Design Microstrip Patch Antenna for Ultra-Wide Band Applications

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Abstract: In the past year all the communication devices uses narrow band spectrum but now days we are using Ultra-wide Band Spectrum. Ultra-wide Band Spectrum is ranging from 3.1 GHz to 10.6GHz. The Proposed antenna covered the ultra-wide band ranges from 3.55 GHz to 11 GHz. HFSS Software is used to design and simulate it.

Keywords: Microstrip patch antenna, UWB

1. INTRODUCTION

The rise in wireless communication systems created large demands for wide band antenna to satisfy high gain and enormous information measure covering all frequency ranges for these systems. In FCC approved the UWB technology within the frequency vary of 3.1-10.6GHz with most radiated power-43.3dB/m/MHz and rate between one hundred ten to two hundred Mbps with in 10m distance. The benefits of the UWB technology square measure high rate, less interference, secure, Low value and low complexness [1-5]. It is utilized in completely different applications like microwave radar, imaging in medication and military communication. UWB patch antennas may well be designed with completely different geometries; i.e. triangular, circular disk, strip loop [6-8]. Many strategies measure accustomed enhance its information measure by victimization, parasitic structures and alternative completely different arrangements. Recently, researchers specialise in planning UWB antenna with band rejection characteristics to eliminate any interference from narrowband wireless applications. The projected antenna is UWB antenna frequency starting from 3.5 GHz to 10.6GHz [9-12].

2. ANTENNA DESIGN

Antenna design with full ground plane has not fulfilled the requirement of Ultra-wide band microstrip antenna, that's why changes square measure created in ground plane length to realize smart broadband characteristic. The partial ground plane shows higher come back loss compared to full ground plane as a result of the antenna is remodeled from patch sort to monopole sort by the partial ground plane. Reducing the bottom plane length up to the purpose wherever the patch edge is simply higher than the bottom plane thereby provides no distance for distribution of electrical and field of force energies that successively ends up in no resistivity matching between the line and Therefore the patch. On any reducing the bottom plane length specified distance I is created between patch and the ground plane .Length of ground plane is shriveled from thirty five metric linear unit to below the sting of the patch as 13.5 metric linear unit and therefore the needed information measure is obtained.

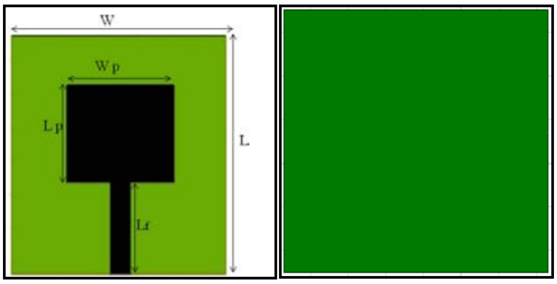

Figure 1 Geometry of Microstrip Patch Antenna for Full Ground Plane

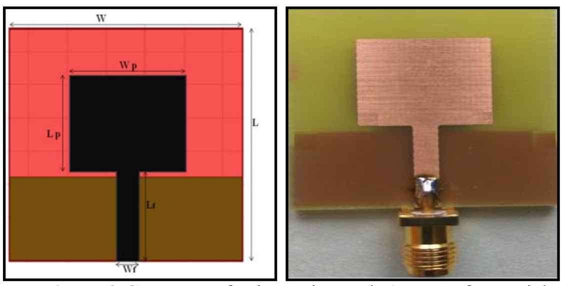

Figure 2 Geometry of Microstrip Patch Antenna for partial Ground Plane

Table 1: Dimensions of microstrip patch antenna for Full Ground Plane

S. No.	**Parameter**	***Symbol***	***Dimension(mm)***
1	Substrate width,	W	30
2	Substrate length,	L	35
3	Patch width,	Wp	15
4	Patch length,	Lp	14.5
5	Feedline width,	Wf	2.85
6	Feedline length,	Lf	13.5
7	Ground plane length	Lg	12.5

The effective length of the patch L_{eff} now become

$$L_{eff} = L + 2\Delta L \quad (1)$$

$$\Delta L = 0.412h \frac{\varepsilon_{reff}+0.3}{\varepsilon_{reff}-0.258}\left(\frac{W/h+0.264}{W/h+0.813}\right) \quad (2)$$

For a given resonant frequency fo, the effective length is

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}} \quad (3)$$

For a rectangular microstrip patch antenna, the resonance frequency for any TM mn mode is given by James and Hall as:

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{0.5} \quad (4)$$

Where m and n are modes along L and W respectively [2-4].

The width W is

$$W = \frac{C}{2f_0}\left(\frac{\varepsilon_r+1}{2}\right)^{-0.5} \quad (5)$$

Where fo = Resonant frequency
C =speed of light in free-space

3. SIMULATION RESULTS

The simulated result of return loss of optimized microstrip patch antenna with full ground plane is presented in figure 3. When the ground plane size is equal to the substrate size; return loss values are not satisfactory. The Antenna has a narrow bandwidth of 740 MHz with frequency range from 9.51 GHz to 10.25 GHz and the resonant frequency is 9.9 GHz with S_{11} – 14 dB. The Result of this design is that Ultra wide band characteristic of microstrip antenna is not achieved. To obtain Ultra-wide band microstrip antenna characteristic changes are made in ground plane length and reducing the ground plane length up to the point where the desired broad bandwidth is achieved.

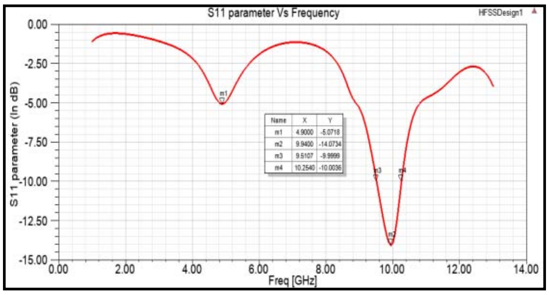

Figure 3 S11 parameter variation w.r.t frequencies for Full ground microstrip patch antenna

The simulated result of return loss and VSWR of optimized rectangular microstrip patch antenna is presented in Figure 4 and 5 respectively. According to figure 4 the antenna has broadband characteristic, i.e. frequency band of 3.55 GHz – 11.05 GHz and bandwidth of 7.03 GHz at -10 dB level. The antenna has resonating frequencies at 4.84 GHz with S11 – 16.93dB and 10.06 GHz with S11 – 13.88dB and VSWR is obtained below 2.

Fig. 5 shows the simulated VSWR of the antenna with a partial ground plane as a function of frequency. VSWR of the antenna in the entire band width range from 3.38 GHz to 10.42 GHz is well w ithin desired 2:1 VSWR ratio.

4. CONCLUSION

The Proposed Microstrip patch antenna has covered the band width of 11.55 GHz. To achieved Ultra-wide band spectrum partial ground condition is used. The Bandwidth of the antenna is inversely proportional to the quality factor of the antenna. So to reduced quality factor the ground dimensions decrease to a value to get good bandwidth. The proposed antenna simulate at 4.84 GHz which lie in the C-Band.

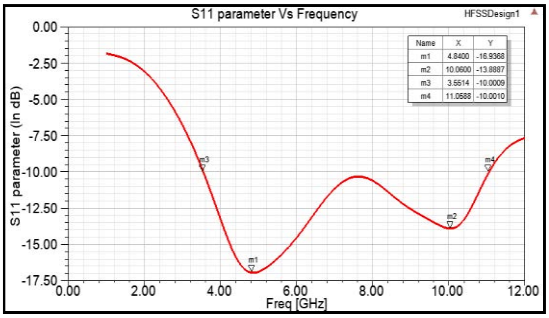

Figure 4 S11 parameter variation w.r.t frequencies for partial ground microstrip patch antenna

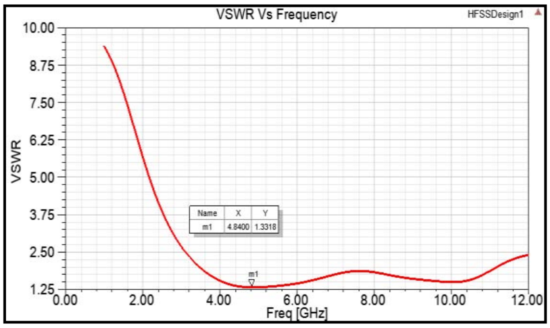

Figure 5 VSWR variation w.r.t frequencies for partial ground microstrip patch antenna

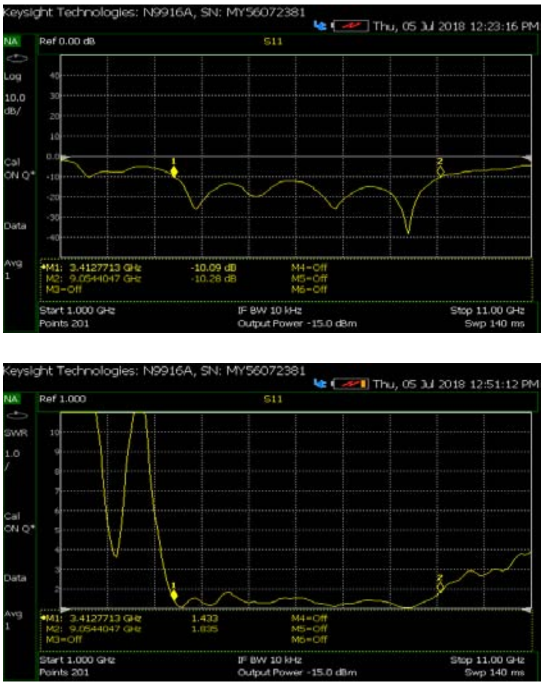

Figure 6 VNA Measurement Graph of MSA for Partial ground Condition

REFERENCES

[1] Ketavath Kumar Naik, “Asymmetric CPW-fed SRR patch antenna for WLAN/WiMAX applications”, AEU - International Journal of Electronics and Communications, (2018), 93, 103-108.

[2] Constantine A. Balanis, “Antenna Theory, Analysis and Design”, 2nd ed., John Wiley and Sons, Inc., 1997.

[3] B. Karthik, S.P.Vijayaragavan and M.Sriram, “Microstrip Patch Antenna for Wireless LAN”, International Journal of Pure and Applied Mathematics, (2018), 118, 25-33.

[4] Purva R. Chopde and Mandar P. Joshi, “Design of Wideband Printed Rectangular Monopole Patch Antenna With Band Notch”, International Conference on Communication, Information & Computing Technology (ICCICT), Mumbai, India 2-3 Feb. 2018.

[5] Tejbir Singh, Heena Choudhary, D.V. Avasthi and Vishant Gahlaut, “Design & parametric analysis of band reject ultra wideband (UWB) antenna using step impedance resonator”, Taylor & Francis, (2017), 1-16.

[6] Ying Suo, Wei Li,Hongyong Wang, “A Dual-Band Notched Ultra Wideband Microstrip Antenna”, IEEE Transmission antennas Propagation, (2017), 1787-1788.

[7] Li Li, Xiaoliang Zhang, Xiaoli Yin, and Le Zhou, “A Compact Triple-Band Printed Monopole Antenna for WLAN/WiMAX Applications”, IEEE Antennas And Wireless Propagation Letters, (2016), 15, 1853-1855.

[8] N. Ojaroudi and M. Ojaroudi, “Novel Design of Dual Band-Notched Monopole Antenna With Bandwidth Enhancement for UWB Applications”, IEEE Antennas and Wireless Propagation Letters, (2013), 12, 698-701.

[9] Hamidreza Dalili Oskouei and Alireza Mirtaheri, “A Monopole Super Wideband Microstrip Antenna with Band-notch rejection”, Progress In Electromagnetic Research Symposium — Fall (PIERS — FALL), Singapore, (2017), 2019-2024.

[10] Noor M. Awad and Mohamed K. Abdelazeez, “Multislot microstrip antenna for ultra-wide band application”, Journal of King Saud University – Engineering Sciences, (2015), 1-8.

[11] Sarkare, K.V. Srivastava, K. Saurav, “A compact microstrip-fed triple band-notched”, IEEE Antennas and Wireless Propagation Letters, (2014), 13, 396–399.

[12] M., Zhang, F.-S. Zhang, W.-Z. Li, T. Quan, H.-Y. Wu, “A compact UWB monopole antenna with WIMAX and WLAN band rejections”, Progress In Electromagnetic Research Letters, (2012), 31, 159–168.