International Journal of Research in Engineering, Science and Management
Volume-1, Issue-12, December-2018
www.ijresm.com | ISSN (Online): 2581-5792

Design Microstrip Patch Antenna with Band Notched Characteristics for Ultra-wide Band Applications

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***Abstract*: One of the main problems in broadband system is the interference within the band. It is essential to minimize the interference with WIMAX & WLAN. WIMAX System is ranging from 3.3GHz to 3.8GHz and WLAN is ranging from 5.15 GHz to 5.825 GHz. The proposed antenna has a bandwidth of 10.12 GHz ranging from 2.97 GHz – 13.09 GHz and WIMAX & WLAN band is rejected in the range from 3.22 to 3.78 GHz and 4.53 GHz – 7.4GHz. I achieved my aim and achieved percentage bandwidth of antenna is to 126 %. In this design both T-stub and U-Slots used in the single geometry to reject the interference bands from the Ultra-Wide Band Spectrum. The antenna has impedance matching at resonance frequencies 3.104 GHz with S11 -13.62 dB, at 4.08 GHz with S11 -21 dB and at 12.187 GHz with -35.42dB using microstrip line feed.**

***Keywords*: Ultra-Wide Band, WIMAX, WLAN, Bandwidth, Gain, HFSS**

1. Introduction

FCC was approved a commercial frequency band from 3.1GHz to 10.6GHz in 2002.UWB communication systems became a promising technology offering for both the indoor and outdoor wireless communication system. It allow high data rate with low cost. In the research field Wireless technology is one of the main areas in the world of communication systems. Former systems were narrowband, wide range systems but in order to extend the use of available spectrum. we are now using Ultra-wideband systems. One of the main problems in broadband system is the interference within the band. It is essential to minimize the interference with WIMAX & WLAN. WIMAX System is ranging from 3.3GHz to 3.8GHz and WLAN is ranging from 5.15 GHz to 5.825 GHz. As there are different techniques are available to get Band notch characteristics such as stub techniques, slot insertion technique, coupling strip etc. In the first aspect simple microstrip square patch antenna is designed with full ground plane. Result of this antenna design is that broadband antenna characteristics are not achieved. In the second aspect antenna is designed with partial ground plane. Result of this antenna design is that broadband antenna characteristics are achieved by change in ground plane length. In the third aspect to achieve notch band characteristic achieved by using Stub-slot insertion technique. The proposed antenna has a bandwidth of 10.12 GHz ranging from 2.97 GHz – 13.09 GHz and WIMAX & WLAN band is rejected in the range from 3.22 to 3.78 GHz and 4.53 GHz – 7.4GHz. I achieved my aim and achieved percentage bandwidth of antenna is to 126 %. VSWR graph of proposed antenna which is less than 2 for entire operating bandwidth except the range from 3.22 GHz to 3.78 GHz and 4.53 GHz to 7.4 GHz. Simulated results of proposed antenna such as Return Loss, VSWR, Gain and Radiation pattern have satisfactory values within desired frequency band. The document Starts from here. And the section 2 continues accordingly.

2. Antenna design equations

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

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

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

For a given resonant frequency fo, the effective length is

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

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

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

Where m and n are modes along L and W respectively.
The width W is

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

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

3. Antenna design

A. *Micro strip patch antenna for WIMAX rejection*

One of the techniques is design an antenna with Stub insertion technique. In this design methodology, antenna is designed initially with T-stub. In this designed technique a rectangular slot is cut from the patch and a T stub is coupled with patch. Due to insertion of stub the direction of current is opposite to the feed current. Due to opposite direction of the current into the stub corresponding band rejects from the spectrum.

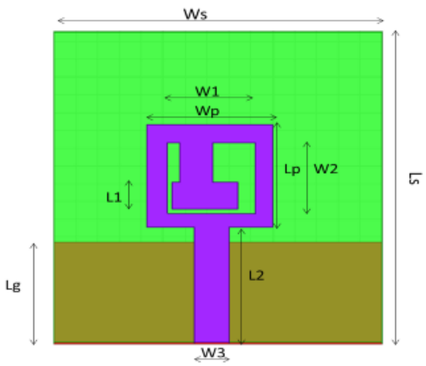

Fig. 1. Geometry of micro strip patch antenna for WIMAX Rejection

B. *Simulation results*

The proposed antenna has a bandwidth of 7.92 GHz ranging from 2.97 GHz – 10.89 GHz and WIMAX band is rejected in the range from 3.27 GHz – 3.89 GHz. The percentage bandwidth of antenna is to 114 %. The presence T-Stub into the patch caused a band notch in frequency range of 3.27 GHz – 3.89 GHz. VSWR graph of proposed antenna which is less than 2 for entire operating bandwidth except the range 3.27 GHz – 3.89 GHz. The antenna has impedance matching at resonance frequencies 3.14 GHz with S_{11} -17.88 dB and 4.35 GHz with S_{11} -45 dB using micro strip line.

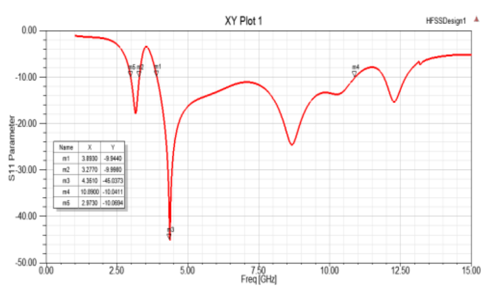

Fig. 2. Return Loss vs. frequency graph of microstrip antenna for WIMAX rejection

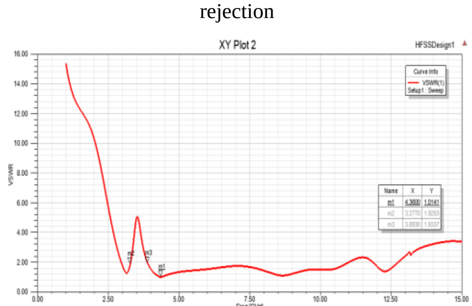

Fig. 3. VSWR vs. frequency graph of micro strip antenna for WIMAX rejection

C. *Micro strip Patch Antenna design for WLAN Rejection*

One of the techniques is design an antenna with Slot insertion technique. In this design methodology, antenna is designed initially with U-stub. In this designed technique U-Slot is inserted into the ground. Due to insertion of slot the direction of current is opposite to the feed current. Due to opposite direction of the current into the slot corresponding band rejects from the spectrum.

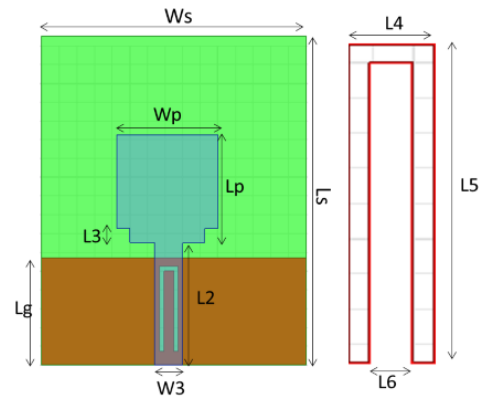

Fig. 4. Geometry of micro strip patch antenna for WLAN rejection

Table 1
Parametric table

Parameter	Dimension
Substrate width, W_s	30 mm
Substrate length, L_s	35 mm
Patch width, W_p	11.5 mm
Patch length, L_p	11.5 mm
Feedline width,W3	3.2 mm
Feedline length,L2	13 mm
Ground plane length, Lg	11.5 mm
L1	3 mm
W1	8 mm

D. *Simulation results*

The proposed antenna has a bandwidth of 8.452 GHz ranging from 3.298 GHz – 11.75 GHz and WLAN band is rejected in the range from 4.766 GHz – 7.41 GHz. The percentage bandwidth of antenna is to 112 %. The presence U-Slot into the ground caused a band notch in frequency range of 4.766 GHz – 7.41 GHz. VSWR graph of proposed antenna which is less than 2 for entire operating bandwidth except the range 4.766 GHz to 7.41 GHz. The antenna has impedance matching at resonance frequencies 3.82 GHz with S_{11} -20.76 dB and 10.4860 GHz with S_{11} -32 dB using micro strip line feed.

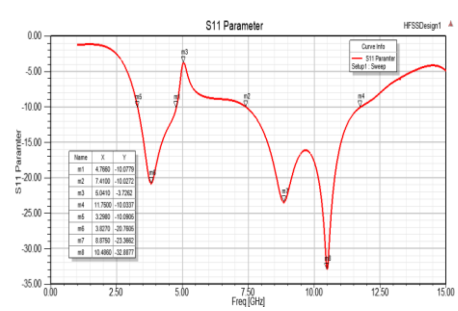

Fig. 5. Return Loss vs. Frequency Graph of Micro strip Patch Antenna for WLAN rejection

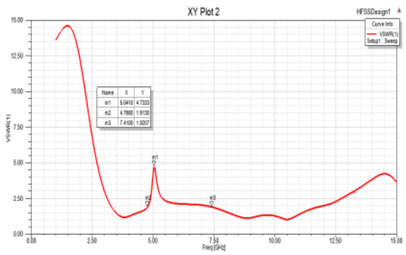

Fig. 6. VSWR vs. frequency graph of micro strip patch antenna for WLAN rejection

C. Microstrip Patch Antenna design for WIMAX & WLAN Rejection

We are now using Ultra-wideband systems. One of the main problems in broadband system is the interference within the band. It is essential to minimize the interference with WIMAX & WLAN. WIMAX System is ranging from 3.3GHz to 3.8GHz and WLAN is ranging from 5.15 GHz to 5.825 GHz.

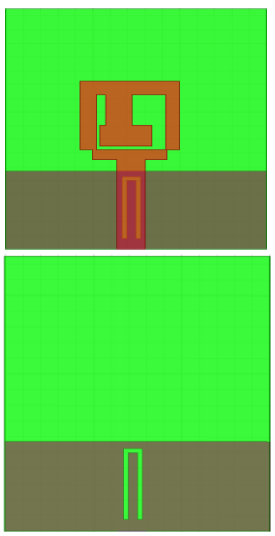

Fig. 7. Proposed antenna structure for WIMAX & WLAN rejection

In this design both T-stub and U-Slots used in the single geometry to reject the interference bands from the Ultra-Wide Band Spectrum. The purpose of using Stub and Slot is already discussed in previous topics. The geometry of Stub and Slot is same as I discussed in section A and B

E. Simulation Results

The percentage bandwidth of antenna is to 126 %. The presence T-Stub and U-Slot caused a band notch in frequency range from 3.22 GHz – 3.78 GHz and 4.537 GHz to 7.4610 GHz. VSWR graph of proposed antenna which is less than 2 for entire operating bandwidth except the range from 3.22 GHz – 3.78 GHz and 4.537 GHz to 7.4610 GHz. The antenna has impedance matching at resonance frequencies 3.104 GHz with S11 -13.62 dB, at 4.08 GHz with S11 -21 dB and at 12.187 GHz with -35.42dB using micro strip line feed.

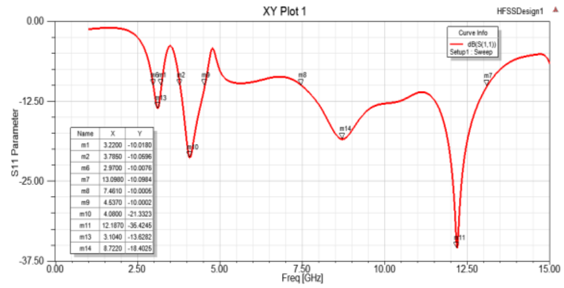

Fig. 8. Return loss vs. frequency graph for proposed antenna

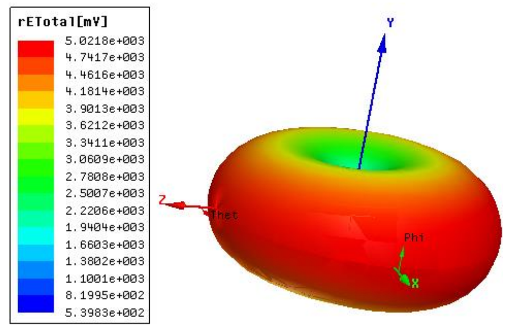

Fig. 9. 3-D Polar Pattern for proposed antenna

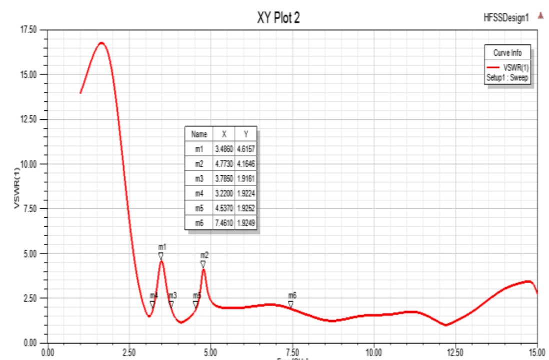

Fig. 10. VSWR vs. Frequency for proposed micro strip patch antenna

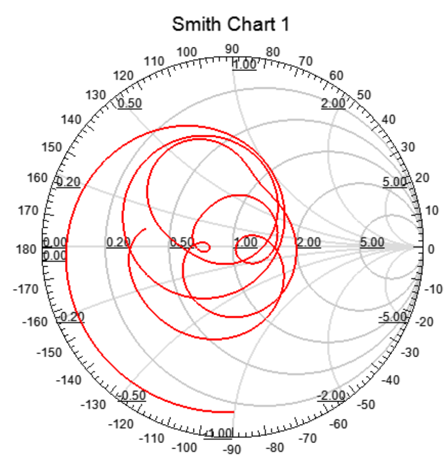

Fig. 11. Smith chart for proposed micro strip patch antenna

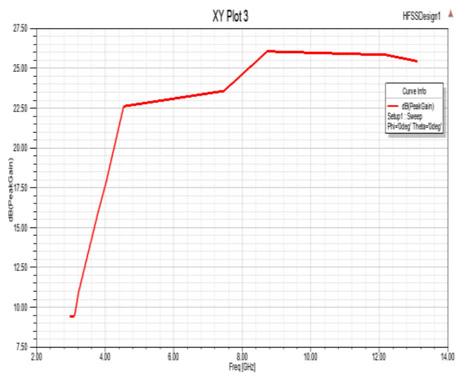

Fig. 12. Gain vs. Frequency graph for proposed micro strip patch antenna

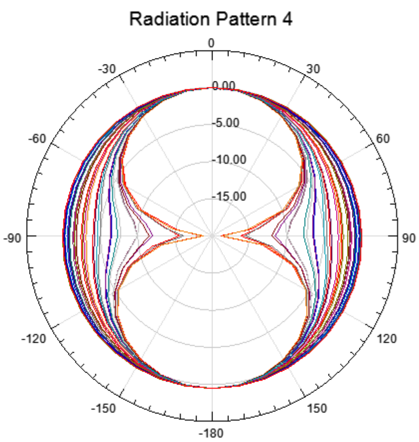

Fig. 13. Radiation pattern for proposed micro strip patch antenna

4. Conclusion

One of the serious problems in Ultra-Wide band antenna is the interference with narrowband antenna. It is essential to minimize the interference with existing WIMAX (3.3 GHz to 3.8 GHz), WLAN (5.1 GHz to 5.825 GHz) technologies. Therefore, various types of planar antennas have been presented. As the result of the researches, antenna design with different types of slot, parasitic strips coupled with radiating patch, ground plane, feed line and two monopoles of same size and a strip to achieve wide bandwidth with band notch characteristic. The aim of my investigations is to achieve wider Bandwidth with rejection in WIMAX and WLAN frequency range nearly close to 3.3 GHz to 3.8GHz and 5.15 GHz to 5.825 GHz. The proposed antenna has a bandwidth of 10.12 GHz ranging from 2.97 GHz – 13.09 GHz and WIMAX & WLAN band is rejected in the range from 3.22 to 3.78 GHz and 4.53 GHz – 7.4GHz. I achieved my aim and achieved percentage bandwidth of antenna is to 126 %. VSWR graph of proposed antenna which is less than 2 for entire operating bandwidth except the range from 3.22 GHz to 3.78 GHz and 4.53 GHz to 7.4 GHz. Simulated results of proposed antenna such as Return Loss, VSWR, Gain and Radiation pattern have satisfactory values within desired frequency band. The future scope of proposed antenna is that it will applicable in high data transfer rate for WPAN applications. It will use for portable wireless communication devices such as cell phones, laptops and personal digital assistants.

5. Future scope

Based on the conclusions and the limitations of the work presented, future work can be carried out in the following areas: In the future the defected ground structure and Electromagnetic band gap structure is also used to further improve the bandwidth. In other aspect fabrication of proposed antenna will be carried out in future and measured results will be compared with simulated results. In second aspect future work will be geometry of antenna design with the RT Duroid. Because RT Duroid has lowest dielectric constants (2.2) than the FR4 epoxy dielectric constant (4.4) and increase the bandwidth because bandwidth is inversely proportional to dielectric constant or permittivity. RT Duroid gives maximum radiation due to its low dielectric constant. Bandwidth and radiation pattern depends on loss tangent. Loss tangent of RT Duroid is 0.0004 while loss tangent of FR4 epoxy is 0.02, so RT Duroid is good dielectric substrate for microstrip patch antenna. RT Duroid also has highest tensile strength and breakdown voltage due to which it does not succumb to the electrical pressure easily that's by it does not lose its insulating property. Thus RT Duroid dielectric material will give better results than FR4 epoxy dielectric material.

References

[1] Anil kumar Agrawal, Shyam Sundar Pattnaik, S .Devi & J G Joshi "Broadband and high gain microstrip patch antenna for WLAN", Indian Journal of Radio & space Physics, vol. 40, October 2011, pp. 282 - 286.
[2] Constantine A. Balanis, "Antenna Theory, Analysis and Design", 2nd ed., John Wiley and Sons, Inc.,
[3] Girish Kumar and K.P. Ray "Broadband Microstrip Antennas" Artech House antennas and propagation library Inc. ISBN 1-58053-244-6, 2003.
[4] Palanisamy, V., and R. Garg, ''Rectangular Ring and H-Shaped Microstrip AntennasAlternative to Rectangular Patch Antennas,'' Electronics Letters, Vol. 21, No. 19, pp. 874–876, 1985.
[5] Chew, W. C., ''A Broadband Annular Ring Microstrip Antennas,'' IEEE Trans.Antennas Propagation, Vol. AP-30, pp. 918–922, September 1982.
[6] Huynh, T., and K. F. Lee, ''Single-Layer Single-Patch Wideband Microstrip Antenna,'' Electronics Letters, Vol. 31, No. 16, 1995, pp. 1310–1312.
[7] Y. X. Guo, K. M. Luk, and Y. L. Chow, "Double U-Slot Rectangular Patch Antenna," Electronics Letters, Vol. 34, No. 19, pp. 1805-1806, 1998.
[8] Kumar, G., and K. C. Gupta, ''Broadband Microstrip Antennas Using Additional Resonators Gap-Coupled to the Radiating Edges,'' IEEE Trans. Antennas Propagation, Vol. AP-32, pp. 1375–1379, December 1984.
[9] Kumar, G., and K. C. Gupta, ''Non radiating Edges and Four Edges Gap-Coupled Multiple Resonator, Broadband Microstrip Antennas,'' IEEE Trans. Antennas Propagation, Vol. AP-33, pp. 173–178, February 1985.
[10] Kumar, G., and K. C. Gupta, ''Directly Coupled Multiple Resonator Wideband Microstrip Antennas,'' IEEE Trans. Antennas Propagation, Vol. AP-33, pp. 588–593, June 1985.
[11] Ray, K. P., and G. Kumar, ''Multi frequency and Broadband Hybrid-Coupled CircularMicrostrip Antennas,'' Electronics Letters, Vol. 33, No. 6, pp. 437–438, 1997.
[12] Croq, F., A. Papiernik, and P. Brachart, ''Wideband Aperture-Coupled icrostripSubarray,'' IEEE AP-S Int. Symp. Digest, xpp. 1128–1131, May 1990.
[13] Baumer, C.," Analysis of Slot Coupled Circular Microstrip Patch Antennas," Electronics Letters, Vol. 28, No. 15, pp. 1454–1455, 1992.

[14] El Yazidi, M., ‘‘Analysis of Aperture-Coupled Circular Microstrip Antenna,’’ Electronics Letters, Vol. 29, No. 11, pp. 1021–1022, 1993.
[15] Luk, K. M., K. F. Tong, and T. M. Au, ‘‘Offset Dual Patch Microstrip Antenna,’’ electronics Letters, Vol. 29, No. 18, pp. 1635–1636, 1993.
[16] Targonski, S. D., R. B. Waterhouse, and D. M. Pozar, ‘‘Design of Wideband Aperture Stacked Patch Microstrip Antenna,’’ IEEE Trans. Antennas Propagation, Vol. AP-46, No. 9, pp. 1245–1251, 1998.
[17] Legay, H., and L. Shafai, ‘‘A New Stacked Microstrip Antenna with Large Bandwidth and High Gain,’’ IEEE AP-S Int. Symp. Digest, pp. 948–951, 1993.
[18] Balakrishnan, B., and G. Kumar, ‘‘Wideband and High Gain Electromagnetically Coupled Circular Microstrip Antennas,’’ IEEE AP-S Int. Symp. Digest pp. 1112–1115, June 1998.