Design and Simulation of Reconfigurable Dual band Antenna Using Dual-Patch Elements for Wireless Application

Shah Vatsal R[1], Prof. A.K.Sisodia[2]

[1]P.G. Student, Electronics and Communication Department, LJIET, Ahmedabad, Gujarat, India
[2]Professor, Electronics and Communication Department, LJIET, Ahmedabad, Gujarat, India

ABSTRACT

In today's modern communication industry, antennas are the most important components required to create a communication link. For all practical wireless applications, miniaturization of antenna has become important. Micro strip antennas are the most suited for aerospace and mobile applications because of their low profile, light weight and low power handling capacity .There are number of parameter associated with micro strip antenna such as gain, return loss, bandwidth, beam width. For the better performance, all these parameters need to be optimized. Design and simulation of Wideband switchable antenna at 4.9 GHz & 5.4 GHz frequency. Designed and simulate Dual micro strip patch antenna at 4.9 GHz & 5.4 GHz and achieved return loss -27dB, Bandwidth 649MHz Gain 5.64dB.

Keyword: *C-slot, patch antenna, reconfigurable antenna, slot antenna, switched antenna, wideband antenna.*

1. INTRODUCTION TO MICRO STRIP ANTENNA CONFIGURATION

Reception apparatus is a transducer intended to transmit or get electromagnetic waves. Micro strip receiving wires have a some focal points over ordinary microwave reception apparatus and consequently are generally utilized as a part of numerous useful applications. Micro strip reception apparatuses in its most straightforward arrangement are appeared in Fig1. It comprises of an emanating patch on one side of dielectric substrate (Єr≤10), which has a ground plane on other side.

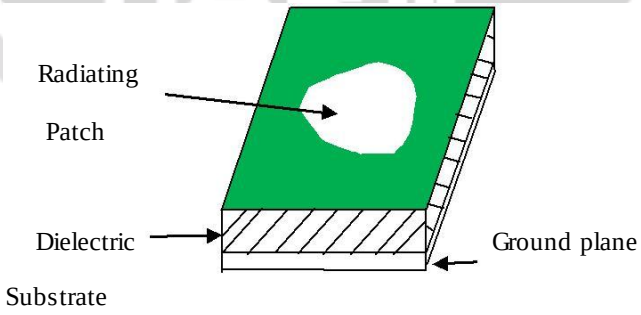

Fig- 1: Schematic of micro strip antenna configuration

There are Four types of Micro strip Antenna Configuration:
(i) Micro strip patch antennas
(ii) Micro strip dipoles
(iii) Printed slot antennas
(iv) Micro strip Travelling wave antennas

2. INTRODUCTION TO MICRO STRIP PATCH ANTENNA

A MPA consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1.1.The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

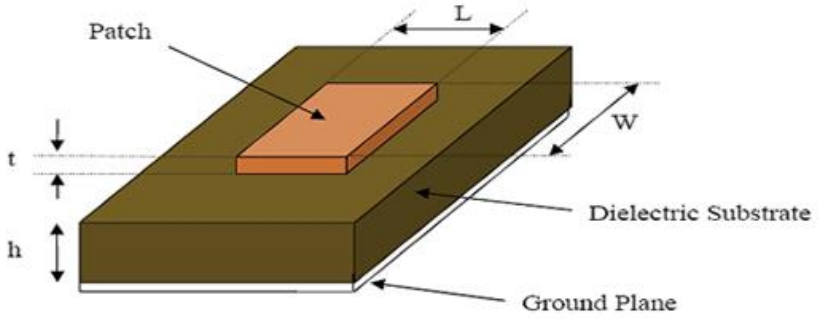

Fig- 2: MICRO STRIP PATCH ANTENNA

3. CALCULATION OF PARAMETERS FOR MICRO STRIP PATCH ANTENNA

The first step is to calculate dimension parameters of driven patch, which are defined as follows:

Following equations are used for designing Micro strip patch antenna.

For Width calculation (W):

$$\text{Width}(W) = \frac{1}{2f_r\sqrt{\mu_0 \varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad \text{..... (1)}$$

The effective dielectric constant of the rectangular micro strip patch antenna:

$$\in_{reff} = \frac{\in_r+1}{2} + \frac{\in_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}, \quad \frac{W}{h} > 1 \quad \text{..... (2)}$$

For Length calculation(L):

The Actual Length of the Patch(L):

$$L_{eff} = L - 2\Delta \quad \text{.....(3)}$$

Where , $L_{eff} = \frac{c}{2f_r\sqrt{\in_{reff}}}$ ..... (4)

Calculation of Length Extension:

$$\frac{\Delta L}{h} = 0.452\frac{(\in_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\in_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad \text{.....(5)}$$

After this calculation, simulation can be done in CST tool.

Parameters	Values of Patch1	Values of Patch2
Width	18.8mm	17.06mm
Height	1.57mm	1.57mm
Length	14.23mm	12.84mm

Table 1:Calculation Of Parameters

4. DUAL MICRO STRIP PATCH ANTENNA DESIGN AT 4.9GHz & 5.4GHz

Now from above data, the design of Dual Micro strip Patch Antenna in CST software is given below.

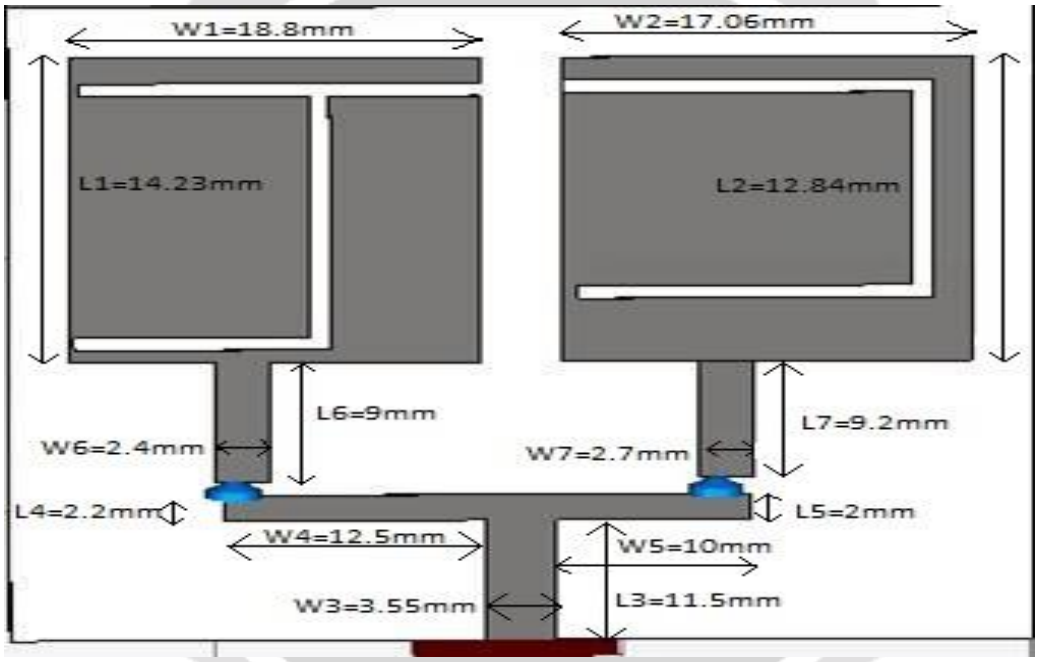

Fig-3: Dual Micro strip Patch Antenna at 4.9GHz & 5.4 GHz in CST

The output of Dual Micro strip Patch Antenna at 4.9GHz & 5.4 GHz is given below.

From above Figure-3, we use reconfigurable technique for a PIN Diode. Here PIN Diode conditions ON-OFF,OFF-ON & ON-ON show in below.

The length of each stage is show in Fig.(3), which corresponds to an electric length (Eeff) of 900.Using CST tool, the dimension of the micro strip line viz. length (L), width (W) and Substrate Height(h) between each other are calculated for the Reconfigurable Micro strip Patch antenna. The width, Height and length of each stage of the Micro strip patch antenna are derived, as illustrated in Table.

Table-1: Calculated Dimension of dual Micro strip patch antenna Section

Stage	W(mm)	h(mm)	L(mm)
1	18.8	1.57	14.23
2	17.06	1.57	12.84
3	3.55	1.57	11.5
4	12.5	1.57	2.2
5	10	1.57	2
6	2.4	1.57	9
7	2.7	1.57	9.2

From the data given in above table, the design in CST is given above Fig(3).

Now, Condition of PIN Diode Patch1 ON & Patch2 OFF:

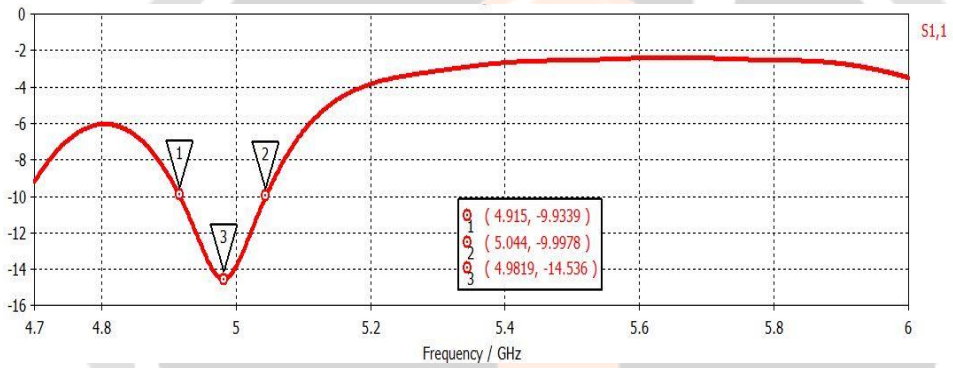

Fig-4: PIN Diode Patch1 ON & Patch2 OFF at 4.9 GHz

From above graph, we obtain Return loss aroun -14.536 dB and Bandwidth is 129MHz.

Now, Condition of PIN Diode Patch1 OFF & Patch2 ON:

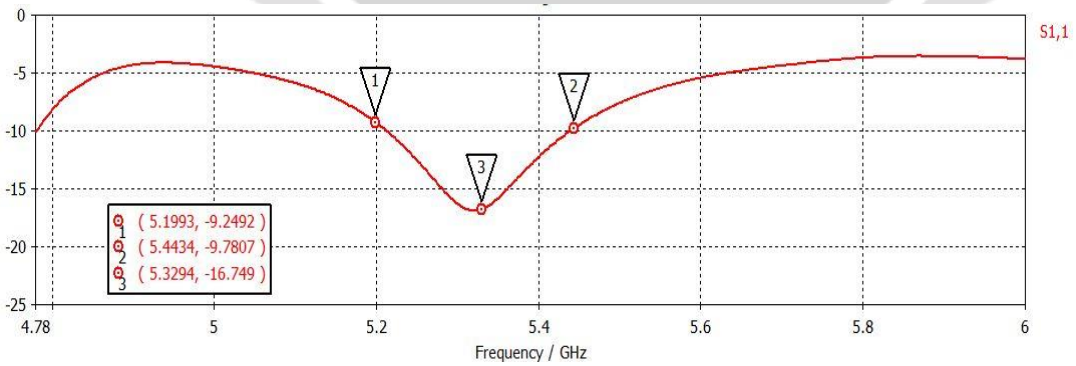

Fig-5: PIN Diode Patch1 OFF & Patch2 ON at 5.4 GHz

From above graph, we obtain Return loss aroun -17 dB and Bandwidth is 234MHz.

Now, Condition of PIN Diode Patch1 ON & Patch2 OFF:

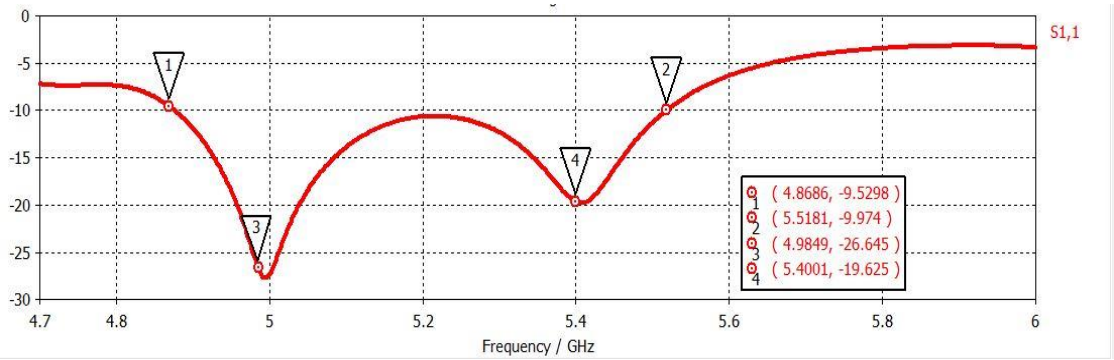

Fig-6: PIN Diode Both Patch ON at 4.9GHz & 5.4GHz

From above graph, we obtain Return loss around -26.6 dB and Bandwidth is 649MHz.

Results Of Gain and Smith Chart are also show in below from the fig.(3)

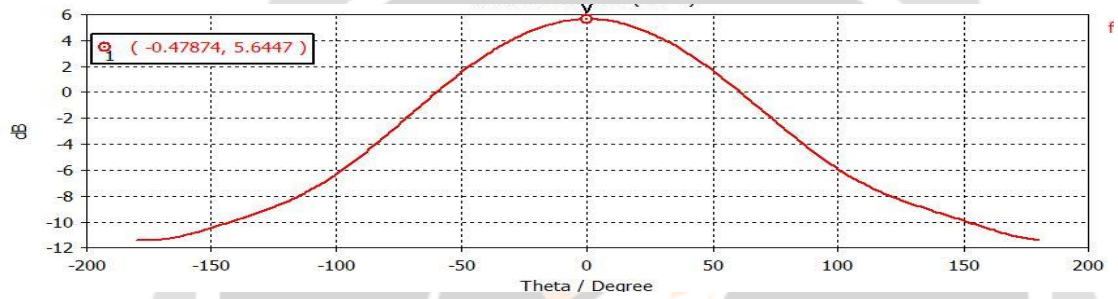

Fig-7: Gain at 5.4GHz

From above graph, we obtain Gain around 5.6447 dB

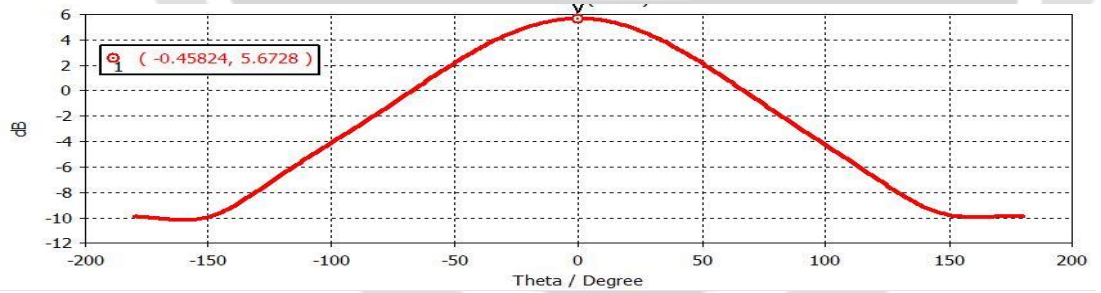

Fig-8: Gain at 4.9GHz

From above graph, we obtain Gain around 5.6728 dB

6. COMPARISON OF OUTPUTS RECONFIGURABLE DUAL BAND ANTENNA USING DUAL PATCH ELEMENT:

There are many technique use foe increase a Bandwidth. Here we use reconfigurable technique and PIN Diode is use as switch. All Results are show in Table 3.we give better results in Both Patch On condition of PIN Diode.

Parameters	ON-OFF	OFF-ON	ON-ON
Frequency	4.9GHz	5.4GHz	4.9GHz-5.4GHz
Bandwidth	129MHz	234MHz	649MHz
Return Loss	-14.5dB	-17dB	-26.6dB
Gain	5.67dB	5.44dB	5.7dB

Table-3: Comparison of outputs

7. CONCLUSION

By using Reconfigurable technique, designing of Reconfigurable Dual band Antenna Using Dual-Patch Elements using CST Software provide very good outputs at the center frequency 4.9 GHz and 5.4 GHz. At the both the center frequency input return loss S_{11} and output return loss S_{22} are greater than -15 dB . In design, outputs are matched with my targeted specification. we get Return loss -26.6dB,Bandwidth 649Mhz and Gain 5.67dB at the center frequency of 4.9 GHz and 5.4 GHz respectively.

8. ACKNOWLEDGMENT

The author thanks Prof. A.K.Sisodia from L.J.Institute of Engineering and Technology for technical discussion and processing support without whom this paper would never be completed.

9. REFERENCES

1. H. Wang, X. B. Huang, and D. G. Fang, "A single layer wideband U-slot microstrip patch antenna array," IEEE 2012 International transactions on antennas and propagation, p.p. 258-261, ISBN: 978-1-4799-4245-9.
2. J.-S. Row, W.-L. Liu, and T.-R. Chen, "Circular polarization and polarization reconfigurable designs for annular slot antennas," IEEE Antennas Wireless Propag Dec.2012, p.p. 5998-6002, ISBN: 978-1-4799-0400-6.
3. Y. B. Chen, Y. C. Jiao, and F. S. Zhang, "Polarization reconfigurable CPW-fed square slot antenna using PINdiodes", International Journal of Engineering Sciences Research-IJESR, p.p. 1233–1236, ISSN: 2230-8504; e-ISSN-2230-8512, Vol.04, Issue 02; March-April 2013.
4. J. Anguera, C. Puente, C. Borja, and J. Soler, "Dual-frequency broadband-stacked microstrip antenna using a reactive loading and a fractalshaped radiating edge," IEEE International transactions on antennas and propagation 2009, p.p. 186-189, ISBN: 978-1-4673-2792-3.
5. S. Qu and Q. Xue, "A Y-shaped stub proximity coupled V-slot microstrip patch antenna", 2012 IEEE Symposium, p.p. 001-004, ISBN: 978-1-4673-0455-9.
6. A. Mak, C. Rowell, R. Murch, and C. Mak, "Reconfigurable multiband antenna designs for wireless communication devices", 2012 IEEE Symposium, p.p. 125-127, ISBN: 978-1-4673-2365-9.
7. F.Yang, X. Zhang, X.Ye, and Y. Rahmat-Samii, "Wide-band E-shaped patch antennas for wireless communications", 2012 IEEE Antenna Wireless Propag. Lett., Microwave Magazine, p.p. 203-206, ISBN:978-1-4577-1155-8.
8. K.-L. Wong and W.-H. Hsu, "A broad-band rectangular patch antenna with a pair of wide slits," IEEE Transaction Antennas Propagation vol. 11, 2012, 9, p.p. 68-74, ISBN:978-1-4577-5012-6.
9. S. Yang, C. Zhang, H. Pan, A. Fathy, and V. Nair, "Frequency-reconfigurable antennas for multiradio wireless platforms", 2011 IEEE Symposium, p.p. 001-004, ISBN: 978-1-4244-9190-2.
10. R. Bhalla and L. Shafai, "Broadband patch antenna with a circular arc shaped slot,", 2010 Annual IEEE India Conference (INDICON), p.p. 001-004, ISBN: 978-1-4244-9074-5.

11. F. Ghanem, P. S. Hall, and J. R. Kelly, "Two port frequency reconfigurable antenna for cognitive radios", sponsored by Nature Science Foundation of china; Grant number: 60572141, 2008 IEEE Transaction Antennas Propagation vol.16, p.p. 001-004, ISBN: 978-1-4244-2108-4.
12. Muhammad Adnan Siddiqui. "Frequency-reconfigurable antennas for multiradio wireless platforms", 2005 IEEE International, p.p. 426-431, ISBN: 0-7803-8977-8.
13. C. A. Balanis, Antenna Theory, 2nd ed. New York: Wiley, 1997
14. Samuel Y. Liao, "Microwave Devices and Circuits", Third Edition, Pearson.
15. K Lal Kishore, "Electronics Devices and Circuits", B S Publication.