Dual-Band Slot Antenna Suitable for Ultrabook Application with Metal Housing

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***Abstract* – This paper proposes a novel dual-band slot antenna suitable for Ultrabook applications with metal housing. The proposed slot antenna has a narrow slot which is directly constructed in the metal housing of the ultra-book, and then feeding the antenna using a 50-Ω microstrip line which is printed on a 0.4 mm FR4 substrate. Through the adjustment of the dimension of the slot and the length of the microstrip line, good impedance matching and dual-band operation bandwidth was obtained. Prototypes have been successfully implemented, and experimental results show that the good antenna efficiency and radiation performance were obtained. Due to it can be integrated with the metal housing of the wireless device, the proposed antenna is very suitable for the WiFi antenna application of a mobile computer, such a notebook or an ultrabook. Details of the proposed antenna and experimental results are presented and discussed.**

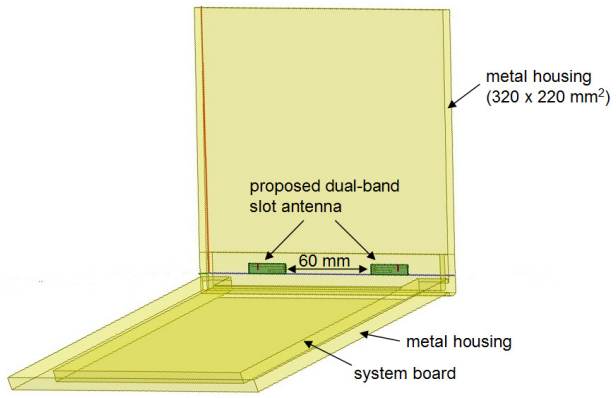
***Index Terms* — Slot antenna, Dual-band antenna, Ultra-book antenna with metal housing.**

I. INTRODUCTION

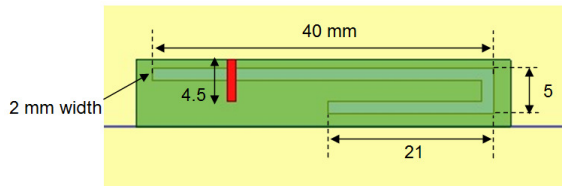
Recently, the outward appearance of the mobile device is becoming more and more important, especially in consumer wireless products such as mobile smart phone, tablet, notebook and ultrabook. Besides, ultra-thin device is also becoming more and more popular. To achieve the requirement of impressive outward appearance and ultra-thin device, whole metal housing is a better solution than conventional plastic cover. But metal housing is also a good shielding for the EM wave transmission. Conventional antenna design method including patch antenna [1], PIFA antenna [2], monopole antenna [3], or slot antenna [4], will be strongly affected by the metal housing. How to reduce the influences from the metal housing and obtain a good antenna radiation becomes a big challenge for the antenna designer. In this paper, we present a dual-band slot antenna design which can be directly constructed in the metal housing of the wireless device. And it is fed by using a 50-Ω microstrip line which is printed on a 0.4 mm FR4 substrate. In the same time, the ground plane of the microstrip line which is also printed on the FR4 substrate must be connected with the metal housing around the slot. So the metal housing can be treated as the necessary big ground plane of the slot antenna. It is also helpful for the impedance matching of the slot antenna. For achieving the dual-band operation, the proposed slot antenna shows a form of un-balance U-shape. The different length of the two arms of U-shape slot can control the center frequency of dual-band resonant modes to meet the bandwidth requirement of WiFi 2.4/5 GHz operation bands. And the total length of the slot is close to the half-wavelength of the 2.45 GHz. Besides, the microstrip line crossed the slot to feed the RF signal and also can adjust the antenna impedance by tuning the length of microstrip line. The good impedance matching can be obtained with suitable length of microstrip line. Details of the dimensions of the proposal antenna are described.

II. ANTENNA DESIGN

Fig. 1(a) shows the structure of the whole ultrabook with metal housing and the proposed dual-band slot antenna which is built in the bottom area of the upper metal cover. The dimension of upper metal cover is about 320×220 mm^2, and it can be treated as the big ground plane of the proposed slot antenna. The lower metal cover has the same size and it includes a system circuit board. In the bottom area of the upper metal cover, it digs two slots with the same dimensions and keep a distance between them about 60 mm which is about half-wavelength of the 2.45 GHz. The detail dimensions of these two slots are shown in Fig. 1(b).



(a)



(b)

Fig. 1(a). Geometry of the whole ultrabook with metal housing and proposed slot antenna. (b) Detail dimensions of proposed slot antenna.

The total length of the slot antenna is about 66 mm, it is close to the half-wavelength of the center frequency (2.45 GHz) of the WiFi 2.4 GHz band. So it can generate a fundamental slot resonant mode during the 2.4 GHz band. And for achieving dual-band operation, the proposed slot antenna shows a form of un-balance U-shape. The different length of the two arms of U-shape slot can control the second higher order slot resonant mode to reach the required 5 GHz band. The width of slot is 2 mm, the larger bandwidth is obtained if the wider of slot width. Besides, the proposed slot antenna is fed by a 50-Ω microstrip line which is printed on a 0.4 mm FR4 substrate. The reference ground plane of the microstrip line is also printed on the FR4 substrate and it must be connected with the metal housing around the slot. The proposed slot antenna needs a big ground plane to achieve the good impedance matching. The metal housing can be as the big ground plane of the slot antenna through the connection with the reference ground of the microstrip line.

The microstrip line is cross in the slot to feed the RF signal and also can adjust the antenna impedance by changing the location and tuning the length of the microstrip line. The location of the microstrip line can affect the real part of antenna impedance to close to the 50-Ω. And the length of the microstrip line will modify the imaginary part of antenna impedance. The good impedance matching can be obtained with suitable position and length of the microstrip line.

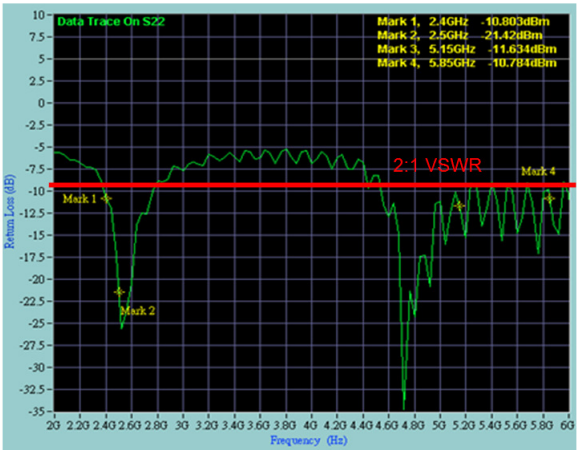


Fig. 2. Measured return loss for the proposed slot antenna.

III. Results And Discussion

The proposed antenna was constructed and tested. Fig. 2 shows the measured return loss for the proposed slot antenna. From the obtained results, two resonant modes at about 2.4 GHz and 5 GHz are excited with good impedance matching over a wide bandwidth. The obtained impedance bandwidths, determined from 2:1 VSWR, are 390 MHz (2390–2780 MHz) and 1300 MHz (4590–5890 MHz), covering the required operating bandwidths of the WiFi 2.4 and 5 GHz bands. Radiation characteristics of the proposed antenna have also been measured.

In practical application of ultrabook, it usually needs two WiFi antennas for MIMO operation. In this paper we also study two proposed slot antennas with a distance about 60 mm and verify the performance. From the measured results shown in Fig. 3, the two slot antennas have good isolation during the operation 2.4 and 5 GHz bands. It can easily to over the 25 dB isolation in the all operation bandwidth. In addition, the return loss, antenna efficiency and radiation characteristic are also tested. They also show the good performance for the two proposed slot antennas.

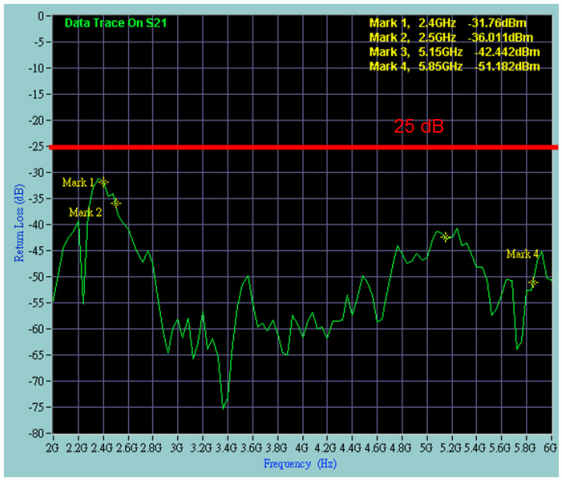


Fig. 3. Measured isolation for the two proposed slot antennas.

IV. Conclusion

A novel dual-band slot antenna suitable for Ultrabook applications with metal housing has been proposed and experimentally studied. Prototypes have been constructed, and good impedance matching for the proposed slot antenna in a dual-band operation bandwidth has been obtained. Due to easy integration with the metal housing of the wireless device, the proposed antenna is very suitable for the WiFi antenna application of a mobile computer, such as an ultrabook.

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