ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 9, September 2013

Microstrip Antenna Array for WiMAX & WLAN Applications

Naresh Kumar Poonia[1], Krishan Kumar Sherdia[2]

M.Tech Student, ECE Department, JCDM College of Engineering, Sirsa, India[1]

Assistant Professor, ECE Department, JCDM College of Engineering, Sirsa, India[2]

Abstract: This paper presents the design of microstrip rectangular patch antenna with center frequency at 2.4 GHz for WiMAX & WLAN application. The array of four by one (4x1) patch array with microstrip line feeding technique was designed and simulated using Computer Simulation Tool (CST) Microwave Environment software. The antenna array designed on Roger5880 substrate with overall size of 200 x 100 x 1.59 mm3 and dielectric substrate with ε_r = 2.2. This antenna structure is designed by using CST Software based on the characteristic impedance for the transmission line model. The performances of designed antenna are compared in terms of parameters like substrate dimension, feed size and ground plane. The antenna performance in terms of its frequency domain and time domain characteristics are investigated.

Keywords: CST Microwave studio, Simulation, Microstrip line feed, microstrip antenna, Omni-directional patterns.

I. Introduction

Recently, the development of communication technology is highly increased and indicating still continues to grow, not least with a wireless communication system. Not only making advanced technology increases, the wireless communication systems such as WiFi (Wireless Fidelity) and WiMAX (Worldwide Interoperability Mobile Access) as well as their services applications are very popular in everyday life with a variety of advantages, such as to provide communication services at anytime and anywhere for the users. Those phenomenon's can be seen by the increasing demand for cellular phone service, wireless internet access, teleconference .These days, there is a very large demand by the end user for integrated wireless digital applications. Antennas which are used in these applications should be low profile, light weight, low volume and broad bandwidth [1]. To meet these requirements, microstrip antenna is preferred. An antenna should be low-profile, comfortable to planar and non planar surfaces, simple and inexpensive to manufacture, mechanically robust when mounted on rigid surfaces[2]. When the particular patch shape and mode are selected they are very versatile in terms of resonant frequency, polarization, pattern and impedance. Microstrip single antenna has several advantages, it also has several disadvantages such as low gain, narrow bandwidth with low efficiency. These disadvantages can be overcome by constructing many patch antennas in array configuration. In this paper, the design of single and four by one (4x1) patch array microstrip rectangular antennas with microstrip line as feeding method is presented. Quarter-wave transformer is used to match the feeding line to the antennas. The center frequency is determined to operate at 1.8 GHz & 2.4 GHz which is suitable for WiMAX application. The 4x1 patch array antenna designed on the substrate type Roger5880 with dielectric constant of 2.2 and thickness of 1.6mm. This antenna offers a return loss of -32 dB . More significantly, as per the rigorous simulation study using CST microwave studio, the 4x1 patch array antenna perform the single patch antenna in terms of radiation gain, directivity and bandwidth.

2. ANTENNA GEOMETRY AND SIMULATION RESULTS

A. Antenna Geometry:

Fig. 1 illustrates the evolution of the proposed Microstrip Antenna on the Roger5880 substrate.

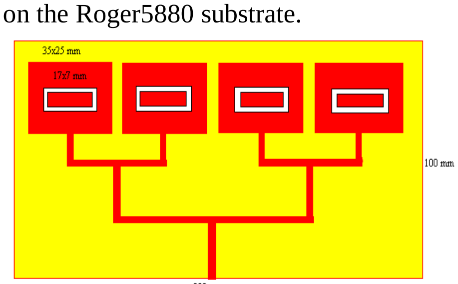
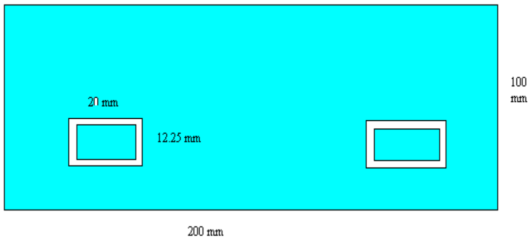


Fig. 1 The proposed Microstrip antenna array
(a) Simulation Model

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 9, September 2013



(b) Ground Structure of Antenna Array

Table-I Antenna Array Parameter

Sr. No	Description	Value/mm
1	Antenna Length	200 mm
2	Antenna width	100 mm
3	Width of the ground plane	63.4 mm
5	Substrate thickness h	1.59 mm
6	Feed Size (Width)	3 mm

B. *Impedance Bandwidth*

Fig.2 shows the simulated return losses (S parameter) of the antenna has a multi-band characteristic in the UWB spectrum. Three resonant frequencies locate at about 1.8GHz and 2.4 GHz with the return losses reach -32dB, and -30dB respectively. The ground plane size selection is also based on the study presented in [3], [4] on the microstrip slot antennas.

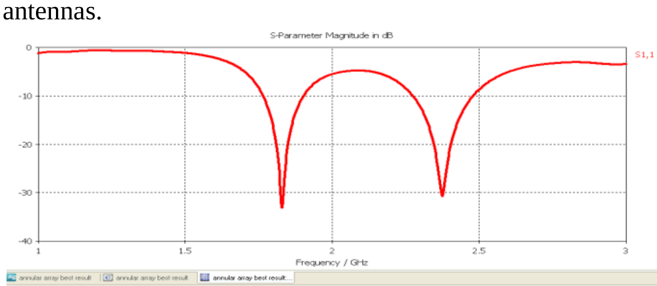


Fig.2.The reflection coefficient (S11, dB) versus frequency (GHz) plot for antenna design.

3. SMITH CHART PLOT

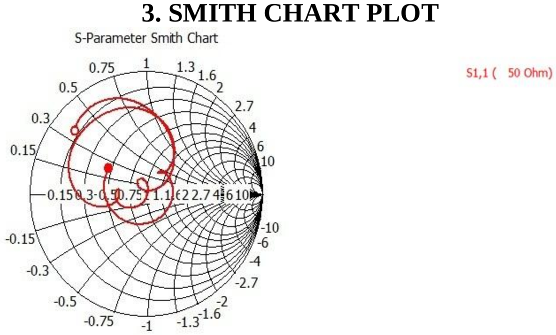


Figure 3:-Smith chart plot (microstrip line feed) for simulated antenna design

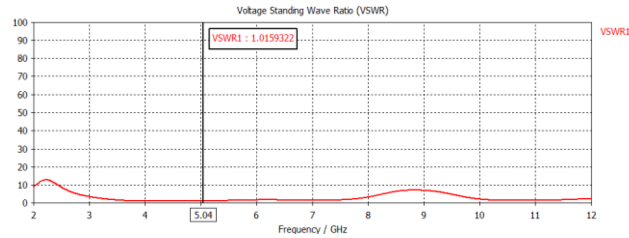


Figure.4 VSWR Plot

4. EFFECT OF PARAMETER VARIATION ON ANTENNA PERFORMANCE

Substrate material Variation: In this case there are comparisons of return loss with the variation in the materials of substrate. In this investigation of effect generally Roger 5880, Roger 4003 & Fr4 are considered. From the result it is to be observed that Roger5880 provides the min. return loss as compared to the Roger 4003 and Fr4. So Roger5880 is considered as a suitable material for the proposed antenna design. With the use of Roger5880 as a substrate material the bandwidth increases as shown in figure below:

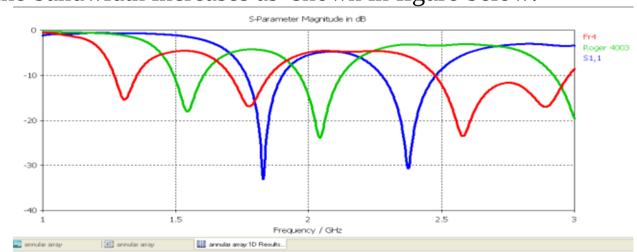


Figure 4: Effect of substrate material on the antenna performance

Substrate permittivity (ε_r) *Variation :* In this case there is comparisons of return loss with the variation in the permittivity of the materials. On decreasing the dielectric constant of substrate , the bandwidth increases as shown in figure below:

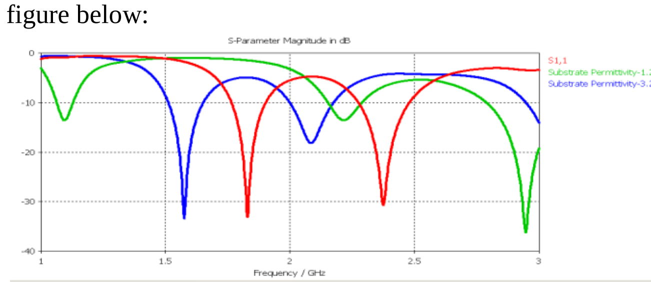


Figure 5 – Effect of substrate permittivity (ε_r) on antenna performance characteristics

Effect of ground size width: On increasing the ground size width, the return loss between the resonant frequencies increases but at a specific value of ground width there is a impedance matching at this value min. return loss is

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 9, September 2013

achieved and the proposed antenna provides the effective result.

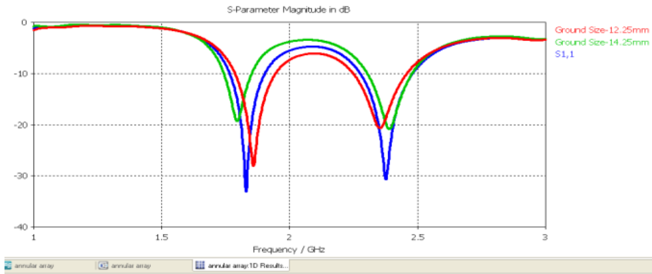


Figure 6: Effect of ground size variation on the antenna performance

Feed width (Wf) Variation : On increasing the feed width (Wf), the bandwidth increases and return loss decreases as shown in figure below:

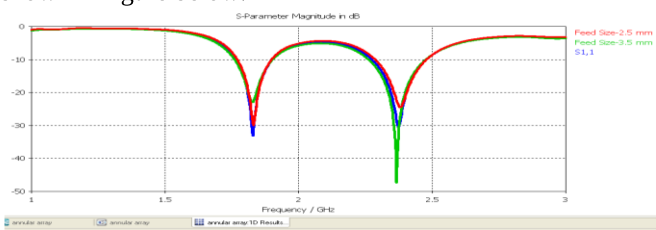
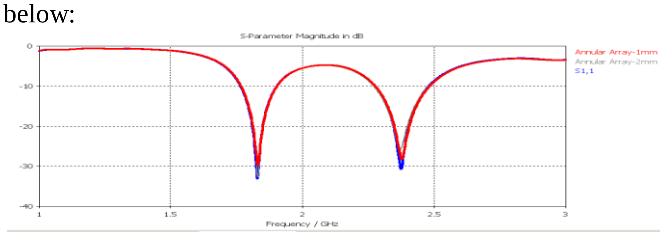
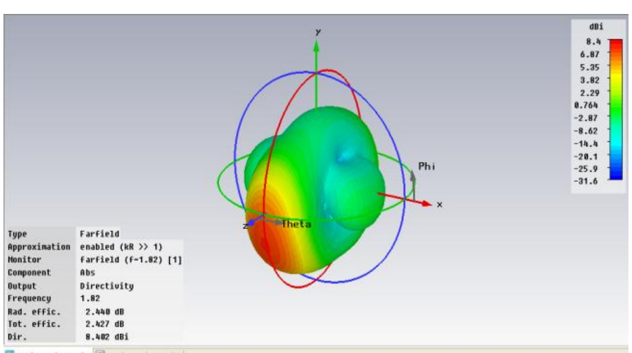


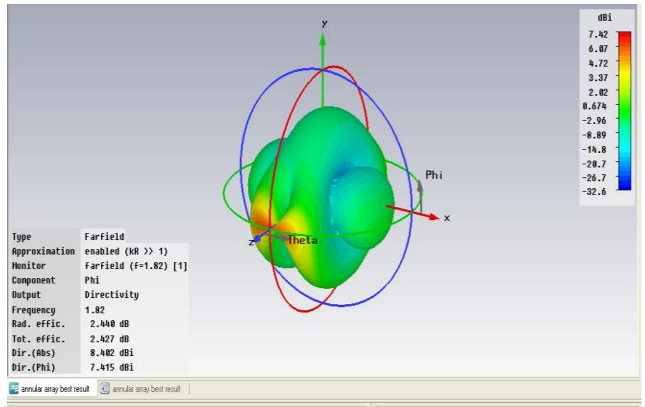
Figure 7 – Effect of feed width (ε_r) on antenna performance characteristics

Annular Ring width (Aw) Variation : At some specific value of annular width there is impedence matching and at this value min. Return loss is achieved as shown in figure below:



5.RADIATION PATTERN





6. CONCLUSION

A microstrip rectangular patch array antenna that feed by microstrip line has been designed, simulated and compared with the single rectangle antenna. The performance was measured and it shows that the array antenna outperform the single antenna in terms of directivity, bandwidth and gain. The final array antenna design was than fabricated and the performance was than compared with the simulated array antenna. Overall, the performance of the array antenna meets the desired requirement in terms of return loss and VSWR. The simulation return loss is equal to -32 dB & -30 dB at the freq. of 1.8 GHz & 2.4 GHz respectively. Adding to this, the performance of the microstrip array antenna strongly depends on several factors such as feeding technique, type of substrate, the thickness and dielectric constant of substrate respectively Although there were some side lobes for the radiation pattern of microstrip array antenna due to the use of array structure, however in general the performance of array antenna has accomplished the specifications required by WiMAX application. The feed size of antenna is inversely proportional to the port impedance. The dimension of the microstrip antenna also has an impact on the antenna performance because the current is mainly distributed along the edge on the radiator. In a broad sense, the ground plane of the antenna design perform operation as an impedance matching circuit, and it tunes the input impedance and hence changes the operating bandwidth with variation of antenna feed size[10].

ACKNOWLEDGMENT

I would also like to thank Er. Naresh Kasnia Assistant Professor at JCDM College of Engineering, Sirsa for their help to provide the basic knowledge about the software CST Software & Antenna concepts.

REFERENCES

[1] T. Huynh and K. F. Lee, "Single-Layer Single-Patch Wideband MicrostripAntenna, " Electronics Lett. , vol. 31, no.16, pp. 1310-1312, August 1995.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 9, September 2013

[2] S. W. Su, K. L. Wong, and F. S. Chang, "Compact Printed Ultra-Wideband Slot Antenna with a Band-notched Operation," Microwave and OpticalTechnology Lett., vol. 45,no. 2, April 2005, pp. 128-130,April 2005.
[3] K. Chyng, J. Kim, and J. Choi, "Wideband Microstrip-Fed Monopole Antenna Having Frequency Band-Notch Function," IEEE Microwave and Wireless Components Lett., vol.15, no. 11, pp. 766- 768, Nov. 2005.
[4] K. F. Tong, K. M. Luk, K. F. Lee, and R. Q. Lee, "A broad-band u-slot rectangular patch antenna on a microwave substrate," IEEE Trans. On Antennas and Propagation, vol. 48,no. 6, pp. 954 - 960, Jun. 2000.
[5] Y. X. Guo, K. M. Luk, K. F. Lee, Y. L. Chow, "Double u-slot rectangular patch antenna," Electronics Lett., vol. 34, pp. 1805-1806, Sep. 1998.
[6] K. F. Lee, S. Yang, A. A. Kishk, "Dual and multiband u-slot patch antennas", IEEE Antennas Wireless Propagation Lett., vol. 7, pp. 645 -647, Dec. 2008
[7] K. F. Lee, S. L. S. Yang, A. A. Kishk, and K. M. Luk, "The Versatile Uslot Patch Antenna, "IEEE Antennas and Propagation Magazine," vol. 52, no. 1, pp. 71-88, Feb. 2010.
[8] M. 1. 1. Ammann, M., "Some techniques to improve small ground plane printed monopole performance," in Antennas and Propagation Society International Symposium. 2007 IEEE, vol. 9
[9] Hossain, 1.; Noghanian, S.; Pistorius, S.; , "A diamond shaped small planar ultra wide band (UWB) antenna for microwave Imaging Purpose," Antennas and Propagation Society International Symposium,2007 IEEE , vol., no., pp.S713-S716, 9-1S June 2007
[10] Sadat, S.; .lavan, S.D.S.; Houshmand, M.; , "Design of a Microstrip square-ring slot antenna filled by an H -shape slot for UWBapplications," Antennas and Propagation Society International Symposium, 2007 IEEE , vol., no., pp.70S-708, 9-IS June 2007
[11] Zhi Ning Chen, Senior Member IEEE & Terence S. P See and Xianming Qing "Small printed UWB Antenna with reduced Ground Plane effect" IEEE transactions on Antenna & Propagation Vol. 55 No. 2, February 2007