IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

DESIGN OF A MULTIBAND MICROSTRIP PATCH ANTENNA FOR 4G APPLICATION

Shefali Naik
Electronics and Telecommunication Engineering
Goa college of engineering, Goa, India

Amita Dessai.
Electronics and Telecommunication Engineering
Goa college of engineering, Goa, India

Abstract: In this paper a multi-band slot micro strip antenna is designed for 4G applications. The antenna consists of an inverted HE shaped slot on the patch and a rectangular slot in the ground plane. The proposed multiband antenna is designed for three different substrates which are FR-4, Rogers 4350 and RT-Duroid, keeping the height of the substrate constant at 3mm. Different parameters which are Return loss, VSWR, directivity and gain are studied and compared. The antenna is been design and simulated using the IE3D software.

Keywords: 4G, Multiband, Slot antenna, IE3D

I. INTRODUCTION

Micro strip antennas are being used in a various range of applications in recent years due to its numerous advantages such as low cost, light weight, small size, low profile, and easy fabrication. Recent growth and demand of wireless communication motivated researchers to obtain multiple operating bands to cover different applications from single antenna design. Various type of techniques has been reported to obtain multiband operating characteristics. To meet the application and design requirement various substrate are being used for fabrication and design of MPA like FR-4, RT duroid, Rogers 4350 etc.

In [1] a Micro strip Patch multiband antenna had been designed for six different frequencies from 2GHz-8GHz. The designed antenna uses the inset feed line technique for feeding the patch and is implemented on RT Duroid as the substrate. The L shaped slots cut on the surface of the patch which increases the gain of the antenna. In [2] the antenna designed contains a rectangular slot with a T-shaped stub, and six E-shaped stubs to achieve multiple frequency bands. The

results obtained showed that the antenna resonated at multiple frequencies such as 1.7GHz for GPS systems, 2.45 GHz, 3.03GHz for S-band, 4.25 GHz, 4.90 GHz, 7.2 GHz C-band and 9.3 GHz for X-band applications respectively.

In [3] a new E shape mounted on patch antenna on FR4 substrate is presented with insertion of shortening pin between patch and ground plane, the proposed structure resonated on 6 frequencies. Co axial cable is used as means of excitation to excite proposed structure with minimum impedance mismatch losses. The proposed design is miniaturized up to 60.66% and can be used for GSM, GPRS, 4G, WLAN and other S-band and C-band applications.

In [4] a low profile planar antenna for most of the used bands between 800MHz to 9GHz (10 bands) is designed. The antenna structure comprises L-type, C-type and inverted F-type. All of the bands showed the gain of over 2dBi and significant S11 parameters of below -10dBm.It is observed that wideband characteristic can be achieved by using coupled fed mechanism and slotted ground structure. The bandwidth of the antenna designed is improved significantly by the alterations made into the ground plane as well as structure of all types of antenna

In [5] a multiband slotted MSPA have been designed on FR4 substrate. Inset feed micro strip line was used to get the desired output. In [6] small size, multi-band rectangular micro strip patch antennas is designed with Defected Ground plane (DGS) for WLAN-5.8 GHz, WiMAX- 5.8 GHz, Airport Surveillance (2.7-2.9 GHz), and DBS (10.7-12.75 GHz). In [7] U, Z, L shaped slots where cut to get the desired multiband characteristics. The antenna as designed on RT-duroid and VSWR was found to be 1.18 & Return loss = -21.5dB. These characteristics make the designed antenna suitable for 4G applications.

The organization of the article is as follows.

Antenna design and configuration for the proposed antennas are portrayed in section II. Section III contains the multi-band performances of the proposed antennas for three different substrates. In section IV a brief conclusion is provided for this article.

II.ANTENNA DESIGN AND CONFIGURATION

Micro strip antenna consists of a ground plane covered with a dielectric substrate. The patch is located in or on dielectric material and is fed by using various feeding method. The length of the patch antenna is almost half wavelength within the dielectric; it's a really critical parameter, which provides the resonant frequency of the antenna. Following antenna design equations are used to obtain the patch length and width at a frequency of 2.2GHz.

1. Width of the patch

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

Where $c = speed\ of\ light$
$= 3 * 10^8 m/sec$
$\varepsilon_r = dielectric\ constant$
$f_0 = resonant\ frequency$
h= *height of substrate.*

2. Dielectric constant (Effective)

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

3. Length due to the effect of fringing field

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

4. Length due to the resonance

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

5. Total length of the patch

$$L = L_{eff} + 2\Delta L$$

6. Length and width of ground plane.

$$L_g = 6h + L$$
$$W_g = 6h + W$$

After calculating the length and width of the patch, an inverted HE shaped slot on the patch to obtain the desired multiband characteristics. For miniaturization, ground plane is introduced with a rectangular slot with dimensions Ls and Ws. The figure1 shows the design of the antenna with the HE shaped slot and the rectangular window like defect on the ground plane. Figure2 shows the dimensions of the HE shaped slots.

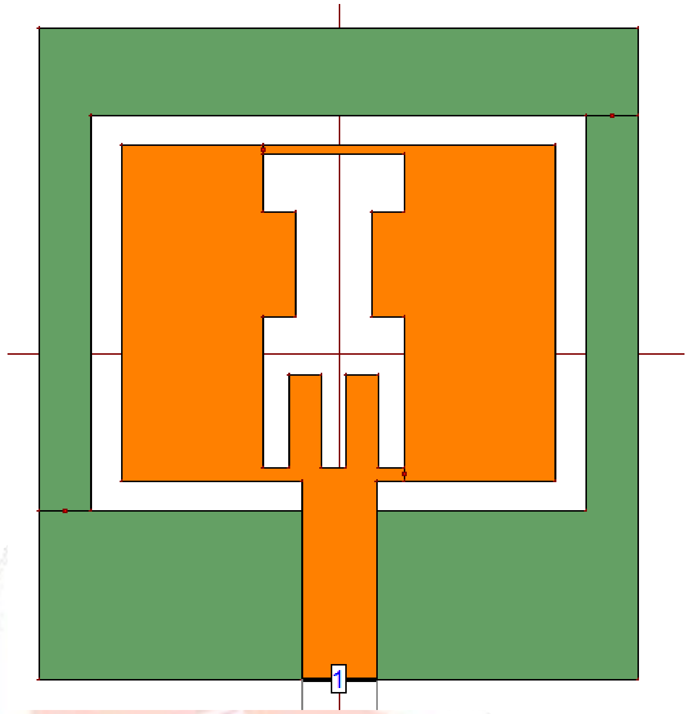


Figure1: Design of the Patch Antenna

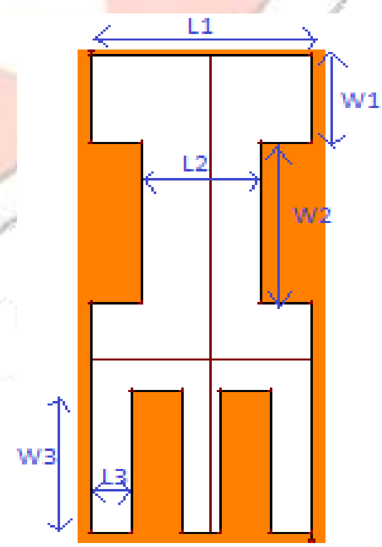


Figure 2: Dimensions of the HE shaped slot

The designing of the antenna is done on three different substrates which are FR4, Rogers 4350 and RT-Duroid keeping the substrate height constant at 3mm.

Regarding the dimensions of the antenna structure for all different types of substrates with all slots information is tabulated in Table1.

Parameters	FR4	Rogers 4350	RT-duroid
ε_r	4.4	3.48	2.2
h	3	3	3

W	39	42	49
L	30	32	40
Wg	57	60	67
Lg	48	50	58
Wf	17	20	28
Lf	5.68	6.81	9.37
L1	11	12	14
W1	5	6	8
L2	9	10	12
W2	5	6	8
L3	6	7	8
W3	2	2	3
Ls	31	33	41
Ws	40	43	50

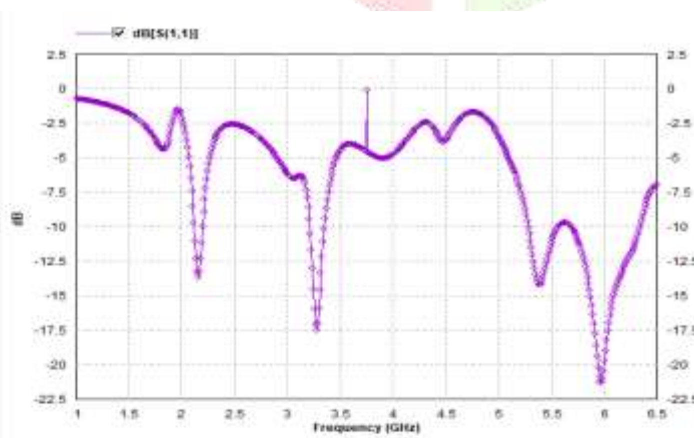
Table 1: Parameters for antenna

III. RESULT & DISCUSSION

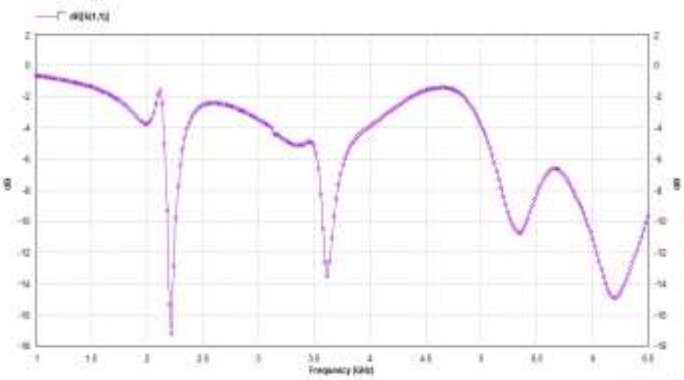
In this section we will describe the simulated results of the HE shaped slot antenna which is designed to work on four different frequencies ranging from 2GHz to 8GHz.proposed antenna which is designed on three different substrates. The designed antenna has been analyzed through three parameters i.e. VSWR, return loss, gain and Bandwidth by using IE3D software. The conclusion is made on the basis of which shows good simulation results.

Figure 3, shows the reflection coefficient versus frequency graph for various substrates. Table 2 gives the values of return loss and VSWR for four different frequencies for different substrates. Return loss observed for the designed frequency is achieved to be below -10dB. From the table it is observed that RT-Duroid has maximum return loss for all the four frequencies, followed by Rogers 4350. FR4 shows the minimum return loss among the three substrates.

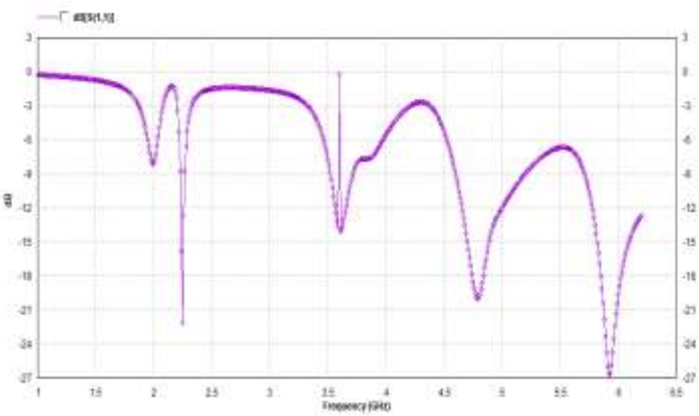
The VSWR for an antenna should be less than or equal to two. The antenna which has VSWR closure to 1 is considered to be good. Hence from the table 2 we can see that RT-duroid has VSWR close to one for all the frequencies achieved. Table 3 gives the values for gain and directivity.



a: Return loss of antenna designed on FR4



b: Return loss of antenna designed on Rogers 4350



c: Return loss of antenna designed on RT-Duroid

Figure 3: Reflection Coefficient v/s Frequency graph

Substrate	Frequency (GHz)	Return Loss (dB)	VSWR
FR4	2.2	-13.53	1.57
	3.3	-17.48	1.31
	5.3	-14.18	1.4
	6	-21.22	1.18
Rogers 4350	2.2	-17.11	1.32
	3.6	-13.08	1.57
	5.3	-10.74	1.82
	6.2	-14.89	1.43
RT-duroid	2.2	-18.38	1.2
	3.6	-14.09	1.5
	4.8	-19.84	1.2
	5.9	-25.66	1.1

Table 2: Return loss and VSWR

Substrate	Frequency (GHz)	Gain (dBi)	Directivity (dBi)
FR4	2.2	4.31	5.48
	3.3	3.28	5.14
	5.3	4.60	6.39
	5.9	3.21	6.50
Rogers 4350	2.2	5.18	5.49
	3.6	3.47	4.79
	5.3	4.07	5.44
	6.2	3.79	5.46
RT-duroid	2.2	4.91	4.44
	3.6	5.12	5.55
	4.8	3.39	3.49
	5.9	4.96	5.03

Table 3: Gain and Directivity.

IV. CONCLUSION

In this paper an inverted HE shaped slotted microstrip antenna is designed on three different substrates. A single antenna works on four different frequencies which is achieved by the HE slot in the patch. The parameters are achieved without the increase in the thickness of the substrate. All the simulations are done in IE3D software. Antenna that is designed on RT-Duroid shows better performance than FR4 and Rogers 4350. It is observed that as the dielectric increases the size of the antenna decreases but the antenna with low dielectric constant shows better performance in terms of VSWR, return loss, gain and directivity.

REFRENCES.

[1] Nikita saxena**, "Design and Analysis of Multi Band antenna for S and C Band "** 2018 IEEE International Conference on Advances in Computing, Communication Control and Networking
(ICACCCN2018) .

[2] Ajay Dadhich, J. K. Deegwal, M M sharma,**" Multiband Slotted Microstrip Patch Antenna for TD-LTE, ITU and X-band Applications"** 2018 5th International Conference on Signal Processing and Integrated Networks..

[3] Mehr-e-Munir, Khalid Mahmood, Saad Hassan Kiani**," E-shape Multiband Patch Antenna for 4G, C-band and S-band Applications",** (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 9, No. 5, 2018.

[4] Snehalatha T K A C and Navin Kumar,**" Design of Multiband Planar Antenna",** 2017 IEEE International Conference on Antenna Innovations & Modern Technologies for Ground, Aircraft and Satellite Applications (iAIM)

[5] Sai Sampreeth Indharapu, and Abhishikth M B, " **A Multiband Slot Antenna For Wireless Communication", 2**018 9th International Conference on Computing, Communication and Network Technologies(ICCCNT)

[6] Amiya Sahoo, Ayush Biswal,Chandan K Sahu, Joyesh C. Dash, and B.B. Mangaraj," **Design of Multi-band Rectangular Patch Antennas using Defected Ground Structure (DGS)**" 2017 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 19-20, 2017, India.

[7] Prakash Kumar Mishra, Vidhi Sachdeva, Drishti sharma, Samir Dev Gupta," **Multiband Microstrip Antenna for 4G Mobile Application"** 2015 Fifth International Conference on Communication Systems and Network Technologies.