Progress In Electromagnetics Research C, Vol. 15, 157–164, 2010

UTM-LOGO WIDEBAND PRINTED MONOPOLE ANTENNA SURROUNDED WITH CIRCULAR RING PATCH

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Abstract—A novel of wideband monopole antenna with UTM-Logo shape is proposed to create specific wide band frequencies which can be applied in the cognitive radio. The antenna is designed to be operated between 1.98 to 6.46 GHz frequency bands (106.16%). It has been fabricated on $30 \times 51\,\mathrm{mm}^2$ FR4 board with thickness of 1.6 mm and the dielectric permittivity and tangent loss of 4.7 and 0.019, respectively. Two slots also been attached on the ground plane for the purpose of increasing the bandwidth of antenna. Simulation and measurement results show good agreement.

1. INTRODUCTION

With the proliferation of new radio systems, a cognitive radio is a radio that has the capability to sense, learn, and autonomously adapt to its environment. The hardware components are essential to optimize the performance of the system. Antenna hardware for cognitive radio applications presents distinctive problems, since in theoretical term, a cognitive radio can operate anywhere in the spectrum. Modern technology needs increasing demands of wideband antennas. Printed monopole antenna has been received more attention for its attractive advantages such as low profile, low weight, high band width and its omnidirectional radiation pattern [1].

Bandwidth of such antenna is strongly depends on the thickness and permittivity of dielectric substrate [2]. Printed monopole antenna

Received 7 July 2010, Accepted 4 August 2010, Scheduled 12 August 2010
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has been widely studied [3–8] due to its alluring merits. Printed monopole antenna is a printed type of antenna consisting of a dielectric substrate sandwiched in between a finite ground plane and a patch. The size of ground plane also determines the bandwidth, gain and return loss of the antenna [9–12]. The bandwidth could also be increased by creating some slots on the patch or ground plane [12]. This way may produce wider bandwidth because it make irregular current surface on the patch and ground plane.

In this paper, a UTM-Logo shape surrounded with a ring patch antenna fed by microstrip feed line is proposed for cognitive radio systems. This antenna has many advantages, such as small size, low-profile, simple structure and easy to fabricate. The design of the antenna was performed using the CST Microwave Studio software. The reason of chosen such shape is due to its novel shape that makes it unique and has ability to produce wideband bandwidth which is suitable to be used for the wideband applications such as the Cognitive Radio System. In the other hand this shape of antenna is made by a combination of curves and straight lines so that the mixture of them can scramble the current distribution. If we disarrange the current distribution carefully we can get more bandwidth from these types of antennas.

2. ANTENNA STRUCTURE

The fabricated printed monopole antenna is shown in Figure 1 and the geometry of the proposed antenna for wideband applications is illustrated in Figure 2. The antenna was fabricated on $30 \times 51\,\mathrm{mm}^2$ FR4 substrate with thickness of 1.6 mm and relative permittivity of 4.7. The antenna consists of microstrip-fed length, h_f of 32.5 mm and a UTM-Logo shape patch which is surrounded by a ring patch.

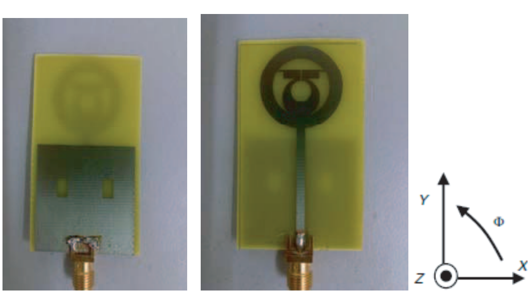
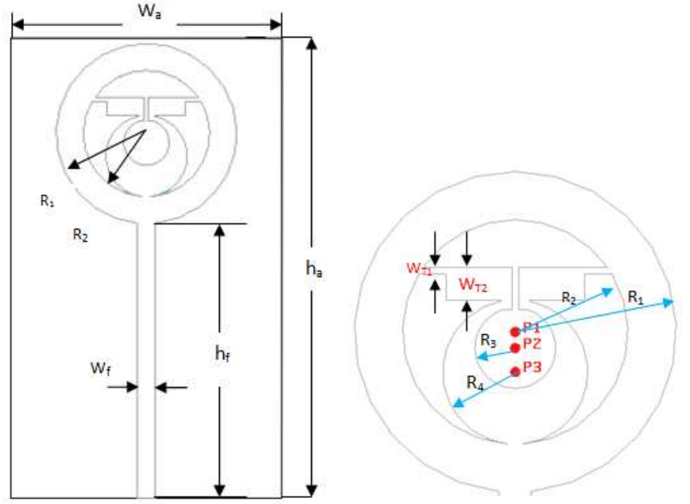


Figure 1. Antenna prototype front view and back view.



(a) Front view (b) Position of UTM-Logo shape

Figure 2. The geometry of the proposed UTM-Logo shaped antenna.

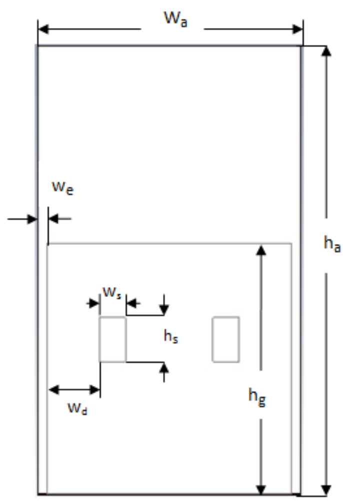


Figure 3. Back view of the proposed antenna.

Figure 3 shows the back view of this antenna. It shows that the ground plane has a vertical length of h_g and there are two symmetric slots with W_S width and h_s on the ground plane which they were used for increasing the bandwidth of antenna. Also there is a gap, W_e for both side of the ground plane which is used to reduce the ripples on the return loss results.

3. RESULTS AND DISCUSSION

The antenna is designed using Computer Simulation Technology Microwave Studio (CST Microwave Studio). Final dimensions of the antenna are obtained by optimizing the antenna characteristics such as better gain, good return loss and radiation patterns. The optimized antenna dimensions are shown in Table 1.

The prototype of the proposed antenna with optimal geometrical parameters as shown in Table 1 has been tested and measured. All the measured results show satisfactory performance and good agreement with the simulated results.

Figure 4 shows the simulated and measured frequency response of return loss for the proposed antenna. As can be seen from the measured result, the antenna impedance bandwidth covers between

Table 1. Parameters of the proposed antenna.

Parameter	W_a	W_f	We	Ws	W_d	W_{T1}	W_{T2}	h_a	h_g	h_f	h_s	R_1	R_2	R_3	R_4	P_1-P_2	P_1-P_3
Size (mm)	30	2	1	3	6	0.4	2	51	28.5	30.5	5	10	7	2.4	4.84	1	2.5

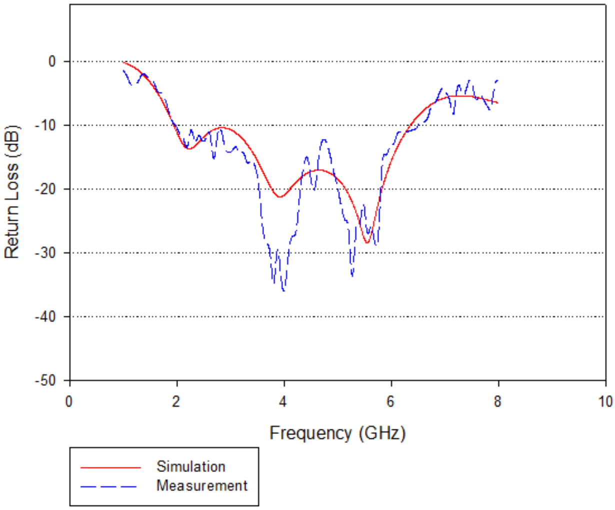
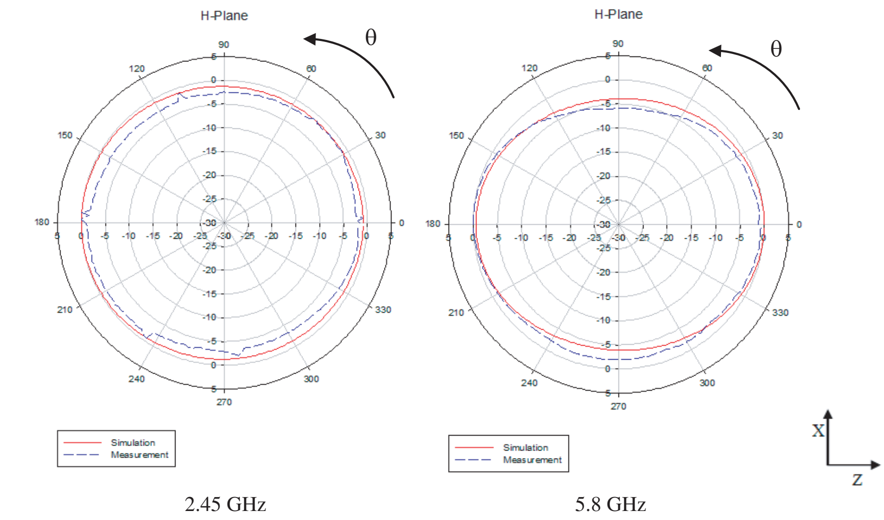
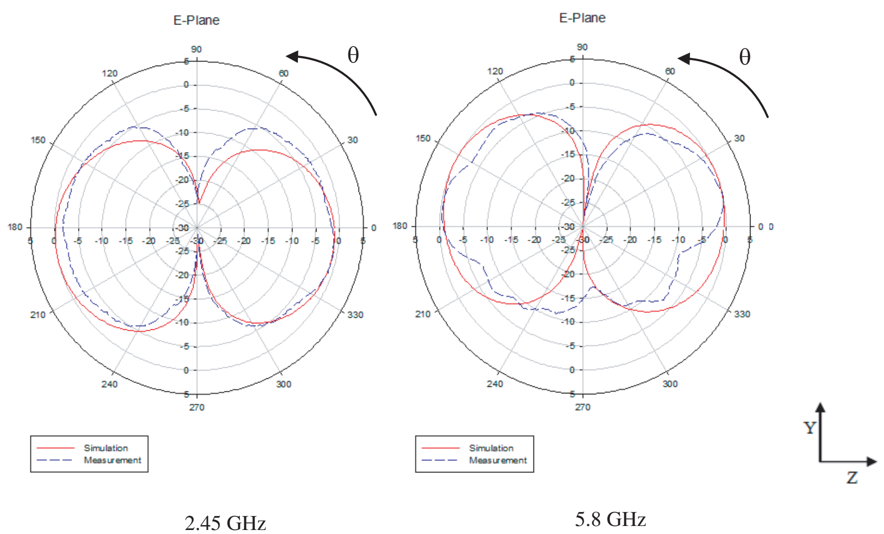


Figure 4. Simulated and measured return loss for UTM-Logo shape surrounded with ring patch antenna.



(a) H-plane



(b) E-plane

Figure 5. Simulated radiation pattern for UTM-Logo shape surrounded with ring patch antenna at 2.45 GHz and 5.8 GHz for (a) *H*-plane, (b) *E*-plane.

1.98 and 6.46 GHz at −10 dB level. On top of that, the measured result produces better impedance bandwidth than the simulated result.

Figure 5 shows the far-field radiation patterns for proposed antenna at the selected frequency which are 2.45 ISM band and 5.8 ISM band. It can be seen from the figures that the radiation patterns are similar to the conventional monopole antenna as it produces an omnidirectional for H-plane patterns for both measurement and simulation. Whilst for the E-plane patterns, the simulated and measured results show similar to conventional monopole antenna. The antenna gain is 2.0 dBi and it has efficiency of 99% dB at 2.45 GHz. Whilst at 5.8 GHz, the antenna gain and efficiency is 3.0 dBi and 98%, respectively.

Figure 6 shows the current distribution for proposed antenna. Low current flow denotes by green color, yellow for moderate current and red for high current density. Now, it can be seen that the electric currents are concentrated at the feeding point. On the other hand, the distribution of current for 5.8 GHz gives more symmetrical compared to 2.45 GHz. The two slots attached on the ground plane has significant effect on the current distribution as it can be seen that much current concentrate at the edge of ground plane for frequency 5.8 GHz whilst for 2.45 GHz, they seem distributed at the upper ground plane.

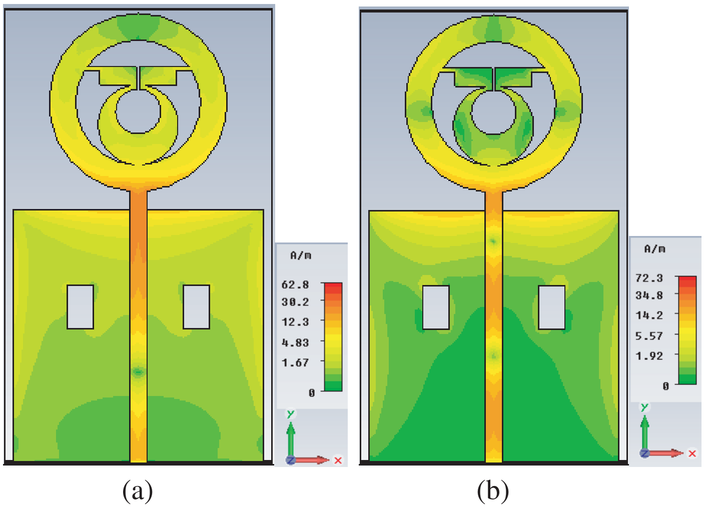


Figure 6. Current distribution for UTM-Logo shape surrounded with ring patch antenna at: (a) 2.45 GHz, (b) 5.8 GHz.

4. CONCLUSION

A UTM-Logo shape surrounded with Ring patch antenna fed by microstrip line is presented in this paper. With an overall adjustment of the geometrical parameters, the proposed antenna can be designed to operate between 1.98 to 6.46 GHz (106.16%) frequency band for wideband applications. The final measured result shows satisfactory performance and good agreement with the simulated result. The antenna has small physical size and can be easily integrated in wearable devices.

ACKNOWLEDGMENT

The authors wish to acknowledge Technology and Innovations (MOSTI), Ministry of Science, the Government of Malaysia for the funding that enables this work to be accomplished and also special thanks to the members of Wireless Communication Centre (WCC), Faculty of Electrical Engineering, Universiti Teknologi Malaysia for their helps and kindness.

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