J. Basic. Appl. Sci. Res., **1(9)1084-1088, 2011**

ISSN 2090-424X
Journal of Basic and Applied Scientific Research
www.textroad.com

Low Profile MIMO Diversity Antenna with Multiple Feed

Waqas Ahmad, Muhammad Wasif Nisar, Ehsan Ullan Munir, Waqas Anwar

COMSATS Institute of Information Technology, Wah Cantt. 47040, Pakistan.
COMSATS Institute of Information Technology, Abbottabad,Pakistan

ABSTRACT

A Compact low profile MIMO Diversity antenna system with multiple feeds with a size of 105mm*61.5mm is proposed. Multiple feeds are used to provide maximum power to antenna elements so that signal can propagate a long distance. The proposed antenna is achieving multiple frequencies, i.e. 2.5 GHz, 3.21 GHz, 4.22GHz, 4.68GHz, 6.5GHz, 6.74 GHz, 7 GHz and 8.35 GHz. Measured S-parameters show the isolation is -23.715 db. The maximum achievable bandwidth is 1.32 GHz (1320 MHz). This antenna can be applicable at Wimax, WLAN, LTE and Satellite Bands.
KEY WORDS: Multiple-input multiple-output (MIMO), multi feed, circular-slots, diversity.

1. INTRODUCTION

MULTIPLE-INPUT–MULTIPLE-OUTPUT (MIMO) wireless communication systems uses multiple antenna elements at both the transmit and receive sides to improve capacity gain as compared to the usual single-input–single-output (SISO) systems [1].

In [2] they have designed a multiband MIMO antenna using a band stop matching circuit. This antenna is applicable at next generation mobile applications. At LTE band antenna has the isolation of approximately 15 dB and 20 dB at the upper bands.

In [3] a compact Microstrip patch antenna operating at tri-bands is being proposed. The proposed antenna operates at 2.7 GHz, 3.2 GHz and 5.3 GHz. The antenna has two U-shaped slots and a small ground plane in order to have better performance. The achieved return losses are -18.5 dB, -14.5 dB and -19 respectively.

In [4] they have presented a single layer, feed, multi frequency, compact rectangular microstrip patch antenna. In order to reduce resonant frequencies they have used the mechanism of cutting rectangular slots at the edges with adding two small circles inside the patch in order to improve the return loss. By cutting the edges the antenna size has been reduced to 64%.

In [5] they have presented the design of LMDS antenna. They have used aperture coupled method in order to enlarge the band of patch. They have also tried to minimize the fringing effect across the band patch. Due to which both the antenna efficiency and frequency bandwidth are increased.

In [6] they have presented a dual-polarized shorted bowtie antenna included with a cross dipole. The dipole is used to get same radiation patterns in order to balance high back radiations which are produced due to shorted patches. The proposed antenna is designed to operate on DCS, PCS, and 3G mobile communication systems working between 1.71 and 2.17 GHz.

In [7] a wideband planar diversity antenna for mobile terminal is presented. The antenna is operate able on UMTS and WLAN bands and has corresponding bandwidth of 1.904–2.504 GHz including UMTS (1.920–2.170 GHz) and 2.4 GHz WLAN (2.400–2.484 GHz) bands. The mutual coupling effect of the antenna has also been reduced.

In [8] a new approach using directive antenna for designing MIMO arrays is presented. The main emphasize in this work is on reducing the mutual coupling. In this work a MIMO array of printed Yagi antennas with integrated balun is presented. The end-fire radiation mechanism of the Yagi is exploited to obtain a triangular array of three sectoral antennas.

In [9] Metamaterial concepts are used to design a novel rectangular patch antenna. The patterned metal patch and finite ground plane form a coupled capacitive-inductive (C-L) circuit of negative index metamaterial. In order to achieve low VSWR, high efficiency, low loss and wideband a new type of antenna is used to design Meta array. The resultant array has more bandwidth than original patch arrays, and high gain can also be obtained in a wide frequency band.

***Corresponding Author:** Muhammad Wasif Nisar, COMSATS Institute of Information Technology, Wah Cantt. 47040, Pakistan. Email: wasifnisar@comsats.edu.pk

In [10] a rectangular patch antenna array for MIMO communications was simulated on a magnetic permeability enhanced metamaterial. The antenna performance was compared with conventional array constructed on normal substrate. The analysis was taken on the basis of degree of mutual coupling for different element spacing, achievable channel capacity, bandwidth and efficiency. The results show the array built on the metamaterial substrate has significant size reduction, less mutual coupling and significant channel capacity improvement compared to similar arrays on conventional substrates.

2. Antenna Design

In this paper multi-feed Mimo antenna is proposed. The geometry of Mimo antenna is illustrated in Figure2. The proposed antenna contains 2 antenna elements having approximately λ/8 (7.5mm). Each antenna element is feeded with 2 feeds one from top the other from the bottom. Both the antenna elements are on common ground. The dimension of the antenna elements are 43mm*27.6mm, dimension of substrate and ground are 105mm*61.5mm. The thickness of the substrate is 1.6mm and have dielectric constant of ε_r =4.4. The antenna elements are feeded with transmission line of 3mm*17mm and have impedance of 50 ohms. Circular slots have been introduced to achieve multibands. A circle with crossing rectangles has been introduced in middle of each antenna element. The radius of the central circle is 6mm and rectangles are of dimensions 3mm*14mm and 14mm*3mm. four more circles with radius 3mm are introduced on the corners of each antenna element.

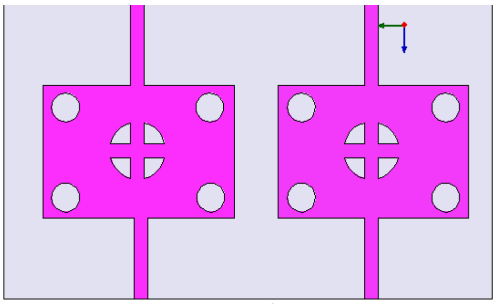

Figure 1: Structure of MIMO Antenna

Structure of antenna in figure 1 has dimension of antenna elements are 41mm*27.6mm. The spacing between the two antenna elements in this design is λ/6. The antenna Operates at multiband and the results are shown in figure 3.

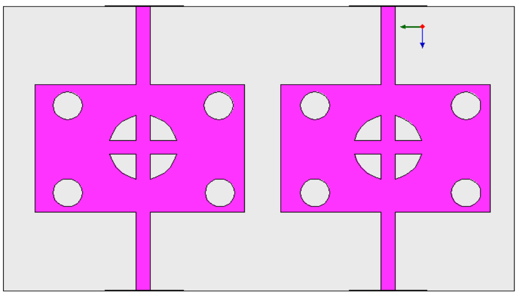

Figure 2: Propsed Structure of MIMO Antenna

The width and antenna elements spacing of Antenna in Figure 1 have been changed to get the improved results. The width of each antenna element is increased 2mm from the left-side and the spacing between antenna elements is approximately λ/8 (7.5mm). As shown in Figure 2. The results of the proposed structure of Mimo antenna is shown in Figure 4.
The Antenna's elements width and length are calculated by the following formula taken from [5].

$$w = \frac{c}{2f_0}\sqrt{\frac{2}{\in_r + 1}} \qquad (1)$$

In the formula (l), ***W*** is the element's width, **C is** the velocity of light in free space, ε_r is the relative dielectric constant, and f_0 is the operational frequency. The effective dielectric constant of the feeding line is calculated by the formula (2)

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 12h/w\right)^{-1/2} \quad (2)$$

Here, **h** is the height of the dielectric, and ***w* is** the width of the conductor. Because the fringing field effect occurs around the patch's edges, the quotient of Δ L is needed to compensate for formula (3)

$$\Delta L = h(0.412)\frac{(\varepsilon_{eff} + 0.3)(w/h + 0.264)}{(\varepsilon_{eff} - 0.258)(w/h + 0.8)} \quad (3)$$

The antenna element's length and the effective length are calculated by the formula (4) and (5)

$$L = \frac{\lambda}{2} - 2\Delta L \quad (4)$$

$$L_e = L + 2\Delta L \quad (5)$$

3. SIMULATIONS AND RESULTS

The simulated results of first structure presented in Figure 1 are shown in Figure 3 below.

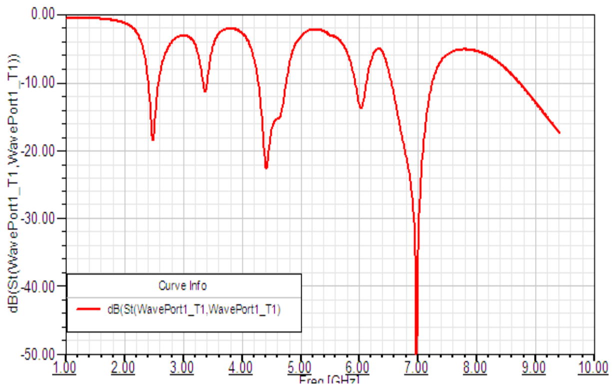

Figure 3: Simulated results of Structure of MIMO Antenna

The simulated results of enhanced structure presented in figure 2 are shown in figure 4 below

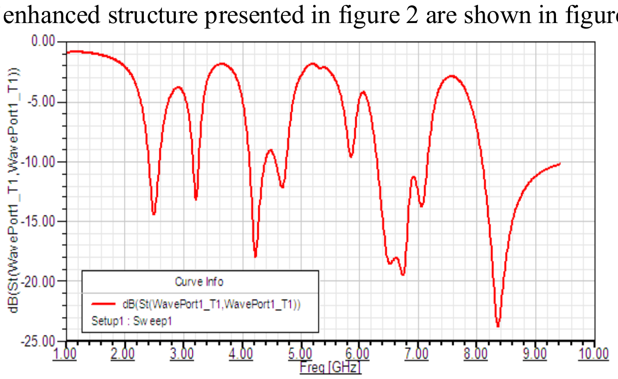

Figure 4: Simulated results of proposed Structure of MIMO Antenna

The following tables show the detailed frequencies, return loss and bandwidth of both the antennas.

Table 1: Simulated results of Structure of MIMO Antenna

Freq (GHz)	Bandwidth (MHz)	Return Loss (db)
2.52	180	**-15.4061**
3.37	70	**-11.6245**
4.42	460	**-24.7065**
6.03	180	**-13.2527**
7.00	660	**-56.2042**
8.75	**1130**	**-22.8125**

Table 1 shows the details about the achieved frequencies, bandwidth and return loss of the Figure 1 of the MIMO Antenna.

Following figure represents the radiation pattern of the individual frequencies.

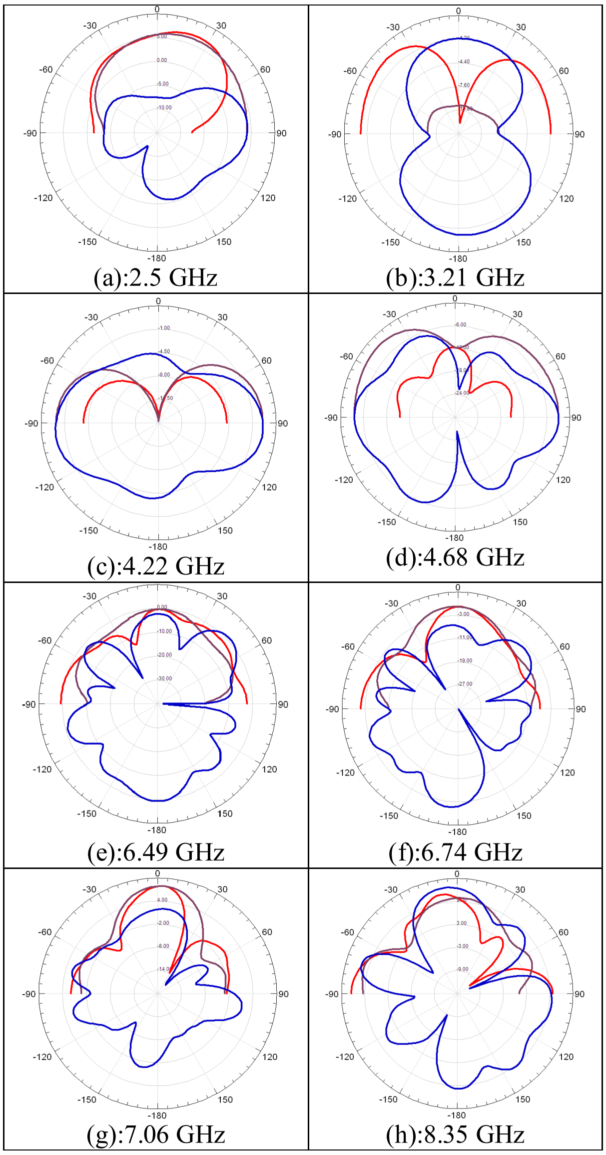

Figure 5: Radiation pattern.

In Figure 5 the radiation pattern shows the Theta and Phi Pattern with values of 0, 90 degrees. Radiation pattern most commonly refers to the *directional* (angular) dependence of the strength of the radio waves from the antenna. The radiation patterns are plotted with respect to E-field and H-field:

H-field:
Theta=all values
Phi= 0' 90 (0= XZ-Plane, 90=YZ-Plane)
E-field :(XY-Plane)
Theta=90
Phi= All values

Table 2: Simulated results of proposed Structure of MIMO Antenna

Freq (GHz)	Bandwidth (MHz)	Return Loss (db)
2.50	180	-14.4958
3.21	100	-13.1467
4.21	250	-17.8958
4.68	160	-12.1023
6.51	840	-18.5250
6.74	840	-19.4977
7.07	840	-13.7091
8.35	1320	-23.7154

Table 2 shows the details about the achieved frequencies, bandwidth and return loss of the Figure 2 of the MIMO Antenna which is much better than the results of Figure 1, here got more bandwidth and achieved more frequencies.

4. Conclusion

A Compact low profile MIMO diversity antenna system with multiple feeds with a size of 105mm*61.5mm is proposed in this paper. Multiple feeds are used to provide maximum power to antenna elements so that signal can propagate a long distance. The proposed antenna is achieving multiple frequencies, i.e. 2.5 GHz, 3.21 GHz, 4.22GHz, 4.68GHz, 6.5GHz, 6.74 GHz, 7 GHz and 8.35 GHz. Measured S-parameters show the isolation is -23.715 db. The maximum achievable bandwidth is 1.32 GHz (1320 MHz). This antenna can be applicable at Wimax, WLAN, LTE and Satellite Bands.

REFERENCES

[1]. G. J. Foschini and M. J. Gans, "On limits of wireless communications In a fading environment when using multiple antennas," *Wireless Personal Commun.*no. 6, pp. 311–335, 1998.

[2]. Min-Seok Han; Jaehoon Choi; "Multiband MIMO Antenna with a Band Stop Matching Circuit for Next Generation Mobile Applications" IEEE Conferences Publication Year: 2009 , Page(s): 1 - 4

[3]. AbuTarboush, H.F.; Al-Raweshidy, H.S.; Nilavalan, R.; "Triple band double U-slots patch antenna for WiMAX mobile applications" IEEE Conferences Publication Year: 2008 , Page(s): 1 - 3

[4]. S. arkar, I.; Sarkar, P.P.; Chowdhury, S.K.; "A NOVEL COMPACT, MICROSTRIP ANTENNA WITH MULTIFREQUENCY OPERATION" IEEE Conferences Publication Year: 2009 , Page(s): 147 - 151

[5]. Hyeonjin Lee; Taehong Kim; Yeongseog Lim; "Wide-Band Microstrip Patch Antenna Design For LMDS Band" IEEE Conferences Publication Year: 2000 , Page(s): 709 - 712

[6]. Ka-Ming Mak; Hang Wong; Kwai-Man Luk; "A Shorted Bowtie Patch Antenna With a Cross Dipole for Dual Polarization " IEEE Journals Volume: 6 Publication Year: 2007 , Page(s): 126 - 129

[7]. Xuan Wang; Zhengwei Du; Ke Gong; "A Compact Wideband Planar Diversity AntennaCovering UMTS and 2.4 GHz WLAN Bands" IEEE Journals Volume: 7 Publication Year: 2008 , Page(s): 588 - 591

[8]. Capobianco, A.D.; Pigozzo, F.M.; Boscolo, S.; Midrio, M.; Sacchetto, F.; Assalini, A.; Brunetta, L.; Zambon, N.; Pupolin, S.; "A Novel Compact MIMO Array based on PlanarYagi Antennas for Multipath Fading Channels" IEEE Conferences Publication Year: 2010 , Page(s): 93 - 96

[9]. Le-Wei Li; Ya-Nan Li; Ke Xiao; "Broadband and High-Gain Metamaterial Microstrip Anetnna Arrays" IEEE Conferences Publication Year: 2010 , Page(s): 1 - 4

[10]. Mookiah, P.; Dandekar, K.R.; "Performance Analysis of Metamaterial Substrate Based MIMO Antenna Arrays" IEEE Conferences Publication Year: 2008 , Page(s): 1 - 4