Novel Dual-Band CPW-fed Monopole Antenna for WLAN/WIMAX Applications

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Abstract: **A novel dual band design of a finite ground coplanar waveguide (CPW)-fed monopole antenna is presented for satisfying wireless local area network (WLAN) and Worldwide Interoperability for Microwave Access (Wi-MAX) applications. The proposed antenna consist of U-shape planar patch element and has frequency bandwidth of 842 MHz (1.95 GHz-2.79 GHz) and 1.08 GHz (4.86 GHz-5.94 GHz) for WLAN and Wi-MAX applications respectively. The basic theory and design are analyzed, and simulation using CST Microwave Studio commercial software is employed to optimize the antenna properties.**

Keyword: CST Microwave Studio, WLAN communication standards and Wi-MAX communication standards.

1. INTRODUCTON

Multiband printed monopole antennas have widespread applications, especially in low power wireless communication gadgets. In the era of modern wireless communication system, dual band or multiband antennas with omni-directional radiation characteristics plays a vital role [1, 2]. The IEEE standard was proposed in 1997 for WLAN applications. The bands for WLAN applications are 2.4 GHz (2.400 GHz-2.484 GHz), 5.2 GHz (5.150 GHz-5.350 GHz) and 5.8 GHz (5.725 GHz-5.825 GHz) and for Wi-MAX applications bands are 2.5 GHz (2.5GHz-2.69 GHz), 3.5 GHz (3.4 GHz-3.69 GHz) and 5.5 GHz (5.25 GHz-5.85 GHz). Wi-MAX technology [3] is the most rapidly growing area in modern wireless communication [4]. The planar monopole antenna has received much more interest than others, due to its potential in providing the various radiation features required for dual band or multiband, wide bandwidth, low profile communication system. However, these kinds of antennas mostly need a large ground plane, which is often printed on opposite side of substrate from the radiating plane. Recently coplanar waveguide (CPW)-fed monopole antenna has become very popular in WLAN and Wi-MAX systems, owing to its many attractive features such as, wider bandwidth, low radiation loss, simple structure of a single metallic layer and easy integration with WLAN integrated circuits [5].

In this paper, a proposed antenna design with CPW feed technology has been used to achieve dual band operations for WLAN and Wi-MAX bands. The proposed dual band antenna consist of U- shape patch element, capable of generating two separate bands with good impedance matching conditions. This way, the antenna can achieve dual band performance to simultaneously cover the most commonly used 2.4 GHz/5.2 GHz/5.8 GHz WLAN bands and 5.5 GHz Wi-MAX bands. Detail of the proposed antenna design are described in the paper, simulated results are presented and discussed in the following section.

2. ANTENNA DESIGN

Fig.1 shows the geometry of proposed finite ground coplanar waveguide (CPW) fed dual band monopole antenna. The proposed antenna is simulated on FR4 substrate with dielectric constant 4.4 and thickness 1.6 mm. The U- shape patch element is chosen with dimensions of width W, length L and with vertical spacing of ‘d’ away from the ground plane. A conventional CPW-fed line designed with a fixed signal strip thickness L_2 and gap distance of ‘g’ between the signal strip and the coplanar ground plane is used for exciting the radiating patch element. Two finite ground planes with the same size of width Wg and length Lg, are situated symmetrically on each side of the CPW feeding line.

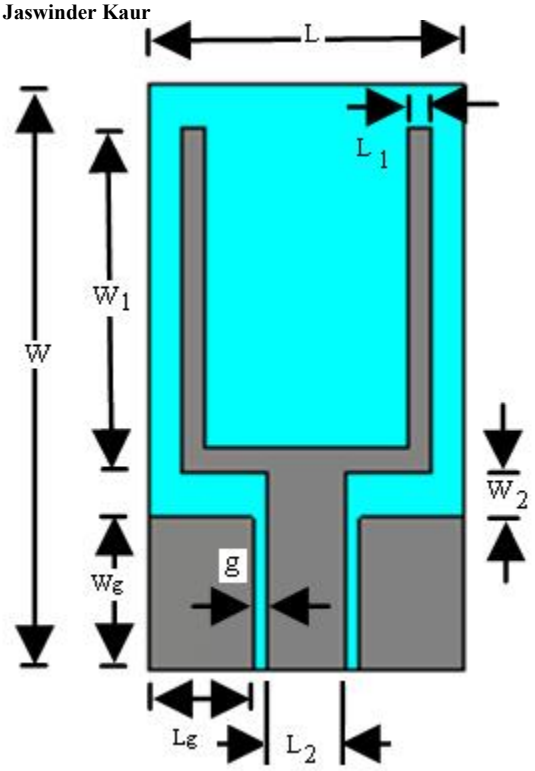

Fig. 1: Geometry view of proposed dual band antenna

The final optimized dimensions of proposed antenna are:

Parameter	Specification
L	25 mm
W	48.32 mm
L_1	2 mm
W_1	28.4 mm
W_2	3.7 mm
Wg	12.62 mm
g	1.095 mm
Lg	8.275 mm
L_2	6.26 mm

Thickness of substrate (h) = 1.524 mm

Substrate permittivity = 4.4

3. RESULTS AND DISCUSSION

The simulated return loss results are shown in Figure 2. The bandwidth of 842 MHz (1.95 GHz – 2.79 GHz) for WLAN / WiMax has been achieved resonating at 2.23 GHz with the corresponding value of return loss as -20.14 dB. The bandwidth of 1.08 GHz (4.86 GHz – 5.94 GHz) also has been achieved resonating at frequency 5.28 GHz with the corresponding value of return loss -54.63 dB. The antenna covers WLAN standard (2.4 GHz, 5.2 GHz and 5.8 GHz)/WiMax standard 5.5 GHz band

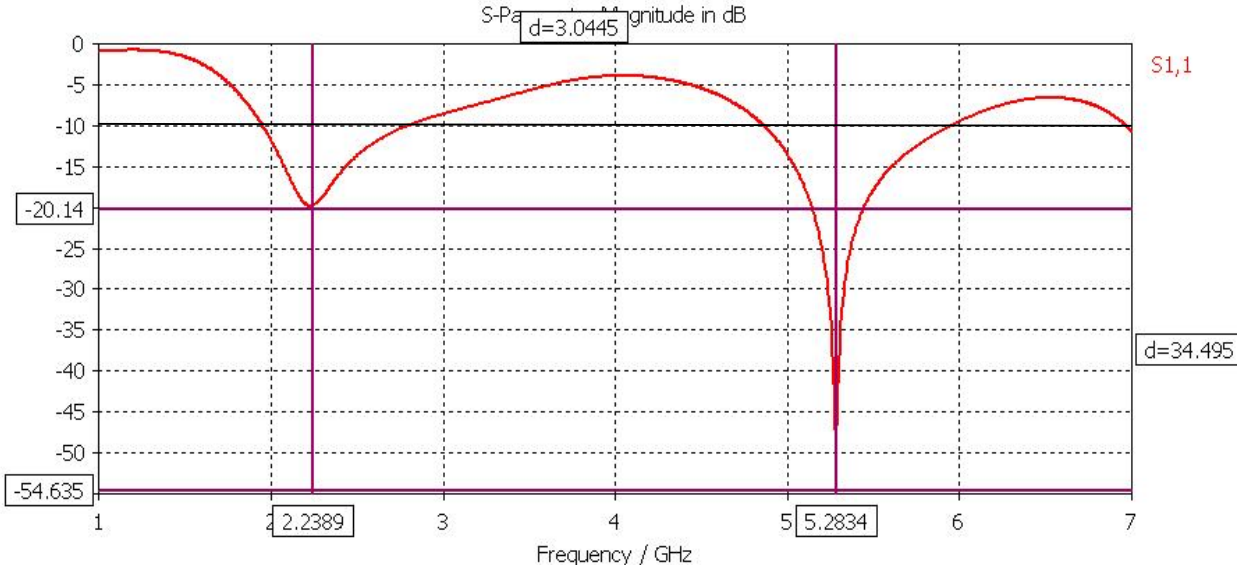

Figure 2: Simulated Return Loss Curve

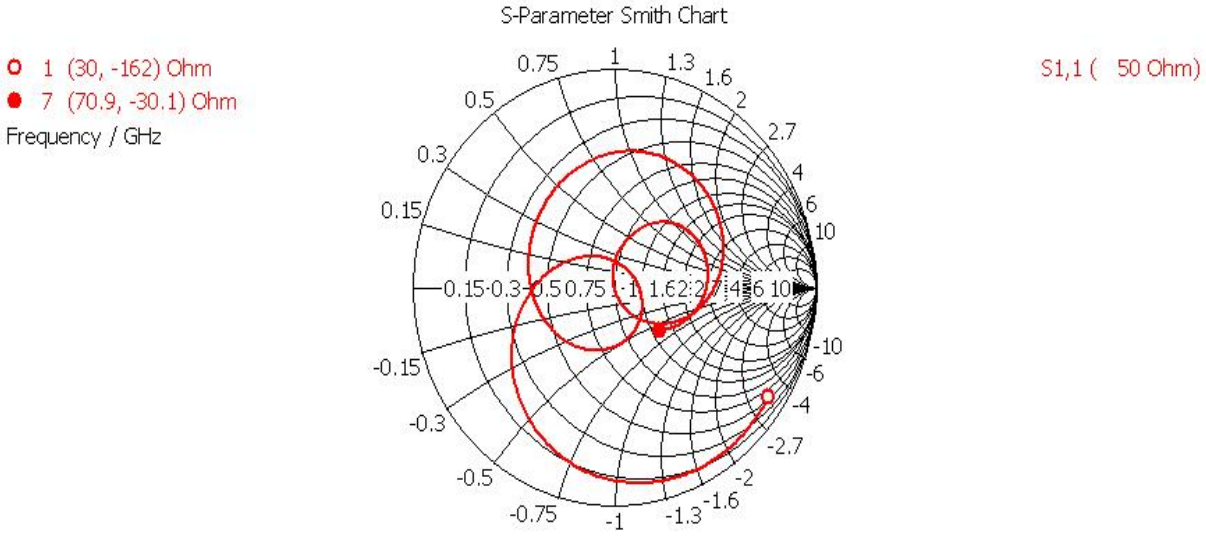

Figure 3: Curve showing antenna characteristic impedance

The achieved value of return loss is good enough and frequency is closed enough to the specified frequency band 5.5 GHz for WiMax application / 2.4 GHz, 5.2 GHz and 5.8 GHz for WLAN application. The CPW fed antenna consist of U shape patch element. As the length of parallel strip of U shape patch element increases, the return loss of 1st band increases but 2nd band shifts towards lower band and vice versa. As the width of feed line increases the return loss of 2nd band increases sharply.

The maximum achievable gain over the entire frequency band of 2.23 GHz and 5.28GHz is 2.50 dB and 4.74 dB respectively. The achieved antenna impedence is 50 ohm as shown in Figure 3, which is very equal to the required impedence of 50 ohm. Figure 4(a) shows the simulated 3-D radiation pattern showing directivity at 2.23 GHz. Fig. 4(b) shows the simulated radiation pattern showing directivity at 5.28 GHz.

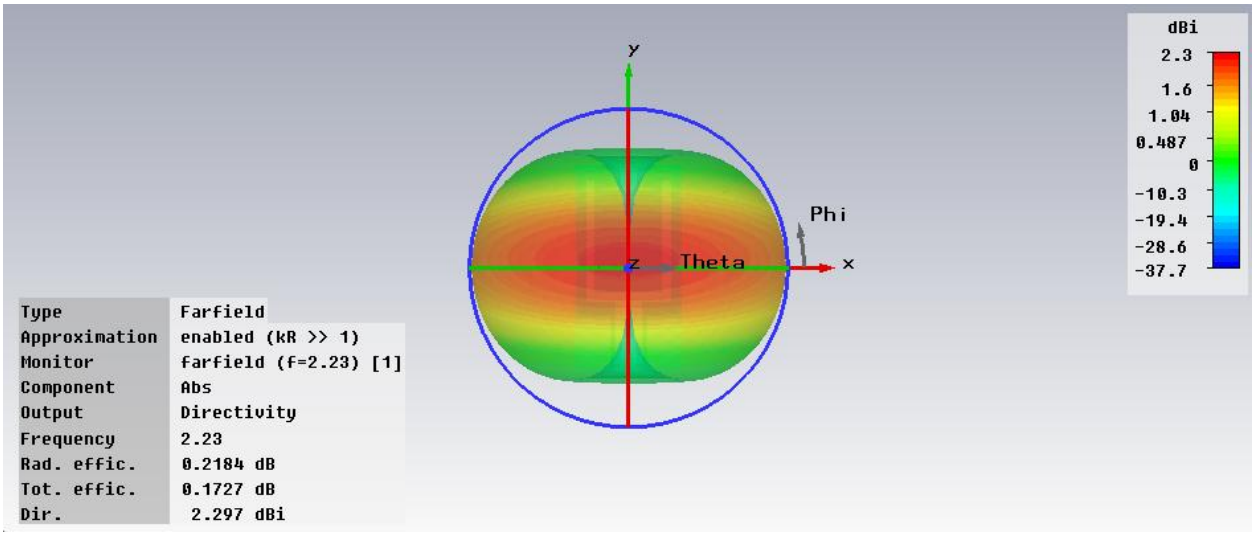

Fig. 4(a) 3-D Radiation pattern of Patch antenna showing directivity at 2.23 GHz

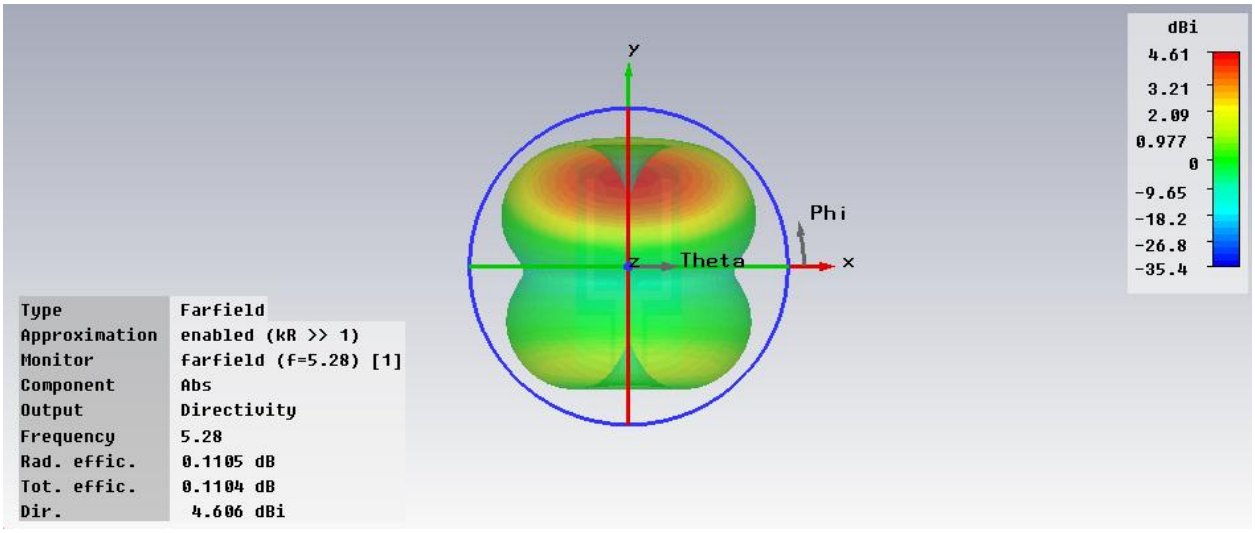

Fig. 4(b) 3-D Radiation Pattern of Patch antenna showing directivity at 5.28 GHz

It shows that the directivity of proposed antenna is 2.29 dBi at resonating frequency 2.23 GHz. It also shows that the directivity of proposed antenna is 4.68 dBi at resonating frequency 5.28 GHz.

4. CONCLUSION

A dual band CPW fed monopole antenna suitable for WLAN/WiMax application is proposed. Using U shape patch element, a resonant mode having excellent impedance performance is achieved. Various parameters like gain, directivity, bandwidth and return loss are also studied. The return loss value -20.14 dB and -54.63 dB suggest that there is a good impedance matching at frequency point below -10dB. An omni directional radiation pattern result has been obtained which seems to be adequate for the envisaged applications. However, the size of microstrip antenna, reported here, is not very small. The gain of antenna is small but it can be increased using gain enhancement techniques.

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