequencies at 2.8GHz in sub-band 2.78-2.85GHz, 3.98GHz in second sub-band 3.88-4.08GHz and 5.78GHz in third sub-band 5.66-5.95GHz associated with high gains and sufficient return losses. The antenna can be used for WLAN, Wi-Max and mobile-communication. The proposed antenna has been simulated by High frequency structure simulation software (HFSS).**

Key Words: SMHPA, WLAN, Wi-Max, Mobile Communication, HFSS

INTRODUCTION

A triple-band linearly polarized patch antenna as well as a dual-band dually polarized patch antenna with novel designs has been reported in previous years. A use of low-cost FR4 epoxy plate (ε_r =4.4, tan δ =0.02) with copper trace of 17μm thickness (rarely used) has been made for its design. Peak gains of 2.44, 2.12, and 1.64 dBi have been obtained at 2.24, 2.36, and 2.52 GHz, which are close to each other, respectively [1]. it was a latest observation in design of dual- or triple-band patch antenna by introducing U-slots in the patch of a broadband antenna, and the M-probe fed patch, the L-probe fed patch, aperture coupled stacked and coax-fed stacked patches, were also tested under the same methodology .In all these cases, authors used complex feed methods, multiple patches and more than one layer[2]. A dual-band, singly fed slotted microstrip antenna is used for wireless local area network (WLAN) at 2.4 GHz and worldwide interoperability for microwave access (Wi-MAX) at 2.5/3.5 GHz. The antenna is comprised of an aperture-feeding method and a square patch with a narrow π-shaped slot to yield a dual-band resonance. The geometry is found to resonate at a lower frequency band ranging over 2.4–2.484 GHz for WLAN band and 2.5–2.69 GHz for Wi-MAX band. The higher-frequency resonance is obtained in the 3.5 GHz Wi-MAX band. The antenna has a multilayered aperture-coupled feed configuration [3]. The multiband circular polarization (CP) is achieved by corner truncation, embedding slits and inclined slots on a three layered antenna structure. The antenna also shows wideband behavior with an impedance bandwidth of 52.13% in the frequency range of 4.85GHz to 8.27 GHz, while 3 dB axial ratio bandwidths in five CP bands are 0.51%, 4.54%, 0.33%, 0.83% and 1.29% in the frequency range of 5.12GHz to 5.15 GHz, 5.45 GHz to 5.70GHz, 5.90GHz to 5.92 GHz, 6.25 GHz to 6.31GHz and 7.68GHz to 7.78 GHz, respectively[4-6].In this proposed work, the microstrip patch antenna-1 and antenna-2resonate with impedance bandwidth of 2.5% and 2.3% at 2.8GHz,5.0% and 7.8% at 3.98GHz,5.0% and 4.89% at 5.78GHz and return losses at the same respective resonant frequencies stand at -16.8dB and -18 dB,-35.33dB and-22.8dB and -12.56dB and-12.36dB.Comparative study of the antenna-1 and antenna-2 is prosecuted

ANTENNA STRUCTURE

Two antenna structures have been designed by two FR4-epoxy substrates of the same thickness of 1.6mm stacked together without any gap with different dimensions and the ground is occupying the whole area underneath the lower substrate and the copper hexagonal patch of side 12mm being centrally off oriented by -1mm from the origin lies on the top of the upper substrate. Figure 1 and 2 exhibit all the dimensions and physical parameters according to given table1 for dimension of antenna-1 and the dimensions of the lower substrate along with ground in antenna-2 shown in figure 3 and 4 are reduced to equal to those of the upper substrate while keeping all the parameters same as those of antenna1.

Table1. Dimensions for antenna1 and antenna2

Specification	Dimension
Substrate dielectric constant ε_r	4.4
Loss tangent	0.02
Length of substrate antenna1 L	70mm
Width of substrate antenna1 W	40mm
Height of substrates H=H1	1.6mm
Length of substrate antenna2 L1	28mm
width of substrate antenna2W1	28mm
Length of rectangular notch W3	10mm
Width of rectangular notch L3	0.5mm
Slot length L2	6m
Slot width W5	0.5mm
Slot height W4	1mm
Probe feed position (X1,Y1)	(4, -8)mm
Shorting pin (X2,Y2)	(-2, 4)mm
Shorting pin radius	0.67mm

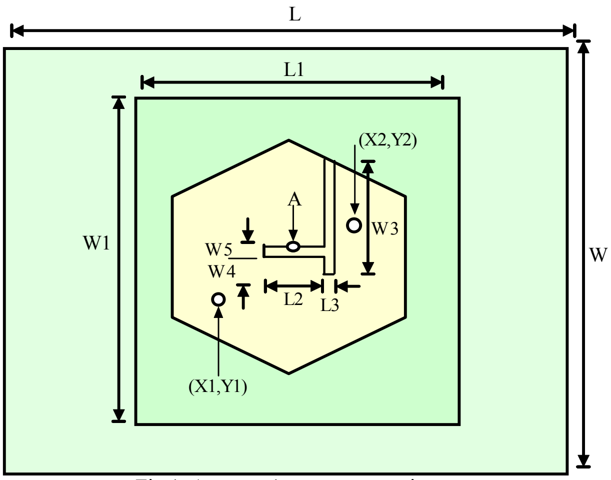

Fig.1. Antenna-1 structure top view

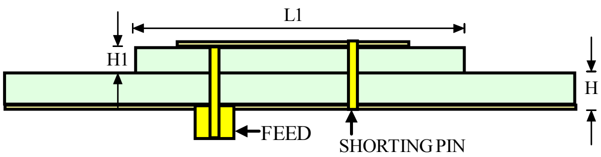

Fig.2. Antenna-1 structure side view

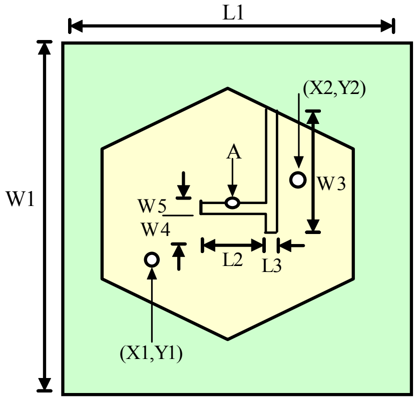

Fig.3. Antenna-2 structure top view

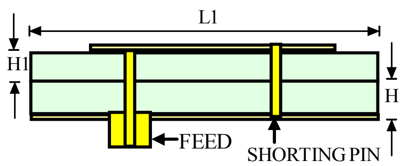

Fig.4. Antenna-2 structure side view

RESULTS AND DISCUSSION

The return losses offered by the proposed antenna-1 fall down to -18.48dB at 2.8GHz, -38.32dB at 3.98GHz and -12.10dB at 5.78GHz and the antenna -2 reaches on -18dB, -22.8dB and -12.36dB on the same consecutive resonant frequencies as shown in figure 5. The voltage standing wave ratios (VSWR) in figure 6are obtained at 1.47, 1.22 and 1.47 for antenna-1 and for antenna-2, 1.23, 1.09 and 1.64 at 2.8GHz, 3.98GHz and 5.78GHz, respectively.

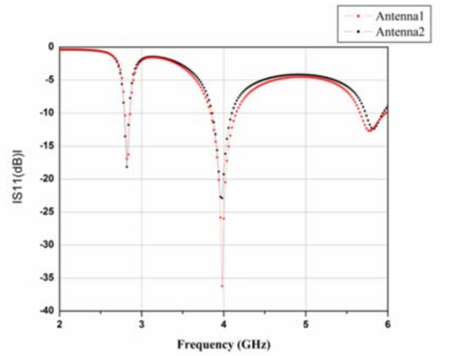

Fig.5.Returnlossversus Frequency of antenna1and antenna2

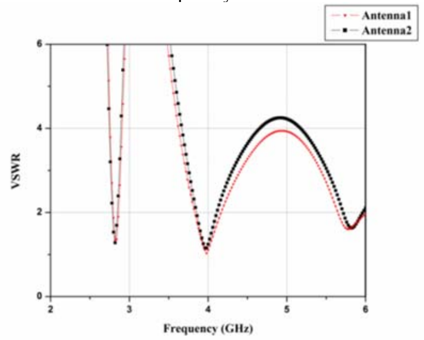

Fig.6. VSWR versus Frequency of Antanna1 and antenna2

Figure7 shows gains at resonant frequencies 2.8GHz, 3.98GHZ and 5.78GHz standing at the levels of 0.9dB, 5.8dB and 1.9dB for antenna1and those of antenna2 at 0.6dB, 6.0dB and 1.92 respectively.

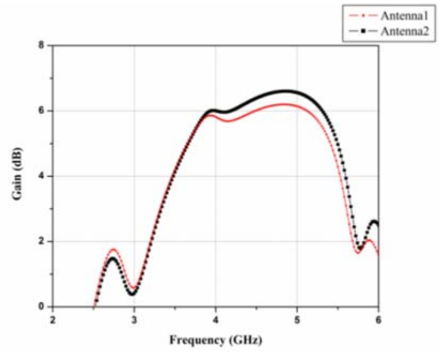

Fig.7. Gain Versus Frequency of antenna1 and antenna2.

The figure 8-13 exhibit the distribution of electric field in E-Plane ($\phi = 0^o$) and H-plane ($\phi = 90^o$). The radii at different Elevation angles (θ) of the circular scale represent the normalized magnitudes of the field in dB aligned along the $\theta = 0^o$ radial axis representing 0.0dB to -40 dB field levels. The field pattern of antenna-1 in figure 8 shows maximum radiation at bore side in E-plane whereas that in H-plane at an angle displaced -30^o (left to bore side ($\theta = 0^o$)) and the half power beam width (HPBW) of antenna-1 in E-plane is 98.86^o and that in H-plane is 88.08^o at 2.8GHz. Figure 9 for antenna-2 shows the maximum field along the bore side in both E-plane and H-plane at 2.8GHz and the half power beam width (HPBW) in E-plane is 99.32^o and that in H-Plane is 93.45^{o}at 2.8GHz. Figure 10 displays the field radiation patterns of antenna 1 with maximum strength along +30^o (to the right of bore side) in E-plane and -30^o (to the left of bore side) in H-plane and the half power beam widths in E-plane and H-plane are found to be 81.72° and 77.2°, respectively at 3.98 GHz. Figure 11 for antenna-2 indicates maximum radiation at 0.43° in both the planes and half power beam widths are obtained to be 83.06° in E-plane and 77.19° in H-Plane at 3.98GHz. Figure 12 for antenna-1 at 5.78GHz shows the radiation pattern of maximum strength at +30° in E-plane and -30° in H-plane whereas the Half Power beam widths (HPBW) are 69.08° and 92.09° in E and H-Planes, respectively. Figure 13 for antenna-2 at 5.78GHz exhibits maximum strength at 31° in both the planes and HPBWs are of 68.17° and 64.97° in E and H-planes, respectively.

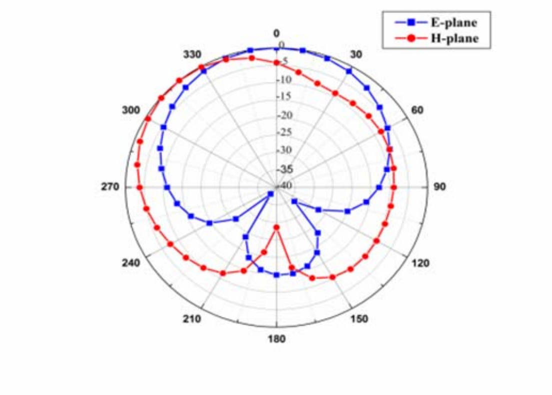

Fig.8.Radiation pattern of antenna1 at 2.8GHz

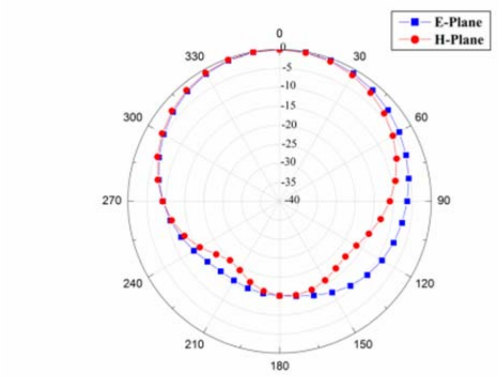

Fig.9.Radiation pattern of antenna2 at 2.8GHz

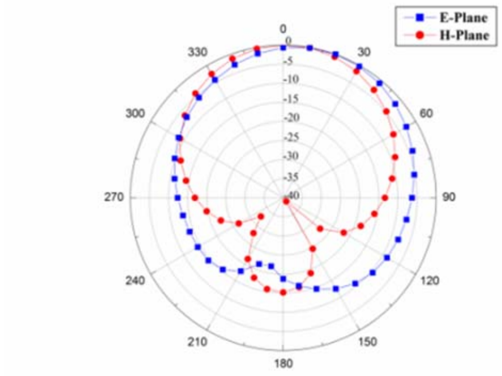

Fig.10.Radiation pattern of antenna1 at 3.98GHz

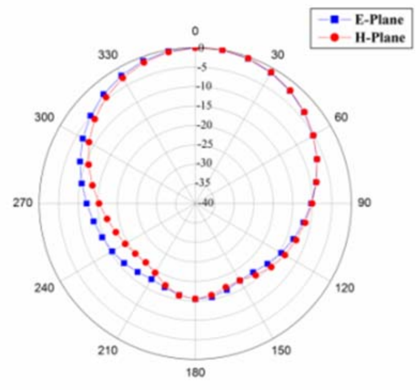

Fig.11.Radiation pattern of antenna2 at 3.98GHz

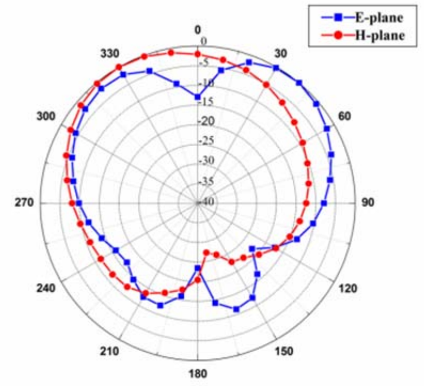

Fig.12.Field radiation pattern at 5.78GHz for antenna-1

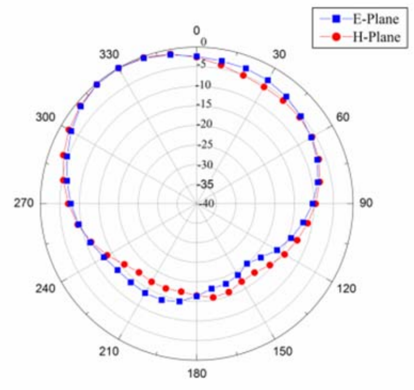

Fig.13.Field radiation pattern at 5.78GHz for antenna-2

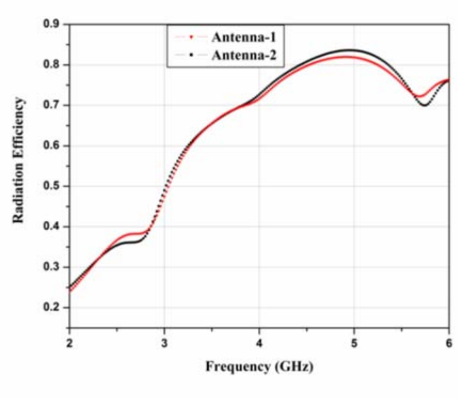

Fig.14. Radiation Efficiency Versus Frequency of antenna1 and antenna2.

Figure-14 shows the comparison between the efficiencies of the antenna-1 and antenna-2. The efficiencies of antenna-1 at 2.8GHz, 3.98GHz and 5.78GHz are 38%, 72% and 73% and antenna-2 at the same frequencies provides 32%, 72% and 70%

CONCLUSION

The put forth antenna in this paper finds its applicability in the field of wireless operation such as, WLAN, Wi-Max and mobile communication. The antenna can be operated at any point of frequency in the operating band 2.70-2.85GHz, 3.88-4.08GHz (S-band) and 5.66-5.95GHz (C-band). A vestige of C-band has been occupied by the second band of the antenna. With small sacrifice in return loss and the gain, some material can be saved.

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