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Improved H-shaped Multiband MSA for DCS, WiMAX and WLAN Application with Enhanced Antenna Parameters

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Abstract: *Multi band H shaped MSA is presented here. This antenna is suitable for DCS, WiMAX and WLAN application. FR-4 epoxy substrate is used on which H shaped slot is cut by etching technique. This structure radiates for DCS (1.71-1.88) GHz, low band WiMAX (2.50-2.69) GHz and WLAN (5.15-5.35) GHz. The return loss obtained at 1.8268 GHz, 2.6352 GHz and 5.2840 GHz are -38.62 dB, -50.62 dB and -19.48 dB respectively. It is obtained that the designed antenna offers enhanced value of S_{11} and VSWR less than 1.24. Ansoft HFSS v11 is used for simulation of this patch antenna.*

Keyword: *MSA, Multi band, Patch antenna, DCS, WiMAX, WLAN, Return loss, VSWR and HFSS.*

I. Introduction

Microstrip antennas are popular for their attractive feature of planer antenna such as low profile, light weight, manufacturing and easy integration to conformal shaping, low cost, simplicity of circuits. The basic form of microstrip patch antenna includes a bottom ground plane, a dielectric substrate which has certain dielectric constant (ε_r) and finally patch reside on opposite to ground plane. Patch radiates only at the desired frequency band [1].

The most common disadvantage of microstrip patch antenna is narrow band width. Enhancement of the performance to cover the demanding bandwidth is necessary. There are numerous and well known method is used to increase the bandwidth of antenna including increase the substrate thickness [2], use of low dielectric substrate, use of various impedance matching and feeding techniques, use of multiple resonators and use of parasitic patches.

Many scholars have proposed diverse shapes of microstrip patch antennas for distinct applications with different feeding techniques [3] [4]. A number of slot shapes have been designed and proposed e.g. E-shaped [5], H-shaped [4], C-shaped [6] and U-shaped [7].

In this paper a simple H shaped multiband microstrip patch antenna with coaxial feed is presented, which is functioning at DCS, WiMAX and WLAN frequency band.

II. Design

This section deals the design of multi band microstrip patch antenna. Fig.1 shows the different part of patch antenna. The configuration of proposed multiband antenna is shown in Fig.2.The antenna consists of a ground plane and rectangular patch loaded with H-shape slot. The proposed antenna is designed on FR-4 epoxy substrate of 1.6 mm thickness. The dielectric constant of the substrate is 4.4 and loss tangent is 0.02. The top view of proposed antenna is shown in Fig.2. All simulation has been carried out on Ansoft High frequency structure simulator (HFSS).

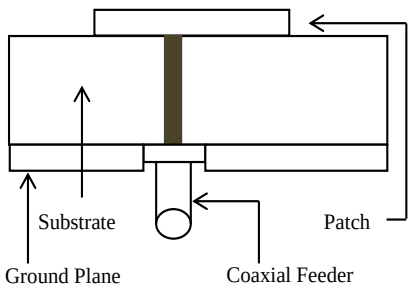

Fig.1 Side view of patch antenna

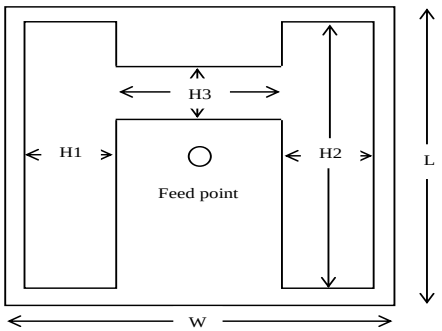

Fig.2 Top view of proposed antenna

Here antenna design parameters are calculated by following formulas-

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{1+\varepsilon_r}} \quad (1)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{W}}}\right) \quad (2)$$

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.300)}{(\varepsilon_{eff}-0.258)}\frac{\left(\frac{w}{h}+0.264\right)}{\left(\frac{w}{h}+0.800\right)} \quad (3)$$

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (4)$$

$$L_{eff} = L + 2\Delta L \quad (5)$$

Here W is the width of the patch, L is the length of the patch, ε_{reff} is the effective dielectric constant, c is the speed of light in vacuum, f_r is the target frequency, ε_r is the dielectric constant of the substrate, h is the thickness of the substrate and L_{eff} is effective length of patch and ΔL represents the extension in the length caused by the fringing effect and by considering the dimension of the patch it can easily be ignored. The proposed antenna have patch of dimension 40×40 mm^2.

The optimized value of the shape parameters of antenna are listed in Table 1.

Antenna Design parameter	**Value (mm)**
W	40
L	40
H1	4×36
H2	29×3.5
H3	4×36
Feed point	35, 39

III. Results and Discussion

HFSS (High Frequency Structure Simulator) is used in designing of this MSA. The simulation results are shown below. The Fig.4 indicates the Return loss of MSA. It is clear that the antenna designed in this paper have three operating frequency, which are 1.8268GHz, 2.6352GHz and 5.2840GHz.

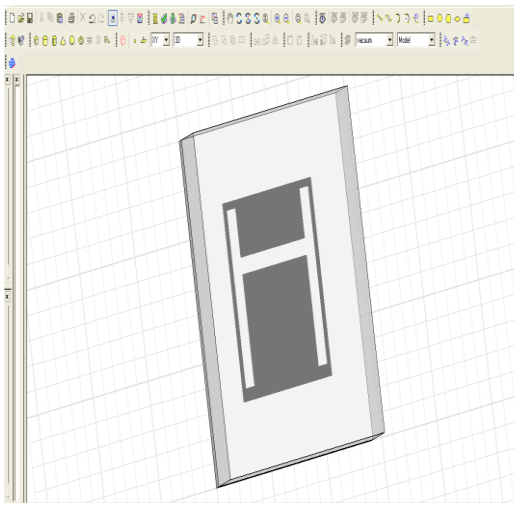

Fig.3. 3D view of H-shaped MSA

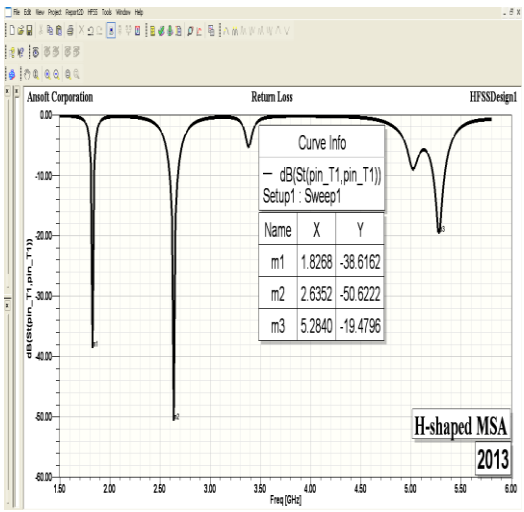

Fig.4. Return Loss of MSA

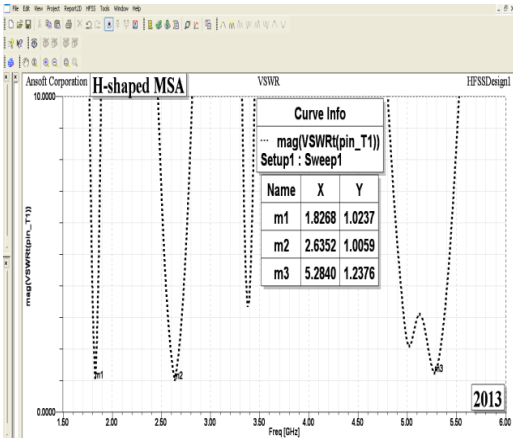

Fig.5 VSWR of MSA

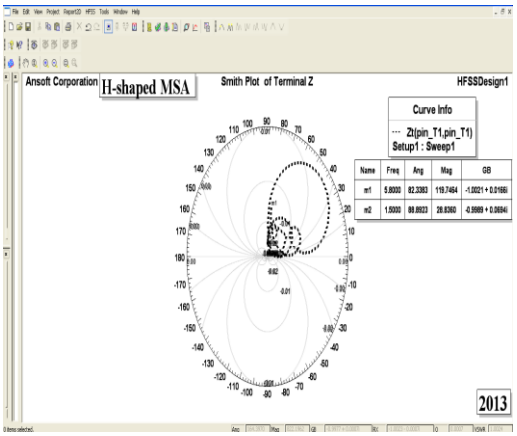

Fig.6 Smith plot of MSA

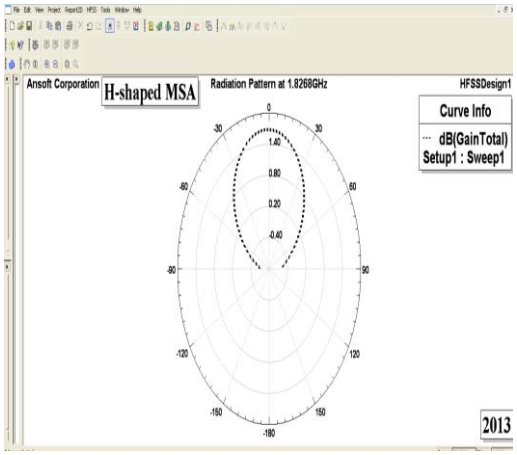

Fig.7 Radiation Pattern at 1.8268 GHz

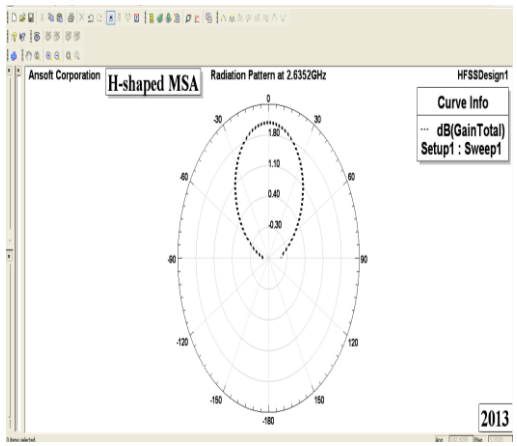

Fig.8 Radiation Pattern at 2.6352 GHz

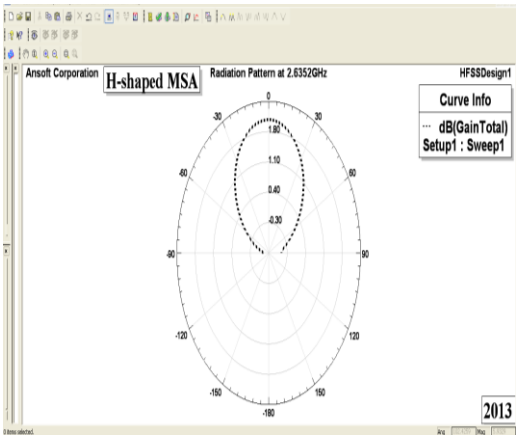

Fig.9 Radiation Pattern at 2.6352 GHz

This proposed patch antenna is suitable for DCS WiMAX and WLAN application for (1.71-1.88) GHz, (2.50-2.69) GHz, and (5.15-5.35) GHz frequency range respectively. The Bandwidth at these frequencies is 3.23%, 8.28% and 12.47% respectively. The maximum Gain obtained is 4.60 dBi. The triband band antenna designed in [8] is suitable for DCS and WLAN application. This antenna radiates three frequencies which are 1.8GHz, 2.45GHz and 5.2GHz. The Return loss S_{11} at these frequencies is -18.31dB, -17.80 dB and -35.40 dB. Bandwidth at these frequencies is 2.5%, 4% and 16% respectively and maximum Gain is 2.10 dBi. The VSWR obtained in this paper is ≤1.5. Better results obtained from improved H-shaped MSA with enhanced antenna parameters with better VSWR (≤1.24) observed from Fig.5.

IV. Conclusion

A multiband antenna has been proposed here that consists of H-shaped slot. When antenna is properly excited by coaxial feed cable then antenna resonates at three different frequencies. The proposed antenna is suitable for DCS, WiMAX and WLAN application. The antenna has good multiband operation performance while maintaining small size and agreement with simulated results. The proposed antenna features are compact size, good multiband Bandwidth, improved Gain and lower VSWR. This indicates that the proposed antenna can be good candidate for DCS, WiMAX and WLAN application.

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