Design of H-Shaped Microstrip Hybrid Patch Antenna for C-Band Applications

Balaji Vignesh L.K.[1] & Dr. K. Kavitha[2]

[1]*Assistant Professor, Department of ECE, AAA College of Engineering and Technology, Sivakasi.*
[2]*Associate Professor, Department of ECE, MepcoSchlenk Engineering College (Autonomous), Sivakasi.*

Abstract*—*In this paper, a compact size microstrip hybrid Patch Antenna is designed and analyzed. The bandwidth enhancement of microstrip patch [MSP] is done by rectangular slotted technique. The designed antenna may be used to reduce return loss and increase the bandwidth. The gain has been improved up to 8.72897 dBi, directivity 11.4703 dBi. The proposed rectangular slotted MSP antenna is used for C-band operations. Study of literature of past few year shows that, the leading work on MSP is focused on designing compact sized broadband microstrip antenna. But inherently MSP have narrow bandwidth so to enhance bandwidth various techniques are engaged. The proposed antenna is simulated using ADS 2009 simulation software based on Momentum and EMDS. The antenna is fed by 50Ω microstrip line feed.

***Keywords*—Ground plane, Microstrip patch [MSP], Enhance bandwidth, ADS 2009 Simulator,Microstrip line feed.**

I. INTRODUCTION

Microstrip antenna [1] consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The major disadvantages of Microstrip antennas are lower gain and very narrow bandwidth [2, 3]. It consists of dielectric substrate, with ground plane on the other side.

In this paper, the purpose of a new designed antenna present to enhance the bandwidth of microstrip hybrid patch antenna for many wideband applications [4], [7]. The major drawbacks of MSP antennas are narrow bandwidth and low gain. They may use many techniques to enhance bandwidth and gain of MSP antennas. By using thick substrate with low dielectric constant and slotted patch can enhance the bandwidth and gain of antennas up to greater extent [5].

The MSP antenna has good features such as low cost, low profile, light weight, high efficiency, easy to implement with circuits [2], [5], [6]. The design structure components of antenna will become small in size and have low processing cost [3].

In this letter, transmission line method is used to analysis the Hybrid Multiband Patch antenna. The design resonated frequency of proposed MSHP antenna is 5 GHz (C-band) with 50Ω microstrip line feed. The proposed MSHP antenna is characterized by using thickness (h), dielectric constant (ε_r).The designed MSHP antenna can be simulated by ADS 2009 Simulation Software. The performance of the designed MSHP antenna can be analyzed by radiation pattern, return loss, directivity, VSWR and gain.

II.PROPOSED SUBSTRATE DESIGN

A. Antenna Dimensions

The mathematical formula is used to calculate the dimensions of ground plane and microstrip patch in the form of length and width. Here, we use the rectangular tri-slotted technique for improve the bandwidth and reduce the return

loss of the MSP antenna. Using the new concept of multidielectric substrate, the return losses are minimized while comparing with the ordinary MSP antenna.The proposed antenna is fed by 50Ω microstrip line feed.

For design purpose, the antenna can be simulated by ADS 2009 software. We take RT-duroid substrate with resonated frequency as 5 GHz and dielectric constant ε_r= 2.2 (Single Layer Substrate). The height between the patch and ground is taken as 1.524 mm.

(i) Width of Rectangular MSP Antenna [8], [9]

$$W = \frac{C}{f_r}\sqrt{\left(\frac{2}{1+\epsilon_r}\right)} \text{----------(1)}$$

Where c=3*10^8 ms^{-1}, ε_r= 4.2

(ii) Effective Dielectric Constant [9], [10]

$$\epsilon_{eff} = \left(\frac{\epsilon_r+1}{2}\right) + \left(\frac{\epsilon_r-1}{2}\right)\left[1+\frac{12H}{W}\right]^{-0.5} \text{----------(2)}$$

H=1.6 mm

(iii) Length Extension of Antenna [8], [9]

$$\Delta L = 0.412H\left(\frac{\epsilon_{eff}+0.3}{\epsilon_{eff}-0.258}\right)\left[\frac{\left(\frac{W}{H}\right)+0.264}{\left(\frac{W}{H}\right)+0.8}\right] \text{----------(3)}$$

(iv)Length of Rectangular MSP Antenna [4], [11]

$$L = \left(\frac{C}{2f_r\sqrt{\epsilon_{eff}}}\right) - 2\Delta L \text{----------(4)}$$

B. Antenna Design Specification

Calculated dimensions of ground plane is constructed by using the resonant frequency(f_r), dielectric constant(ε_r), substrate thickness(H) and loss tangent(tan δ) and 50Ω microstrip line feed is fed into patch. Calculated dimensions are obtained by formula and compact rectangular tri-slotting is done on the rectangular patch.

TABLE I**:** Antenna Design Specifications

S.No	Antenna Parameters	Data
1.	**Resonant Frequency(f_r)**	**5 GHz**
2.	**Substrate thickness(H)**	**1.524 mm**
3.	**Dielectric Constant (ε_r)**	**2.2**

C. Antenna Design Procedure

Using the above equations and geometrical parameters, dimensions of antenna is calculated. In the design of antennas is constructed by using dimensions after that slots cut in to the microstrip patch.

Table II: Calculated Antenna Dimensions in mm

S.No	Parameters	Value
1.	**Ground Plane width, W_g**	**26.984**
2.	**Ground Plane length, L_g**	**31.024**
3.	**Patch width, W**	**21.68**
4.	**Patch length, L**	**17.84**
5.	**a**	**4.572**
6.	**b**	**4.572**
7.	**c**	**8.696**
8.	**d**	**3.184**
9.	**e**	**2.756**
10.	**f**	**6.368**
11.	**g**	**3.184**
12.	**h**	**4.572**
13.	**i**	**12.736**

13.	**j**	**4.572**

III. MICROSTRIP HYBRID PATCH ANTENNA DESIGN

The proposed Microstrip Hybrid Patch antenna design is as shown in Figure 1. The antenna is built by single layer substrate with dielectric constant (ε_r = 2.2) and thickness (t =1.524 mm).

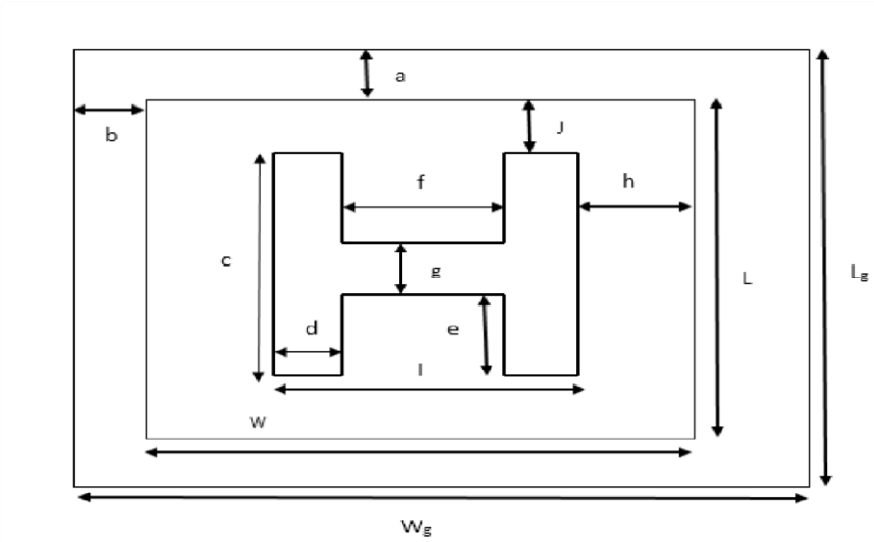

Figure 1: Geometry of Proposed Antenna (C-band)

A. Steps in Microstrip Hybrid Patch Antenna

The Steps followed in designing Microstrip Hybrid Patch antenna design operate at 5 GHz for various wideband applications are shown in Figure 2.

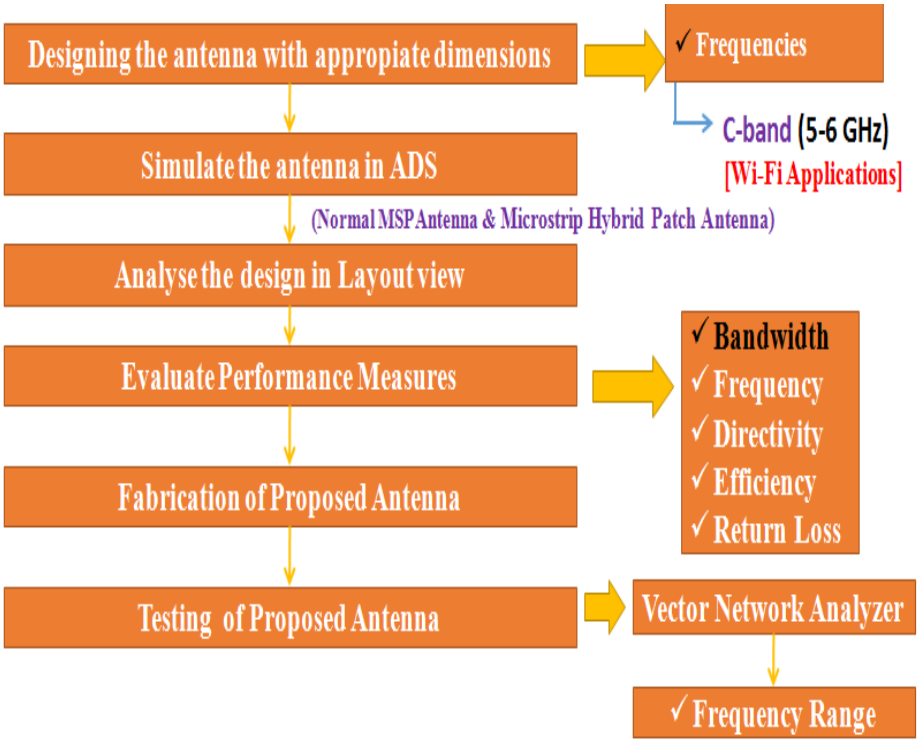

Figure 2: Steps followed in Hybrid Patch Antenna

IV. RESULTS AND DISCUSSIONS

The designed microstrip hybrid patch antenna is analyzed by both Single layer substrate is shown in Figure 3.

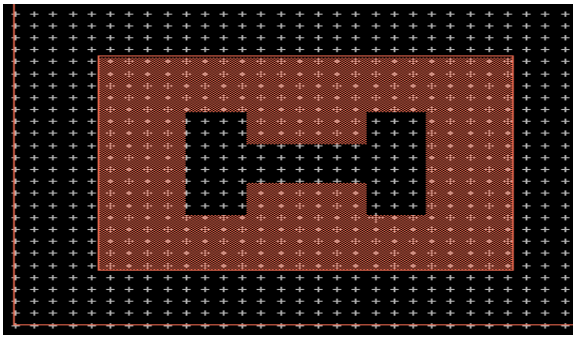

Figure 3: Microstrip Hybrid patch antenna

A. Return loss and resonant frequency

The return loss and resonant frequency of single layer substrate is calculated as -23.459 dB and 4.898 GHz. The simulated result is shown in Figure 4.

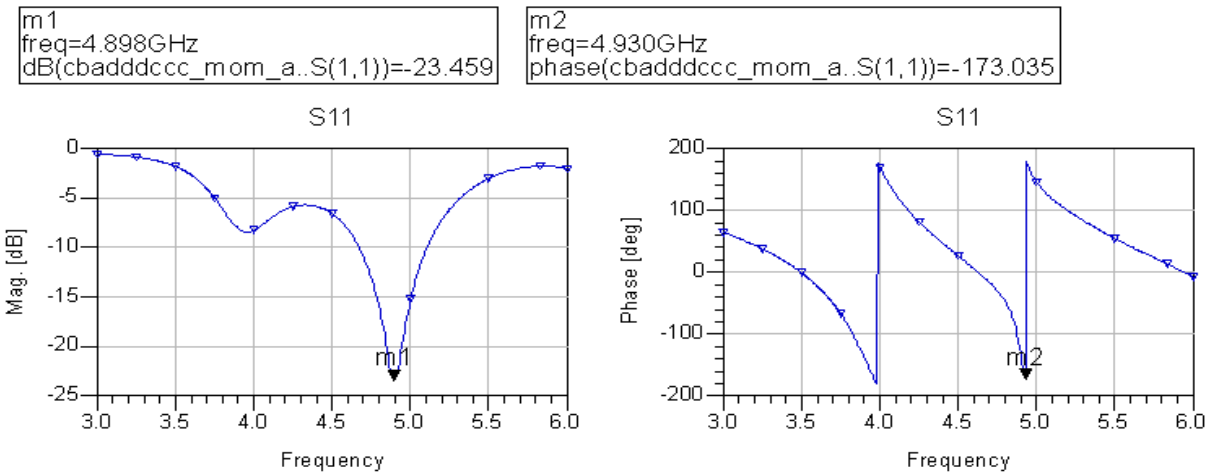

Figure 4: Momentum (S-Parameters) using Single Layer Substrate

Power radiated (Watts)		0.00494378
Effective angle (Steradians)		0.895741
Directivity(dBi)		11.4703
Gain (dBi)		8.72897
Maximim intensity (Watts/Steradian)		0.00551921
Angle of U Max (theta, phi)	36	359
E(theta) max (mag,phase)	2.03868	-30.2381
E(phi) max (mag,phase)	0.0476937	-26.8059
E(x) max (mag,phase)	1.64991	-30.2364
E(y) max (mag,phase)	0.0190315	-21.6107
E(z) max (mag,phase)	1.19831	149.762

OK

Figure 5: Antenna Parameters using Single Layer Substrate

The Radiation Pattern of Single Layer Substrate is shown in Figure 6.

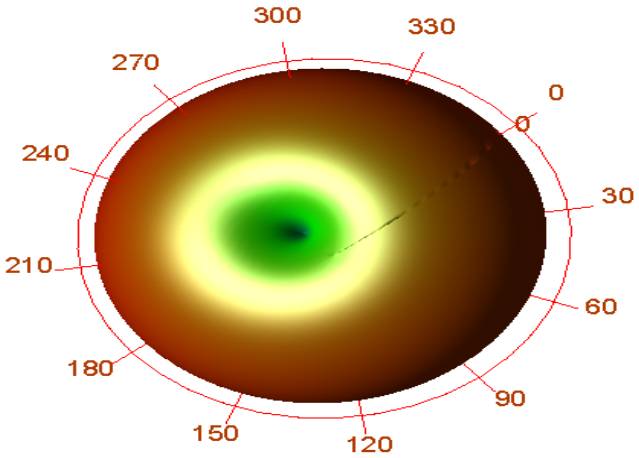

Figure 6: Radiation Pattern using Single Layer Substrate

V. BANDWIDTH ENHANCEMENT ANALYSIS

The Bandwidth Enhancement analysis is defined as the difference between the highest frequency and lowest frequency. **Highest Return Loss taken (up to 20 dB),**

$$BW = f_{(high)} - f_{(low)}$$

Table III: Performances Measures of Proposed Antenna

Parameters	Single Layer Substrate
Frequency resonated	**4.898 GHz**
Return Loss	**-23.459 dB**
VSWR	**1.836**
Directivity	**11.4703 dB**
Gain	**8.72897 dB**
Bandwidth	**4.4 GHz -5.4 GHz (1 GHz)**

The Bandwidth Enhancement of Microstrip Hybrid Patch Antenna can be analyzed by Single layer substrate. The effect of bandwidth on Single layer substrate can be calculated as 1 GHz is shown in Table 3. The gain and resonant frequency of single layer substrate of Microstrip Hybrid Patch antenna is calculated as 8.72897 dB and 4.898 GHz.

VI.CONCLUSION

A microstrip hybrid patch antenna has been designed by multidielectric slotted patchaimed to operate at 5 GHz and they are analyzed by Agilent ADS 2009 software.It is based on the rectangular patch antenna (slotted technique). Slotted technology is used to enhance the bandwidth of antenna by reducing the return loss. The enhance bandwidth of designed microstrip Hybrid Patch antenna is calculated as 1 GHz (4.4 GHz to 5.4 GHz). A hybrid multiband antenna was optimized to obtain a high performance.The gain of the antenna is 8.72897dBi at 4.898 GHz frequency and VSWR< 2 or it is 1.836 with return loss -23.459dBi. So, the antenna had an excellent performance of wide bandwidth that can be used as wideband applications such as missile, wireless, satellite, mobile communication and military purposes.

AUTHORS

L.K.BalajiVignesh is currently working as Assistant Professor, Department of ECE, AAA Colleg and Technology, Amathur, Sivakasi. He received his B.E degree (Electronics and Communicat from PET Engineering College, Vallioor in 2013 and M.E.degree (Communication AlagappaMepcoSchlenkEngineering College (Autonomous), Sivakasi in 2015. His research area ir and Microwave. He has presented many Technical papers inInternational, National Journals and has received three best paper awards in the area of Antenna Design.

K. Kavitha is currently working as Associate Professor, Department of ECE, MepcoSchlenkEng (Autonomous), Sivakasi. She received her B.E degree (Electronics and Communication Er MepcoSchlenk Engineering College in 1998 andM.E.degree (Microwave and Optical En AlagappaChettiar College ofEngineering andTechnology,Karaikudi in 2000. Her researcl ImageClassification and Change Detection. He received his Ph.D. degree from Anna University, Cl 2017. She has published many Technical papers inInternational, National Journals and Conferences.

REFERENCES

[1] *W.L.Stutzman and G.A. Thiele, Antenna Theory and Design, 2nd ed. New York: Wiley, 1998.*

[2] *Thomas A. Milligan. 2nd Ed. Modern antenna design. pp. 318-354.*

[3] *A.K. Bhattachrjee, S.R.Bhadra, D.R. Pooddar and S.K.Chowdhury, Equivalence of impedance and radiation properties of square and circular microstrip patches antennas. IEE Proc.136 (Pt,H, vo.4):338-342, Aug 1989.*

[4] *D.Bhattacharya and P.Prasanna, Bandwidth Enrichment for MicrostripPatch Antenna Using Pendant Techniques, IJER, ISSN: 2319-6890, VolumeNo.2, Issue No.4, pp. 286-289, Aug.–2017.*

[5] *ParikshitVasisht andTarunaGautam. Designof V- Slotted Trapezoidal Patch Antenna in Wi-MaxBandUsingOptimizedFeed LocationMethod, IJETAE, ISSN: 2250-2459, Vol.2,Issue 6,June-2013.*

[6] *A compact micro strip patch antenna for wireless communication. U Chakraborty, S.Chatterjee, S.K.Choudhry. Progress in Electromagnetic Research (PIER) M, Vol.18, pp 211-220, 2012.*

[7] *SukhbirKumar andHitenderGupta, DesignandStudy ofCompactandWideband MicrostripU-SlotPatch Antenna for Wi -Max Application, IOSR-JECE, ISSN:2278-2834,Vol.5,Issue2,pp.45-48,(Mar– Apr 2013).*

[8] *C. Balanis "Antenna Theory Analysis and Design", second edition, John Wiley, 1997.*

[9] *T.Jayanthy,M.Sugadev,J.MohamedIsmaeelandG.Jegan, DesignandSimulationofMicrostripM-PatchAntennawithDoubleLayer,IEEETrans.AP-978-1-4244-2690-4444, 2016.*

[10] *ParminderSingh,Anjali ChandelandDivyaNaina,BandwidthEnhancementof Probe FedMicrostripPatch Antenna,IJECCT,ISSN:2249-7838,Vol. 3, Issue 1,January-2013.*

[11] *MohammadTariqul Islam,MohammedNazmusShakib, NorbahiahMisran, andBaharudinYatim, Analysisof Broadband SlottedMicrostripPatch Antenna,IEEE Trans.AP-1-4244-2136,2012.*