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Wide Branch Msa for Quadra Band Wireless Applications

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Abstract: This paper presents an approach for the design of a compact patch antenna which operates in Qadra band and it is independent of the operating frequency. The antenna comprises of a main patch with sub patches containing resonating slots. The main patch is fed by 50Ω microstrip line. It is designed to generate up to five separate modes to cover the frequency range from 1.89GHz to 9.74GHz for the operation of wireless devices supporting multiple standards including Cable and Wireless Worldwide TV application (CW applications, 1.8GHz-1.9GHz), Wireless Local Area Network (WLAN, 5GHz – 6GHz), (Cordless, 7.1GHz to 7.9 Ghz), (Radar Applications, 8GHz to 10GHz).The design is verified through the numerical simulation by using ANSOFT HFSS and obtained four separate modes that covers the frequency from 2.2GHz to 6.9GHz.

Key words: MSA · Resonating slot · WLAN

INTRODUCTION

In today's modern communication industry, antennas are the most important components required to create a communication link. Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure [1]. Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers. It is also most suited for aerospace and mobile applications because of their low profile, light weight and low power handling capacity. They can be designed in a variety of shapes in order to obtain enhanced gain and bandwidth for multiband frequency application independent of the operating frequency. Several methods are proposed to obtain the multiband frequency. Multiband frequency antenna may avoid the use of multiple antennas. Here single compact antenna is designed to cover the 5 modes to cover the frequency range from 1.89GHz to 9.74GHz. Electromagnetic bandgap (EBG) structure is used as defect ground plane structure to reduce size and achieve multiband resonant frequencies [2]. The design of a microstrip patch antenna with different shapes to create multiband characteristics has been confirmed by using different shaped resonating slots [1]. Wideband structures can be obtained by loading the patch with one or more slots. The characteristics obtained depend on the shape and position of the slots. When the slot is cut, the currents and the excited mode is perturbed, then the resonant frequency is lowered. Another technique to obtain the multiband frequency is meandering the patch. Meandering is achieved by inserting several narrow slits at the patch's non radiating edges. The excited patch's surface currents are effectively meandered, leading to a greatly lengthened current path for a fixed patch linear dimension. This behavior results in a greatly lowered antenna fundamental resonant frequency and thus a large antenna size reduction at a fixed operating frequency can be obtained.

Rectangular Microstrip Patch Antenna: Microstrip patch antenna in its most basic form consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Fig1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiation pattern is dependent on the patch. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane [3].

The radiating patch and the feed lines are usually photo etched on the dielectric substrate.In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, elliptical or some other common shape.

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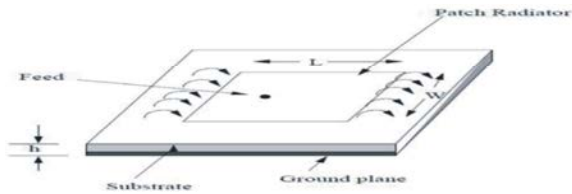


Fig. 1: Simple rectangular patch antenna

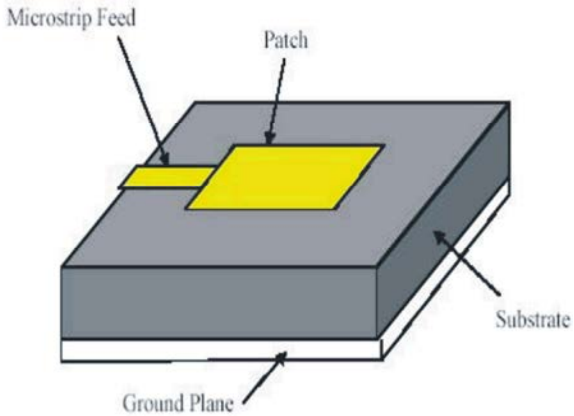


Fig. 2: Microstrip feed technique

Microstrip patch antennas can be fed by a variety of methods. The four most popular feed techniques used are the microstrip line, coaxial probe, aperture coupling and proximity coupling.

In our design we use the microstrip line feed. In this type of feed technique, a conducting strip is connected directly to the edge of the microstrip patch as shown in Fig2. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. Hence this is an easy feeding scheme, as it provides ease of fabrication and simplicity in modelling [4].

Design Parameters: For a rectangular patch, the length L of the patch is usually $0.3333\lambda o < L < 0.5\lambda o$, where λo is the free-space wavelength. The patch is selected to be very thin such that $t << \lambda o$ (where t is the patch thickness). The height h of the dielectric substrate is usually $0.003\lambda o \le h \le 0.05\lambda o$. The dielectric constant of the substrate (ε_r) is typically in the range $2.2 \le \varepsilon_r \le 12$[5]. Formulas used for the patch design is given below,

1) Patch Width, $W = \dfrac{c}{2f\sqrt{\dfrac{(\varepsilon_r+1)}{2}}}$

2)Patch Length, L= $L_{eff} - 2dL$

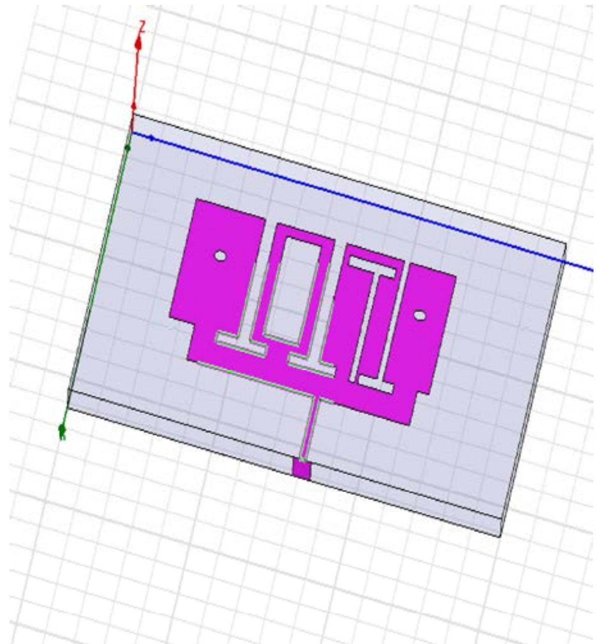


Fig. 3:

where $L_{eff} = \dfrac{C}{2f\sqrt{\varepsilon_{reff}}}$

$$dL = 0.412h\frac{\left(\varepsilon_{reff}+0.3\right)\left(\frac{W}{h}+0.264\right)}{\left(\varepsilon_{reff}-0.258\right)\left(\frac{W}{h}+0.8\right)}$$

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

3) Ground Length L_g=6h+L

4)Ground width W_g=6h+W

5)h→substrate height;

6)Substrate material choosen→FR4;

Design Parameter Values

Wide Fork Edged Msa

Structure: Our design has one main radiating patch and four sub patches as shown in Fig 3. We have introduced a resonating slot on sub patch 2&3. The size of the rectangular slots determines the specific resonant frequency.

Table 1: Dimensions of the antenna in mm

Parameters	Value(mm)
Main patch(l x b)	7 x 38.5
Sub patch 1(l x b)	24 x12
Sub patch 2(l x b)	24 x10
Sub patch 3(l x b)	24 x10
Sub patch 4(l x b)	24 x 8
Resonating slot of sub patch 2 (l x b)	20 x 6
Resonating slot of sub patch 3(l x b)	2 x 8
	1 x 22
strip of sub patches(l x b)	2x4
strip of main patch(l x b)	12.5x7
Feed at position (x,y)	(56,39)
Feed (l x b)	2.4x3
Circle in subpatch 1,4 of radius	1

Table 2: Simulated result for the proposed antenna

Resonant frequency (GHZ)	Return Loss (dB)
1.89	-12.59
5.73	-15.79
7.66	-20.20
8.40	-22.81
9.74	-18.06

Simulated Results: The designed antenna is drawn by using the ANSOFT HFSS software.Optimum output is obtained by changing the feed location.We obtain five band of frequency at feed location (56mm,38mm,2.4mm).

Rectangular Plot

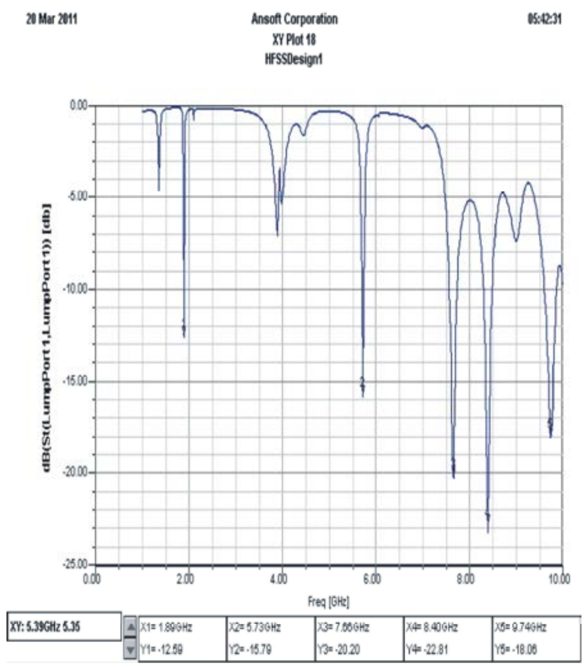
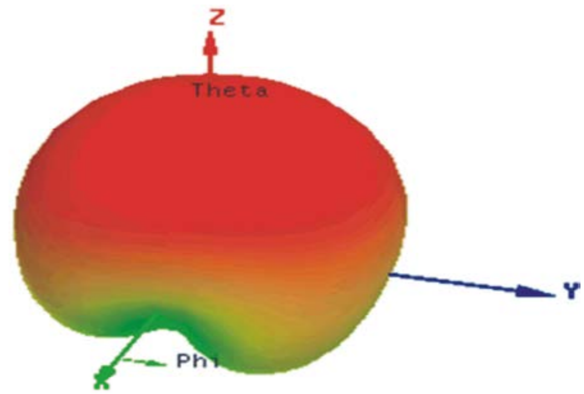
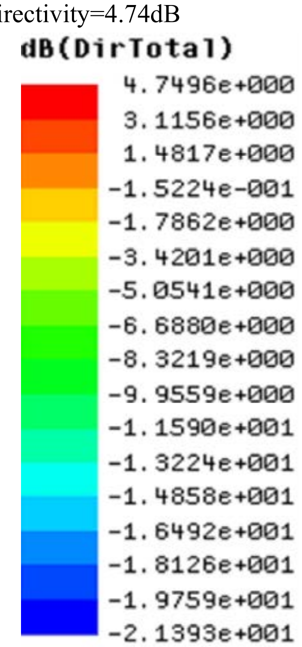


Fig. 4: Simulated result loss of the antenna.

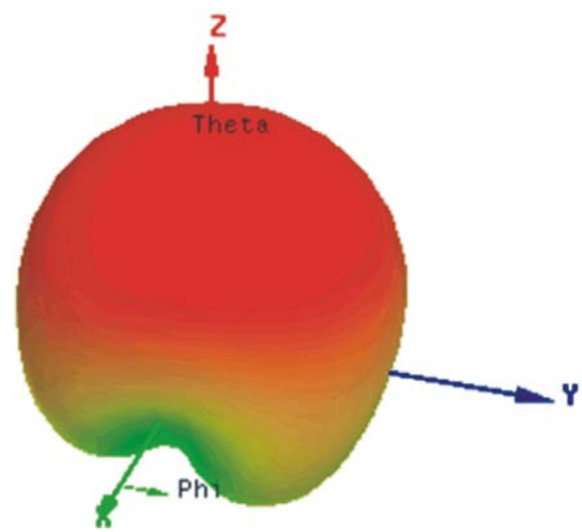
B. 3D POLAR PLOT-DIRECTIVITY



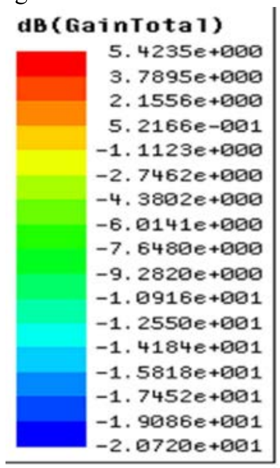
Maximum directivity=4.74dB



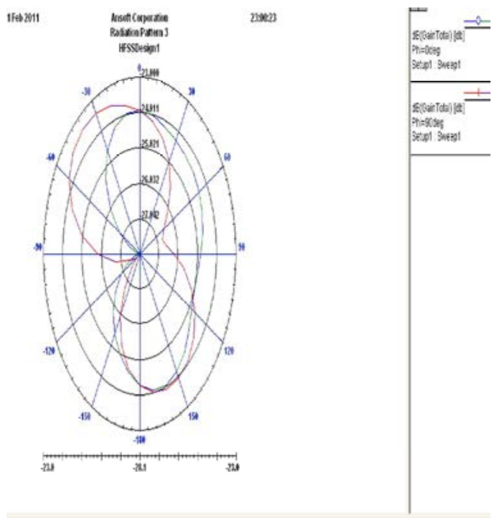
C.3D POLAR PLOT-GAIN



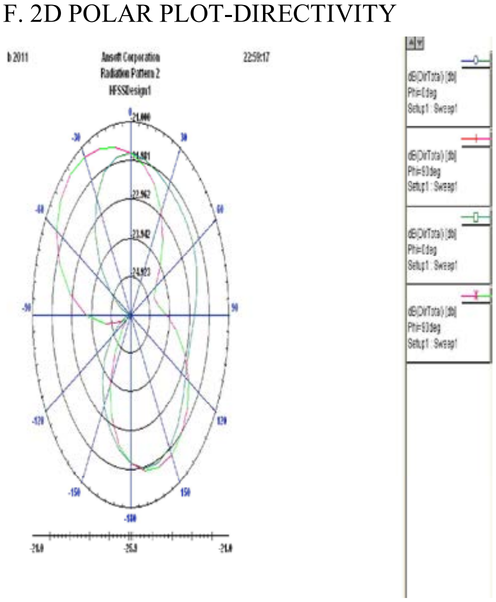
Maximum gain=5.4235dB



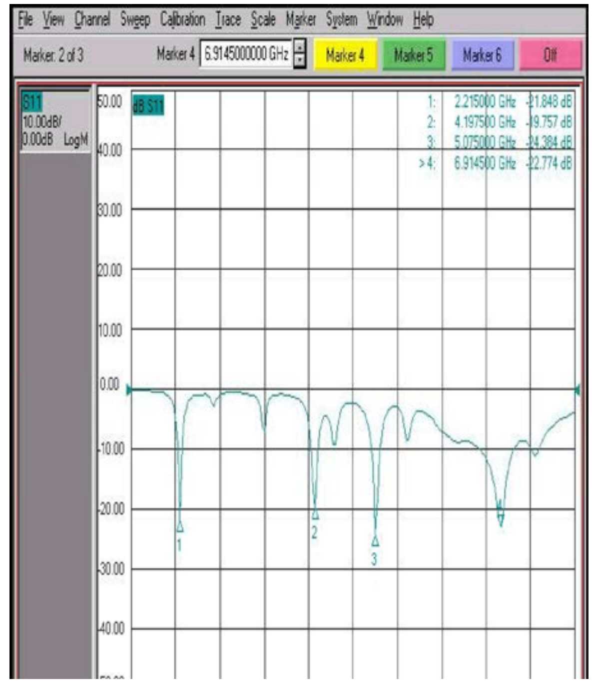
D. 2D POLAR PLOT-GAIN



F. 2D POLAR PLOT-DIRECTIVITY



G.HARDWARE RESULT



CONCLUSION

The antenna is designed and successfully simulated,verified experimentally a FORK MSA. It covers the frequency band from 2.2GHz to 6.9GHz experimentally. It is used for WLAN,WIMAX satellite communication band and it has been observed that tha antenna exhibits a minimum return loss of about -24.384dB at 5.07GHz when we introducing the resonating slots in the subpatches.The antenna also operates at various other frequencies with considerable impedance matching with a gain of about 5.4235dB [6].

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