Multi-band Circular Patch Antenna for Wideband Application

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Abstract— This paper presents a multi-band circular patch antenna for wideband applications. The antenna operates at 1.5, 2.8, 4.0, 4.8, 7.5 and 8.8 GHz frequency bands. The antenna has been designed, simulated and fabricated on an FR4 substrate with dielectric constant (ε_r) of 4.4 and thickness of 1.6 mm. A dual feed approach has been used in the design of the proposed wideband antenna. The multi-band circular patch antenna is smaller than the conventional antenna for wideband application. The final optimized design is $50 \times 50\,\text{mm}^2$. The measured and simulated return loss results and simulated radiation pattern results of proposed antenna has been presented. The dual feed improves the gain of the proposed antenna. The measured and simulated results show that the proposed antenna provides good performance in term of return loss and radiation pattern for wideband applications.

1. INTRODUCTION

A lot of researches have been done for the different applications of portable wireless communication devices, such as notebook computers and mobile phone handset antennas with low manufacturing cost and low-profile planar structures. One of the advantages of a multi-frequency band operation includes accommodating multifunctional services, such asinstance video, voice and data transmissions for mobile communications.

It has been reported in [1] the suitability of multi-band wideband antenna for many applications because it requires less space for composition and less cost compared to the use of different antenna for each frequency band [2]. In recent years, a lot of low-profile multi-band wideband antennas have been developed for wireless applications [1–6], however, most of the previous antenna have large size and few bands for wideband application.

This paper presents the multi-band circular patch antenna cover (1.27–1.51 GHz), (2.66–2.83 GHz), (3.8–4.1 GHz), (4.74–4.86 GHz), (7.5–7.65 GHz) and (8.8–8.92 GHz) in the frequency bands for Radio location application. The antenna design and simulation has been done using CST Microwave Studio software 2012 software package based on finite integral method.

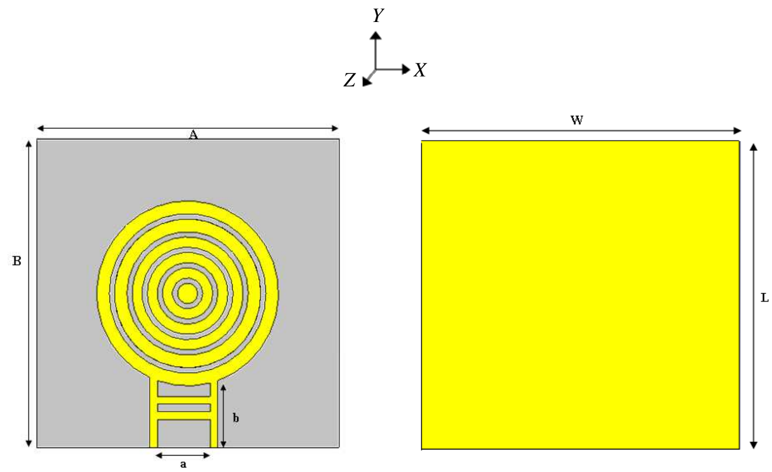
2. ANTENNA DESIGN

The multi-band circular patch antenna is designed to operate at 1.5, 2.8, 4.0, 4.8, 7.5 and 8.8 GHz frequency bands. The geometry of the proposed multi-band circular patch antenna is shown in Figure 1. The antenna consists of circular patch with ring slot fed by double fed. A dual feed approach used to improve the gain of the proposed antenna. The antenna is printed on the FR4 substrate with dielectric constant of 4.4, loss tangent of 0.02, thickness of 1.6 mm. The optimized dimension of the proposed antenna is $50 \times 50 \times 1.6\,\text{mm}^3$. The parameters of circular patch are as follows: $A = 50\,\text{mm}$, $B = 50\,\text{mm}$, $a = 10.5\,\text{mm}$, $b = 13\,\text{mm}$, $W = 50\,\text{mm}$, $L = 50\,\text{mm}$, radius = 18 mm, and feed line width = 1.5 mm. The prototype of the circular patch antenna is shown in Figure 2.

3. RESULTS AND DISCUSSION

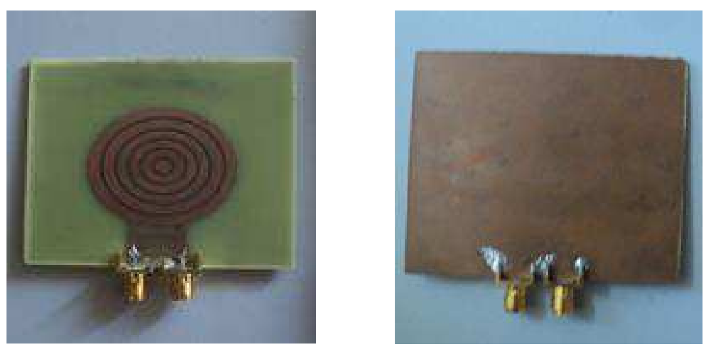
The comparison of the simulated and measured return loss results of the proposed antenna has been shown in Figure 3. It can be seen that the resonances of the proposed antenna are 1.5, 2.8, 4, 4.8, 7.5 and 8.8 GHz. The measured frequency bandwidths obtained of the proposed antenna were 240 MHz (1.27 to 1.51 GHz), 170 MHz (2.66 to 2.83 GHz), 30 MHz (3.8 to 4.1 GHz), 120 MHz (4.74 to 4.86 GHz), 150 MHz (7.5 to 7.65 GHz) and 120 MHz (8.8 to 8.92 GHz), while the simulated bandwidth obtained were 240 MHz, 170 MHz, 27 MHz, 90 MHz, 92 MHz and 95 MHz It can be seen that the measured and simulated results have a similar result. The experimental results indicate wide impedance bandwidths (VSWR < 2) of 18% (1.27–1.51), 6.2% (2.66–2.83), 7.6% (3.8–4.1), 2.55% (4.74–4.86), 1.93% (7.5–7.65) and 1.35% (8.8–8.92) in the specified frequency bands.

Figure 4 shows the E-plane and H-plane radiation patterns at 1.5, 2.8, 4, 4.8, 7.5 and 8.8 GHz of the proposed antenna. The simulation gain obtained of the circular patch antenna were 4 dB at



(a) (b)

Figure 1: Geometry of the proposed P-shaped monopole antenna. (a) Front view. (b) Back view.



(a) (b)

Figure 2: Prototype of the proposed antenna. (a) Front view. (b) Back view.

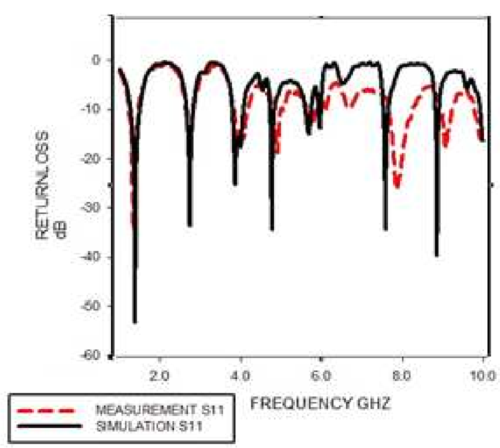


Figure 3: Measured and simulated return loss of the proposed antenna.

1.5 GHz, 4.5 dB at 2.8 GHz, 3.2 dB at 4 GHz, 2.1 dB at 4.8 GHz, 6.8 dB at 7.5 GHz and 1.5 dB at 8.8 GHz.

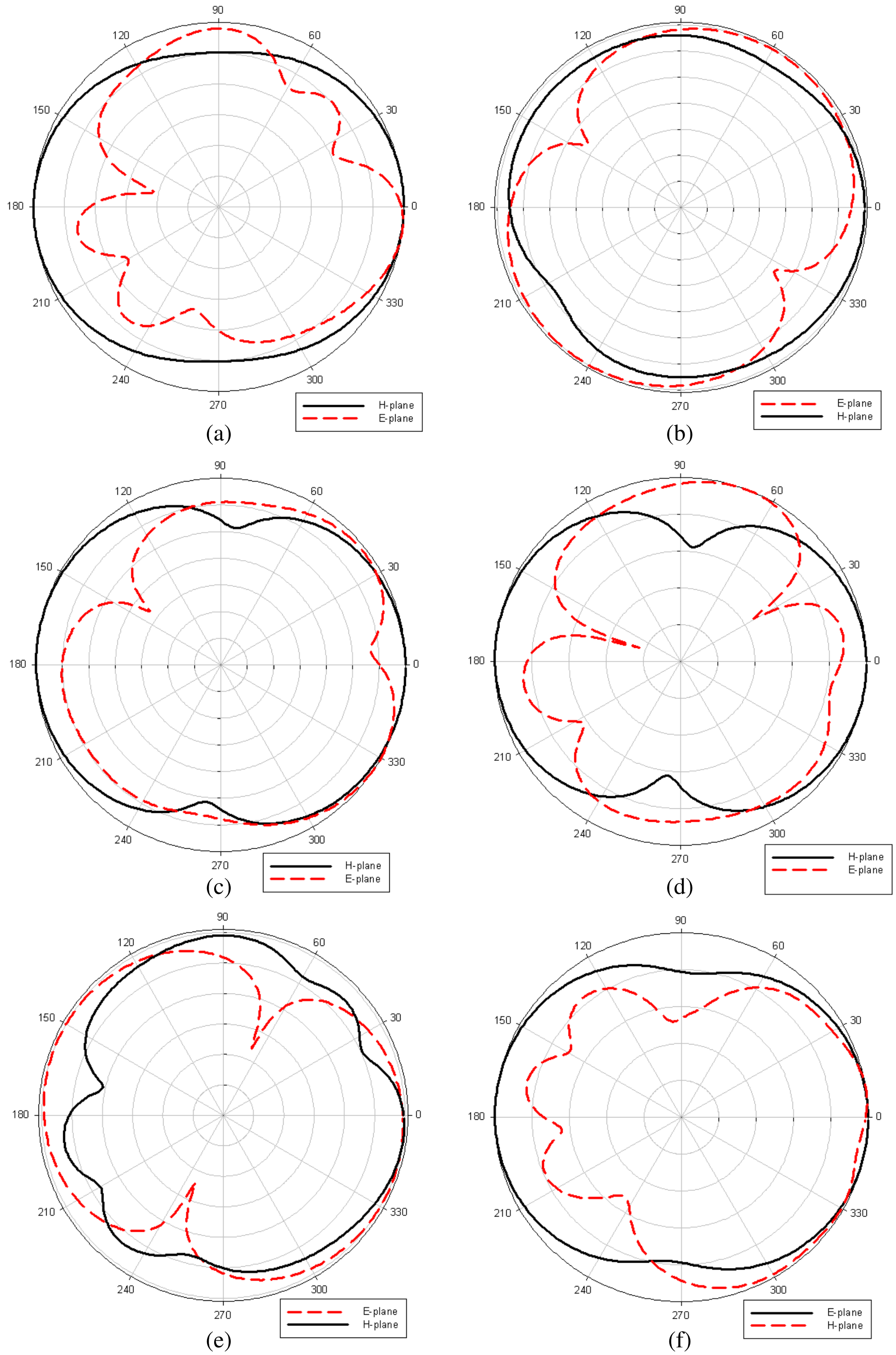


Figure 4: The radiation pattern E-plane and H-plane patterns of the multi-band circular patch antenna (a) at 1.5 GHz, (b) at 2.8 GHz, (c) at 4 GHz, (d) at 4.8 GHz, (e) at 7.5 GHz, (f) at 8.8 GHz.

4. CONCLUSIONS

In this paper a multi-band circular patch antenna with a dual feed approach has been presented investigating the return loss, gain, radiation patterns for wideband application. The antenna has been designed, simulated and fabricated. The measured and simulated results of return loss, gain, and radiation patterns have been analyzed. The proposed antenna provides an impedance bandwidth of 0.24 GHz (1.27–1.51 GHz), 0.17 GHz (2.66–2.83 GHz), 0.3 GHz (3.8 to 4.1 GHz), 0.12 GHz

(4.74–4.86 GHz) 0.15 GHz (7.5 to 7.65 GHz) and 0.12 GHz (8.8 to 8.92 GHz). The dual feed improves the gain of the circular patch antenna which gives 4, 4.5, 3.2, 2.1, 6.8 and 1.5 dB at 1.5, 2.8, 4, 4.8, 7.5 and 8.8 GHz, respectively.

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