Design and analysis several band antenna for wireless communication

Abeer Khalid Nghaimesh[1], Ali Khalid Jassim[1], Waleed Khalid Abid Ali[2]
[1]Department of Electrical Engineering, College of Engineering, Al Mustansiriyah University, Baghdad, Iraq
[2]Department of Communication, Technical Engineering College, Alfarahidi University, Baghdad, Iraq

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ABSTRACT

This article describes the construction of a dual-band planar monopole antenna. A microstrip patch antenna with a feedline impedance of 50 ohm and a patch composed of G-shaped and inverted L-shaped strips is used to make the suggested antenna ultra wideband for frequencies ranging from 3.1 to 10.6 GHz. In order to design the antennas, we need to know the dimensions 40x40x1.6 mm^3 and the thickness of the ground plane (0.035 mm) (5.2 GHz). There is a method of altering the present distribution by introducing slots. the proposed worldwide interoperability for microwave access (WiMAX) and wireless local area network (WLAN) bands, with a peak gain of 5.2% and an omnidirectional radiation pattern, suitable for ultra wide band (UWB) were shown to be viable.

Corresponding Author:

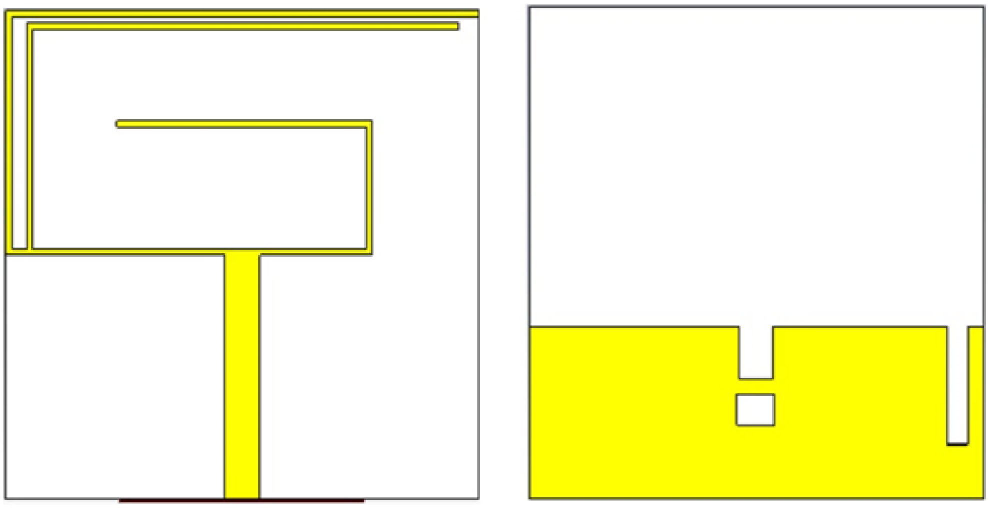
Abeer Khalid Nghaimesh
Department of Electrical Engineering, College of Engineering, Mustansiriyah University
Baghdad, Iraq
Email: eema1006@uomustansiriyah.edu.iq

1. INTRODUCTION

Traffic management, communication, defense, and detection are just a few of the many uses for antennas. For this reason, the study of microstrip patch antenna has been picking up speed. In the field of electronics, the development of the microstrip patch antenna was revolutionary. Its widespread use is due in large part to its simplicity of production, cheap cost, consistent and reliable outcomes, and ease of accessibility [1]-[3]. The ground and patch of a microstrip patch antenna are composed of the same material [4], whereas the substrate is constructed of a separate material [5], [6]. The substrate layer is an insulating dielectric layer that separates the antenna patch from the ground [7], [8]. A microstrip feed line connects the patch to the ground, which generates the radio frequency waves in the antenna [9]. Dual-band patch antenna with G and inverted L shaped slots has been developed [10]. Antenna patch feed lines were modified to get the required results [11]-[13]. 3.2 GHz and 5.2 GHz frequencies were found to be acceptable for a variety of wireless applications [14]. WiMAX and WLAN applications are catered to in the final design. For this design, two U-shaped and one rectangular ground-plane slots are used to provide dual-band characteristics [15]-[17]. A microstrip patch antenna with a frequency response of 3–11 GHz has been developed. It has been employed as a substrate and returned loss of -33 dB at the 3.2 GHz frequency and 21 dB at the 5.8 GHz frequency, which is lower than the return loss of FR-4. Gains of 4.08 dB in the 3.2 GHz band and 5.2 dB in the 5.2 GHz band [18]-[20], have been reported. WiMAX and WLAN applications were proven to be compatible with the architecture [21], [22]. The intended results were achieved by designing a dual-band antenna [23], [24].

2. ANTENNA PARAMETER (METHOD)

A G-shaped patch antenna with an inverted L element is seen in Figure 1(a) frontal view and Figure 1(b) view from behind and measures 40 millimeters in width and 20 millimeters in length. We picked FR-4 as our dielectric material because of its relatively low dielectric constant (h=1.6 mm) and high dielectric thickness (d=4.3). The antenna is fed by a 50 Ω microstrip line with a 3 mm wide width to match the antenna's impedance. Carved into the earth in order to produce dual-band radiation are both U slits and rectangular holes. 0.035 millimeters is that of the copper used for the ground plane and patch. Table 1 displays the planned antenna's parameters.



(a) (b)

Figure 1. the suggested antenna geometry (a) frontal view and (b) view from behind

Table 1. Specifications for the suggested antenna design

Parameter	Symbol	Value in (mm)
The patch's length	Lp	20
The patch's width	Wp	40
The feed's length	Lf	20
The feed's width	Wf	3
The substrate's length	Ls	40
The substrate's width	Ws	40
The ground's length	Lg	14
The ground's width	Wg	40

The dimensions of microstrip antennas can be determined using the (1), (2) [1]. The width of patch is found by:

$$w = \frac{c}{2\, f_0 \sqrt{\frac{\varepsilon_r + 1}{2}}} \tag{1}$$

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 2\,\frac{h}{w}\right)^{-\frac{1}{2}} \tag{2}$$

where h is the substrate's high.

$$\Delta L = \frac{h}{\sqrt{\varepsilon_r}} \tag{3}$$

The patch's length is determined by (4):

$$L = \frac{h}{2\, f_0 \sqrt{\varepsilon_r}} - \Delta L \tag{4}$$

The dimensions of the ground are provided by (5), (6):

$$L_g = L + 6h \tag{5}$$

$$w_g = w + 6h \tag{6}$$

The length L_f and width w_f of feed line for microstrip are determined by (7), (8):

$$L_f = \frac{6h}{2} \tag{7}$$

$$z_0 = \frac{87}{\sqrt{\varepsilon_r + 1.41}} In \frac{5.98h}{0.8w_f} \tag{8}$$

3. RESULTS OF THE SUGGESTED ANTENNA

The results of the dual-band antenna simulation have been generated. Modeling the desired geometry was done using CST. For WiMAX and WLAN, the antenna's bandwidth input S11 parameters had a coefficient of reflection less than -10 dB. There are two poles in the first band, which is shown graphically in Figure 2, with simulated frequency bandwidths in the ranges of 3.2 and 5.2 GHz. The Figure 3 shows the suggested antenna's gain for the two frequencies. Figure 4 display the antenna's directivity gain at (3.2, 5.2) GHz.

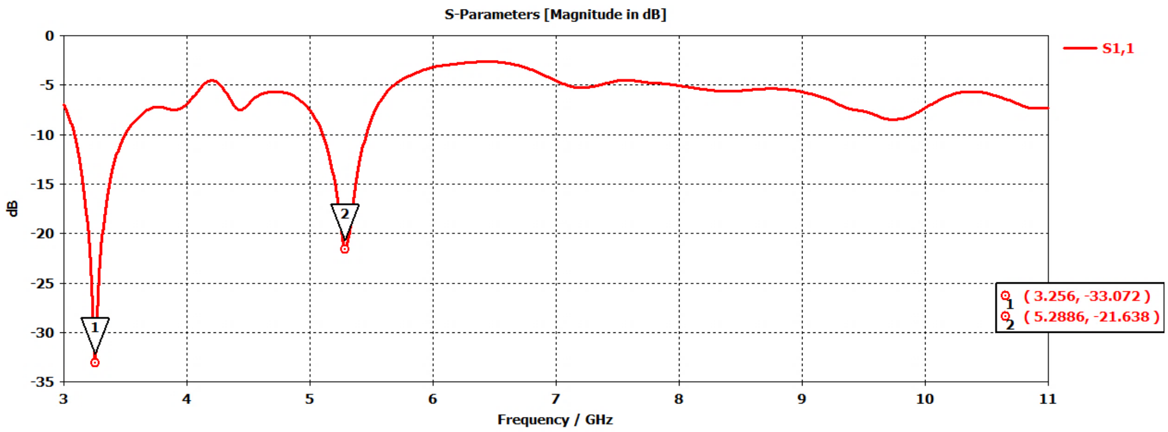


Figure 2. Reflection coefficient of the of suggested antenna

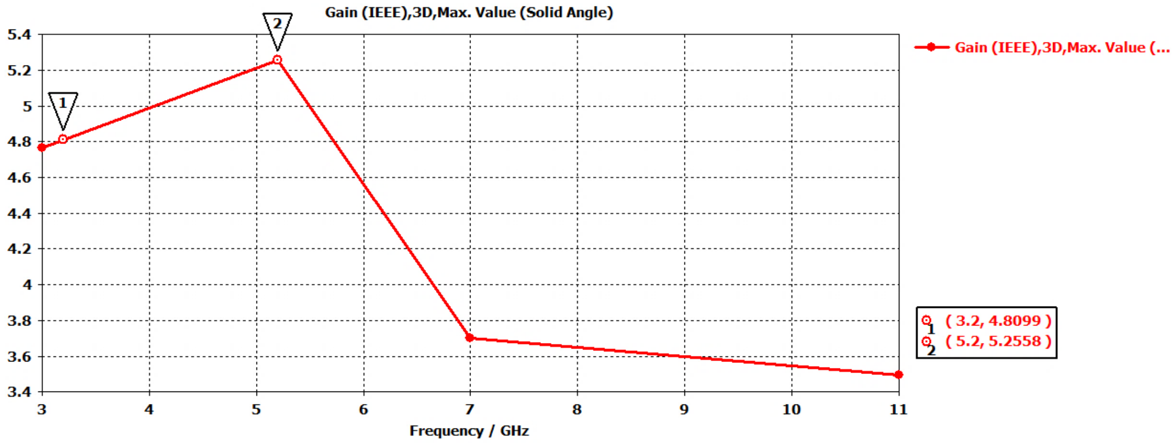


Figure 3. Gain at (3.2, 5.2) GHz for the suggested antenna

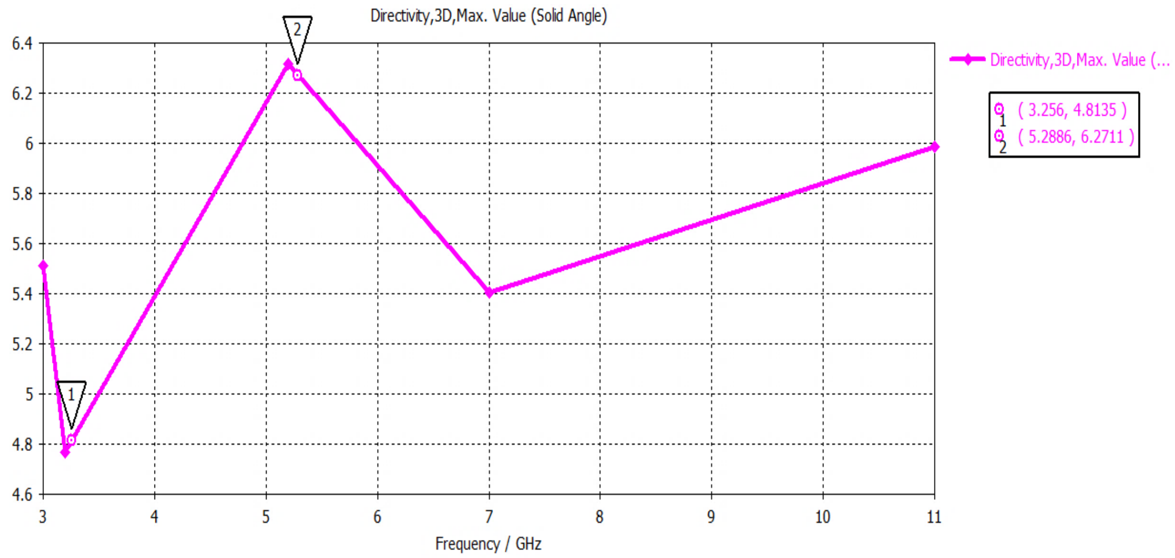


Figure 4. Directivity gain of the suggested antenna at (3.2, 5.2) GHz

The VSWR at the suggested antenna's central frequency is shown in Figure 5. Antenna reflection coefficient as a function of voltage standing wave ratio (VSWR) [25].

$$VSWR = \frac{\Gamma+1}{\Gamma-1} \quad (9)$$

In the actual world, the importance of VSWR can never be overstated. Small VSWR values indicate that the antenna and transmission line are well matched. The optimal VSWR for an antenna is one. Electrical energy cannot be transferred to the antenna when antenna and feed are incompatible (i.e., reflection occurs). Figure 6(a) at 3.2 GHz and Figure 6(b) at 5.2 GHz illustrates the distribution of surface currents at (3.2, 5.2) GHz with a maximum surface current of 92.4784 A/m and 75.3698 A/m, respectively.

Figure 7(a) real and Figure 7(b) imaginary depicts the input impedance versus frequency of the proposed antenna. Simulation results for the antenna show that the input impedance at 3.2 GHz to have a real part value of 47.187 Ω and the imaginary has a value of around -1.33. At the 5.2 GHz, the input impedance is found to have a real part value of 51 Ω while the imaginary part has a value of -5.0287 Ω.

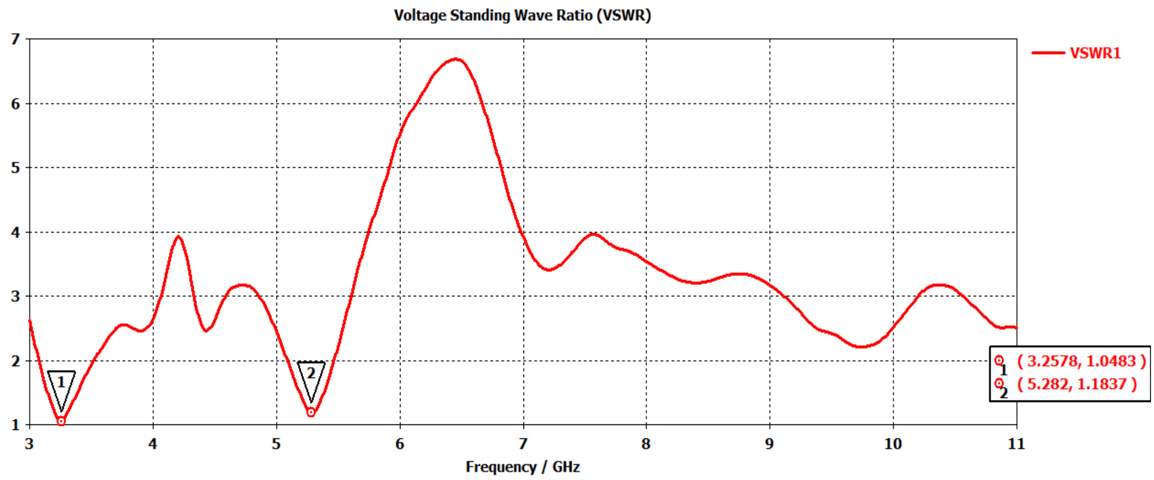
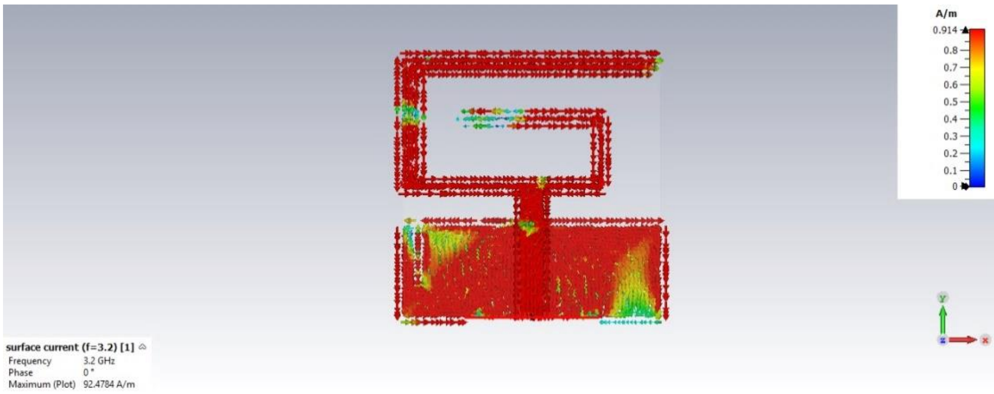
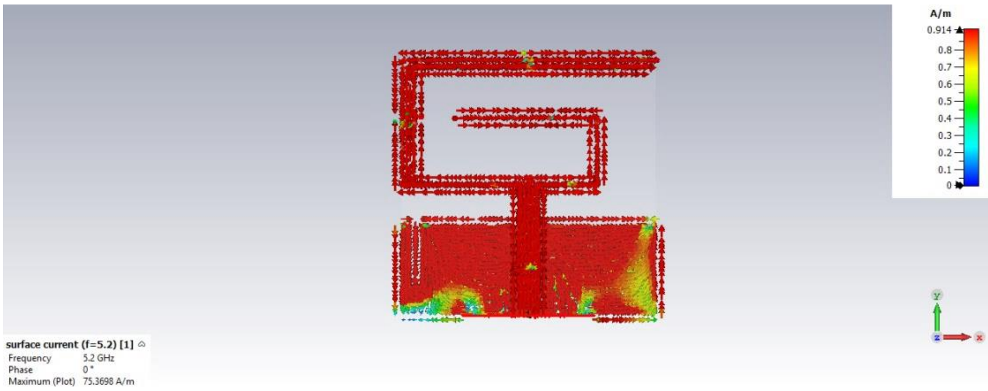


Figure 5. VSWR of the proposed antenna

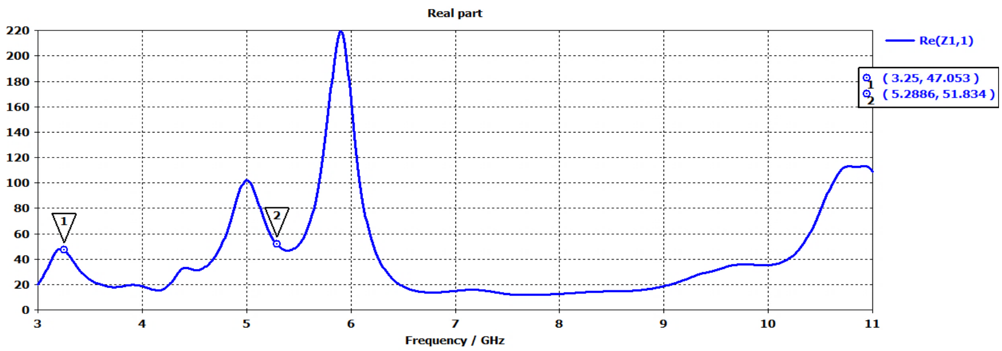


(a)

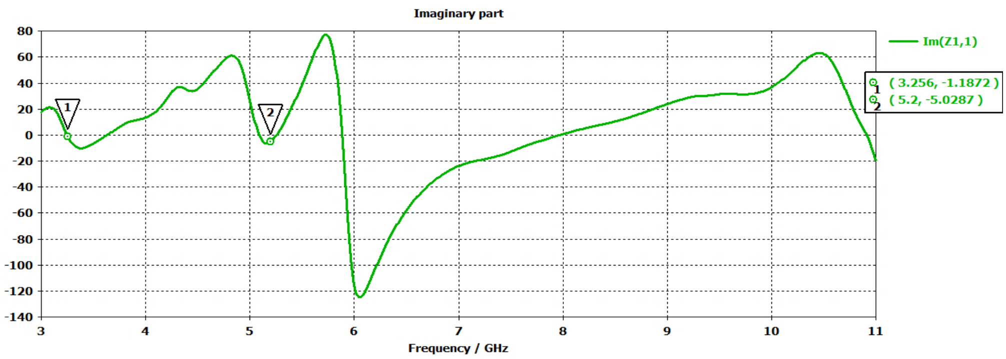


(b)

Figure 6. The distribution of surface currents (a) at 3.2 GHz and (b) at 5.2 GHz



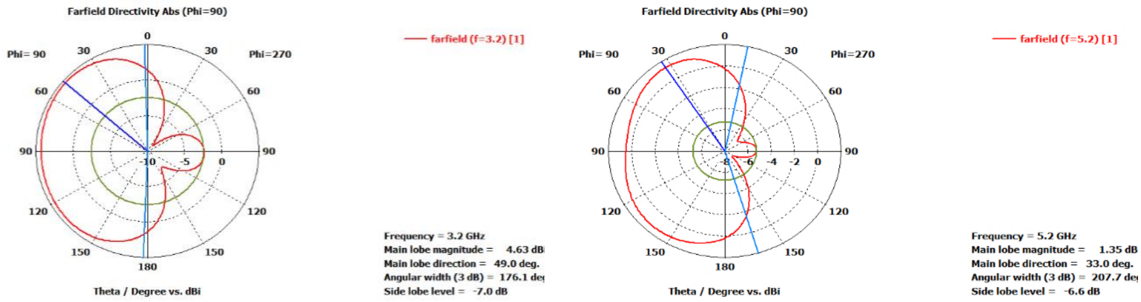
(a)



(b)

Figure 7. Input impedance of proposed antenna (a) real and (b) imaginary

A wide half-power beam width of 3 dB is seen in Figures 8(a) and (b). At the 3.2 GHz resonant frequency, the resulting 3 dB loss is 49.0 degrees. The 207.7-millimeter beam diameter is used.



(a) (b)

Figure 8. The (2D/3D) farfield at (a) f=3.2 GHz and (b) f=5.2 GHz

Figure 9 illustrates the simulated findings as well as the actual data. There is a little discrepancy between the simulation and the observed results. These variations in frequency, fringing effect, and discontinuity are all linked to manufacturing mistakes. Front and rear views of the antenna as seen in Figure 10(a) frontal view and Figure 10(b) view from behind, have been constructed. Table 2 compares the dimensions of the suggested antenna to those of other antennas, resonant frequency, and antenna purpose. This table demonstrates that the suggested antenna is more compact and capable of supporting dual-band operation.

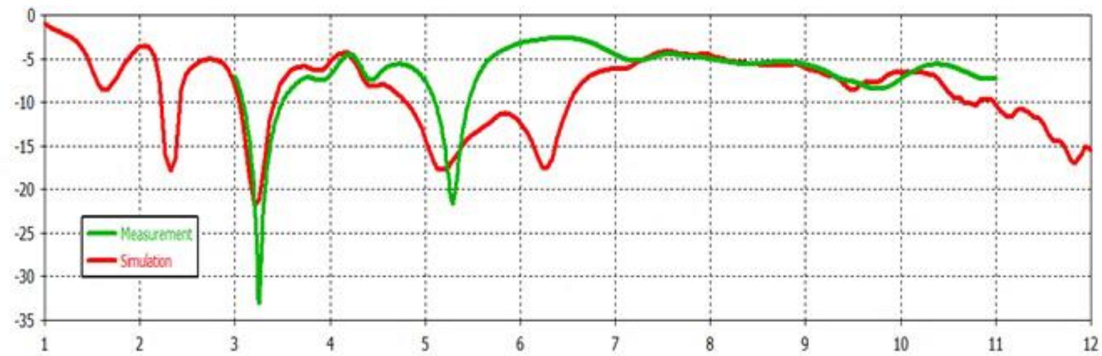
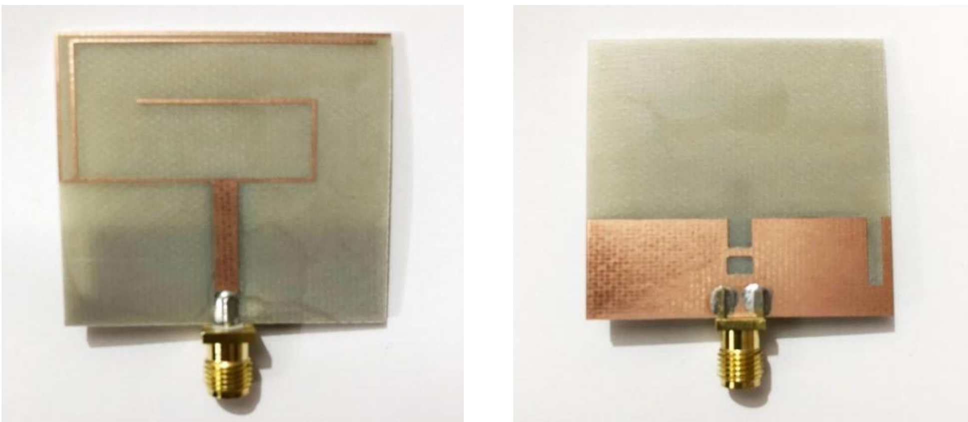


Figure 9. Reflection coefficient vs frequency, as measured and simulated



(a) (b)

Figure 10. Constructed antenna (a) frontal view and (b) view from behind

Table 2. Comparison of the suggested antenna with others in references

Antenna	Size of antenna (mm)	Resonant frequency GHz	Purposes of an antenna
[2]	14 x 24	(3.1, 10.6)	Dual-band
[10]	44 × 44	(1.8, 2.1, 3.5)	Tri-band
[18]	19 x 23	(10.1, 18.3)	Dual-band
[20]	59.5 x 47	(1.56, 2.45, 3.53)	Tri-band
Suggested antenna	40 × 40	(2.3,5.2)	Dual-band

4. CONCLUSION

This study describes a WiMAX and WLAN dual-band microstrip antenna operating at 3.2 GHz and 5.2 GHz. Slits cut into the ground provide both the U and rectangular slots needed for the antenna to function. WiMAX and WLAN may both benefit from the results, which indicate acceptable return loss and gain. A -10 dB reflection coefficient is considered to be a good result. A prototype of the proposed antenna was built, and its performance was evaluated using computer simulations in (CST).

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BIOGRAPHIES OF AUTHORS

Abeer Khalid Nghaimesh received the B.S. E. E. degrees in electrical engineering from Mustansiriyah University, Baghdad, Iraq, in 2006. Her current research interest, in the areas of multi-band antennas for a master's degree. She can be contacted at email: eema1006@uomustansiriyah.edu.iq.

Asst. Prof. Dr. Ali Khalid Jassim at Mustansiriyah University, College Engineering of Electrical Engineering Department. Holds a Bachelor's degree in 1999 and a Master’s degree in 2010 and a Ph.D. in 2019 in communications engineering. Works in the field of cellular networks communications and antennas and has a many of research in international journals and scientific conferences. Currently, he holds the position of deputy of dean for scientific affairs. He can be contacted at email: alijassim79@yahoo.com and alijassim@uomustansiriyah.edu.iq.

Asst. Prof. Dr. Waleed Khalid Abid Ali Department of Communication, Technical Engineering College, Alfarahidi University. Master’s degree in 1971, and a Ph.D. in 1983 in communications engineering. Field of Interest Radar and Communication, works in the field of cellular networks communications and antennas and has a many of research in international journals and scientific conferences. Head of Department of Electrical Engineering in Mustansiriyah Univercity Head of Department of Technical Computer. Alturath University. He can be contacted at email: Walid-K@alfarahidiuc.edu.Iq or Dewk2014@yahoo.com or waleedKaa1949@gmail.com.