Design of circular shape MIMO antenna for WLAN & WiMAX applications to reduce mutual coupling

Ch.Mounika[1], K.Vasu babu[2]

[1]Project student, Department of E.C.E, VasireddyVenkatadri Institute of Technology, Nambur, AP,India
[2] Asst. professor, Department of E.C.E, VasireddyVenkatadri Institute of Technology, Nambur, AP, India
[1]chmonika1927@gmail.com, [2]vasubabuece@gmail.com

Abstract: **In this paper, the design of MIMO and neutralization antenna for WLAN and WiMAX applications is proposed. The proposed antenna comprises of a MIMO circular radiating patch with a pair of rectangular slits and an inverted U-shaped slot. By adjusting the inverted U-shaped slot, a pair of rectangular slits and neutralization line we obtain distinct resonance frequencies centred at 4.819 GHz can be generated. The VSWR results are centred around ≤ 2. The far field values obtained at a wide operational bandwidth of 1 GHz. The measurements show that the proposed antenna can cover frequency bands with sufficient bandwidth. The proposed antenna exhibits an omni-directional radiation pattern and acceptable gain.**

Index terms **: WIMAX, WLAN, MIMO patch antenna, neutralization line, U-shaped slot.**

I. INTRODUCTION

WiMAX (Worldwide Interoperability for Microwave Access) is a family of wireless communications standards initially designed to provide 30 to 40 megabit-per-second data rates, with the 2011 update providing up to 1 Gbit/s for fixed stations. A WiMAX tower, similar in concept to a cell-phone tower [1-5]. A single WiMAX tower can provide coverage to a very large area as big as 3,000 square miles (~8,000 square km). A WiMAX receiver - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way Wi-Fi access is today. Both IEEE 802.11, which includes Wi-Fi, and IEEE 802.16, which includes WiMAX, define Peer-to-Peer (P2P) and wireless ad hoc networks, where an end user communicates to users or servers on another Local Area Network (LAN) using its access point or base station[1-10].

A wireless local area network (WLAN) is a wireless distribution method for two or more devices that use high-frequency radio waves and often include an access point to the Internet. A WLAN allows users to move around the coverage area, often a home or small office, while maintaining a network connection. A wireless LAN (or WLAN, for wireless local area network, sometimes referred to as LAWN, for local area wireless network) is one in which a mobile user can connect to a local area network (LAN) through a wireless (radio) connection. The IEEE 802.11 group of standards specify the technologies for wireless LANs. Mobile devices can connect to Wireless access points providing they are within range of the wireless network and have built-in Wi-Fi capabilities.

The majority of smart phones and some feature phones have built-in Wi-Fi connectivity.

WLAN is also known as Wi-Fi, 802.11a, b, g and n. wireless local area network (WLAN 2.4-2.4835 GHz and 5.15-5.875 GHz) and worldwide interoperability for microwave access (WiMAX: 3.3-3.7 GHz) technologies have been widely used in mobile devices. Much attention has been focused on designing multiband antenna which can operate at both WLAN and WiMAX frequency bands [1-10]. Most proposed multiband antennas in handheld devices are planar inverted-F antennas (PIFA) and monopole antennas.

The most common type of microstrip antenna is the patch antenna. Antennas using patches as constitutive elements in an array are also possible. A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Multiple-input and multiple-output, or MIMO is a method for multiplying the capacity of a radio link using multiple transmit and receive antennas to exploit multipath propagation. MIMO has become an essential element of wireless communication standards including IEEE802.11n (WiFi), IEEE802.11ac (WiFi), HSPA+ (3G), Wi-MAX (4G), and Long term evolution 4G[1-12].

More recently, MIMO has been applied to power-line communication for 3-wire installations as part of ITU G.hn standard and Home Plug AV2 specification. "MIMO" specifically refers to a practical technique for sending and receiving more than one data signal simultaneously over the same radio channel by exploiting multipath propagation. MIMO is fundamentally different from smart antenna techniques developed to enhance the performance of a single data signal, such as beam forming and diversity.

II. CIRCULAR SHAPE PATCH GEOMETRY

The antenna geometry is shown in Fig. 2.1 without neutralization. The MIMO circular antenna has two patches, one mirrored to the other, as a single patch that leads to symmetrical geometry with respect to both axes. The circular shaped patch has a inverted U-shaped slot, with a rectangular slit on both sides. The top radius of the patch is 19. The material used for substrate is FR-4 lossy where as for ground, patch, slots and strip we use PEC. The outer patch has L*W as dimensions. The remaining dimensions can be shown in Table 1. The designed geometry is presented with the use of CST (computer simulation technology) software. With respect to the materials frequency also plays an important role in the design.

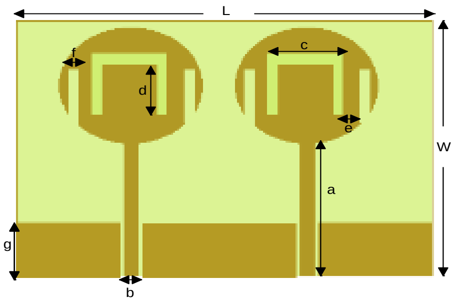

Fig: 2.1. Design geometry of circular MIMO antenna

Design parameters	L	W	a	b	c	d	e	f	g	h
Value(mm)	100	80	41	3	17	23	4	2	15	2

Table1. Dimensions of circular shape MIMO antenna

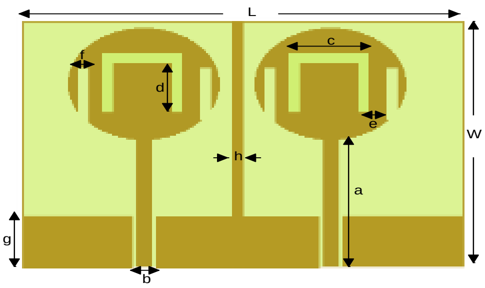

Fig. 2.2 Design geometry of circular shape MIMO neutralization antenna

Fig 2.2 shows the design geometry of circular shape MIMO antenna with neutralization, the structure resemblance is same as Fig 2.1, there will be an extra adding of a strip of 2 mm in between the two circular patches, the material used for neutralization strip is PEC material.

III. RESULTS AND DISCUSSION

By using different types of approaches of design of microstrip MIMO antenna in references [1- 10], the return loss and mutual coupling parameters are compared with the proposed antenna design we get better results in terms of their antenna parameters as shown in figures 3.1, 3.2 & 3.3. Here we observed the VSWR is improved in this entire band it lies between 1.00 to 1.28. At a particular resonant frequency band of 6.453 GHz standing wave ratio value is around 1.009. The below fig 3.5 represents the far field results of proposed MIMO antenna.

By using different types of methods to reduce the mutual coupling between the MIMO antennas. Here a coplanar wave guide (CPW) is inserted between the two antennas to reduce the mutual coupling. Some of other methods [5-15] like EBG structure, Defected ground Structure and neutralization methods to reduce mutual coupling. Here the propose method got good result compared to other reference methods.

The proposed system with a return loss of S_{11} and S_{12} at a frequency of 4.8GHz with 46.45dB and -21.63326dB for without neutralization, similarly S_{11} and S_{12} at a frequency of 4.819 GHz with -37.803304 dB and -22.19643 dB for with neutralization line are shown in Fig 4.1and 4.2 used in the applications of WLAN, WiMAX, laptops, Ethernet and radar applications. The proposed antenna with a VSWR values less than 2 at 4.8GHz frequency for all the three designs are shown in Fig 3.3 and 3.4.The simulation results of proposed antenna with far field results for three designs are shown in shown in Fig 4.5 and 4.6.

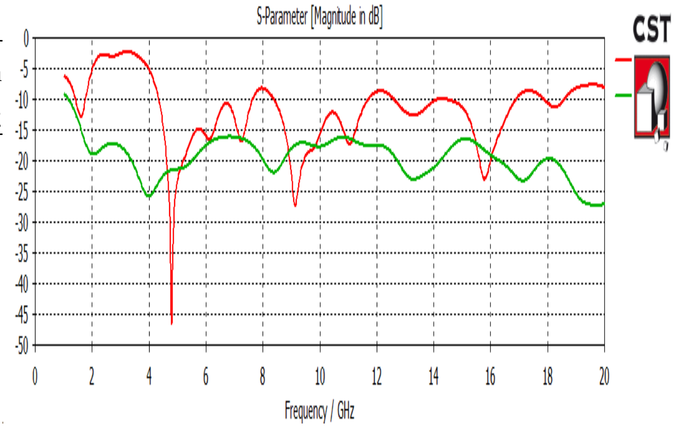

Fig. 3.1 S_{11} and S_{12} parameter without neutralization line

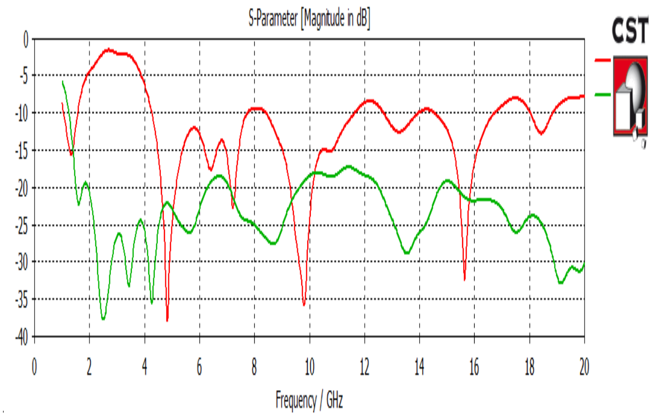

Fig. 3.2 S_{11} and S_{12} parameter with neutralization line

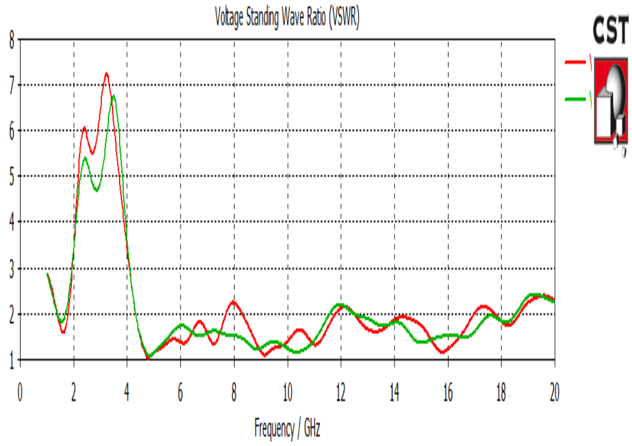

Fig. 3.3 VSWR results without neutralization line

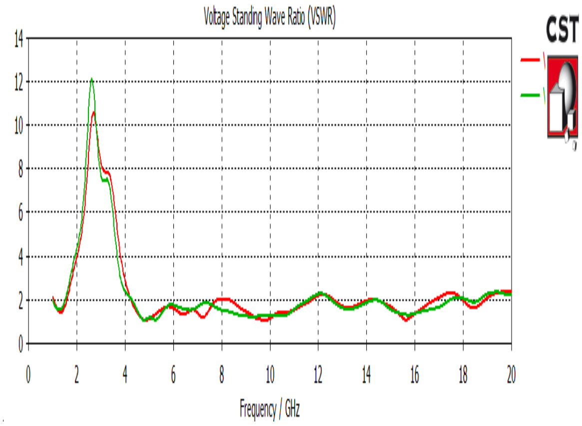

Fig. 3.4 VSWR results with neutralization line

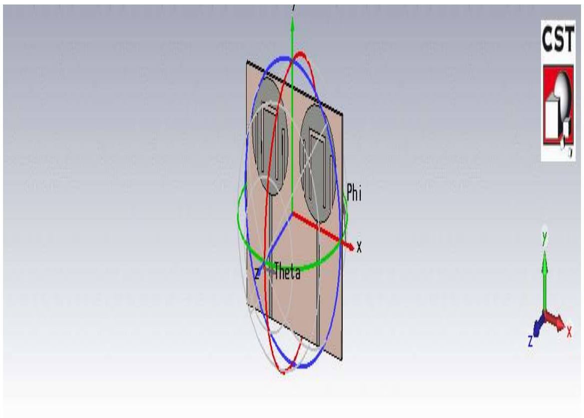

Fig. 3.5 Far field results of with neutralization line

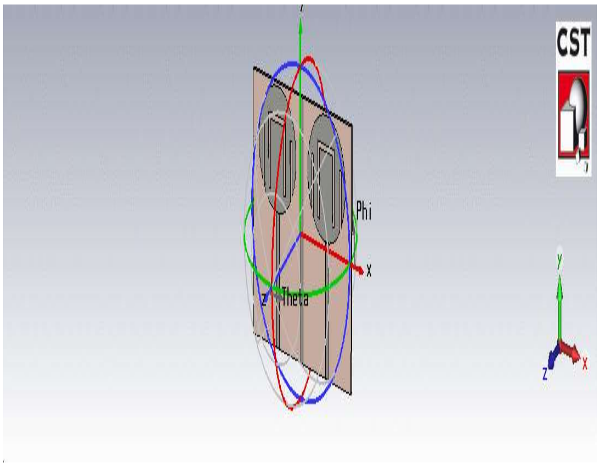

Fig. 3.6 Far field results of with neutralization line

IV. CONCULSION

In this paper, we present a planar multiband antenna with a pair of rectangular slits and an inverted U-shaped slot in the circular radiator. By using the pair of rectangular slits the multiband resonance frequency and bandwidth can be tuned and controlled. The proposed antenna shows an omni-directional radiation pattern and acceptable gain. The proposed antenna features simple structure, broad operating bandwidth, stable radiation patterns, and acceptable gain, which make it a good candidate for WLAN/WiMAX applications.

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