

Wi-Fi 7 MIMO Antennas for Metal-Housing Laptop

Wen-Shan Chen^{1*} and Wei-Ren Huang¹

¹ Department of Electronic Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan
chenws@stust.edu.tw

Abstract - This paper presents a design of Wi-Fi 7 MIMO antennas for laptops with a metal housing. The one set of antenna pairs is printed on an FR4 substrate with a thickness of 0.8 mm and has a compact design measuring $35 \times 4.8 \times 3$ mm³. There are four sets of antenna pairs are integrated into a $350 \times 200 \times 3$ mm³ metal housing. The proposed design supports 8 × 8 Multi-Input Multi-Output (MIMO) technology. The set of antenna pairs consists of two antennas. One antenna includes an L-shaped microstrip line, grounded L strip, and an L-shaped open-slot structure placing on the other side to achieve full-band coverage for Wi-Fi 7, including Wi-Fi 2.4 GHz (2.4 – 2.484 GHz), Wi-Fi 5 GHz (5.15 – 5.825 GHz), and Wi-Fi 6 GHz (5.925 – 7.125 GHz). Additionally, the antenna adopts space diversity to ensure an isolation level below -10 dB, ensure excellent signal quality and system stability.

Keywords —Full Metal Housing, Wi-Fi 7, coupled antenna, MIMO.

I. INTRODUCTION

As Wi-Fi technology advances to the seventh generation, Antenna design with MIMO technology has become a key element. By the way, it is important for increasing the number of antennas within a limited space, and it presents a significant challenge on antenna design. Ref. [1] adopts vertical mounted antennas placed on a slotted backplate, while [2] uses a microstrip line and slot resonance to support Wi-Fi bands coverage and enable narrow-bezel designs. Ref. [3] places the antenna within the frame and adds capacitors, forming a segmented ring structure to enhance antenna bandwidth. Ref. [1] – [3] explore different metal housing designs to achieve the Wi-Fi 7 frequency bands, while ref. [4] and [5] follow traditional designs, utilizing loop antennas and adding capacitors to share coupling paths to improve antenna isolation. This paper presents a Wi-Fi 7 MIMO antenna designed for laptops with a metal housing, covering the Wi-Fi 2.4 GHz (2.4 – 2.484 GHz), Wi-Fi 5 GHz (5.15 – 5.825 GHz), and Wi-Fi 6 GHz (5.925 – 7.125 GHz) frequency bands. The proposed antenna uses an L-shaped microstrip line and L-shaped open slot to generate the low-frequency Wi-Fi 2.4 GHz signal, while the high-frequency Wi-Fi 5/6 GHz is excited through an L-shaped microstrip line and a grounded L-shaped strip.

II. ANTENNA DESIGN

Fig. 1 shows the front view of the antenna structure and Fig. 2 presents the side view of the antenna structure. The set of antenna pairs is printed on a 0.8mm-thickness FR4 substrate with a dielectric constant of 4.4 and a loss tangent of 0.0245. The overall dimensions of the design are $350 \times 200 \times 3$ mm³, with the size of the set of antenna design is $35 \times 4.8 \times 3$ mm³, positioned 20 mm from the edge. Ant. 1 and Ant. 2 are spaced 20 mm apart on the side, while Ant. 3 and Ant. 4 are positioned on the right side. There are four sets of antenna pairs in the design. One set of antenna pairs is composed of an L-shaped microstrip line, grounded L strip, and an L-shaped open-slot structure located on the other side. The central area is reserved for the laptop's webcam, so no antennas are placed there. As shown in Fig. 3 and Table I, the MIMO antennas are excited by 50-ohm coaxial cables and use L-shaped microstrip-lines. The L-shaped open slot on the back side is excited by microstrip-line generates the band of Wi-Fi 2.4GHz, while the Wi-Fi 5 GHz and 6 GHz bands are generated by exciting the L-shaped microstrip and grounded L-shaped stripe. By utilizing space diversity techniques, the isolation between antennas is improved without requiring additional isolation mechanism, ensuring good performances.

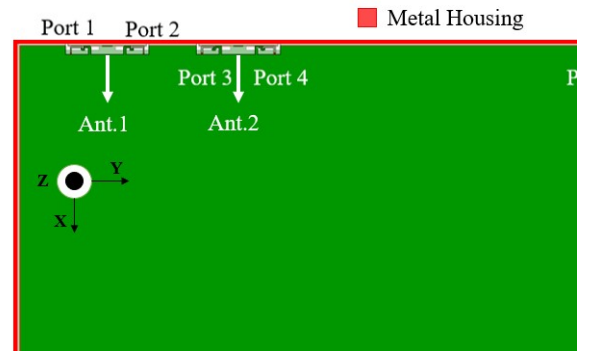


Fig.1. Front view of the antenna structure.

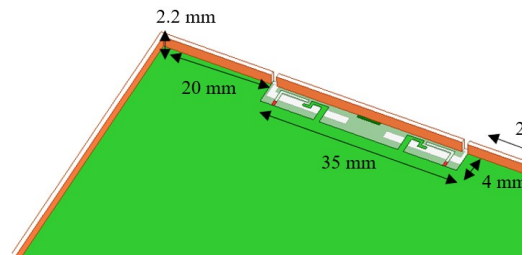


Fig.2. Side view of the antenna structure.

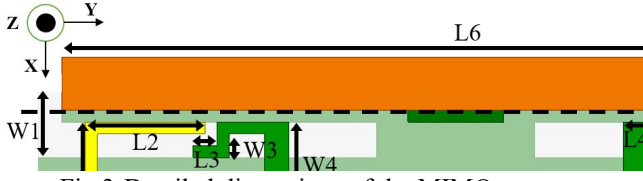


Fig.3. Detailed dimensions of the MIMO antennas

TABLE I Dimensions of the MIMO antenna design

Parameters	L1	L2	L3	L4	L5	L6
Unit (mm)	0.5	5	1	3	1	33
Parameters	W1	W2	W3	W4	W5	W6
Unit (mm)	2.8	2.5	1	3.5	1.5	2.2

III. RESULTS AND DISCUSSION

Fig. 4 and Fig. 5 show the simulated and measured S-parameters of the MIMO antennas, with S11 to S88 below -10 dB in the bands of Wi-Fi 2.4 GHz (2.4 – 2.484 GHz), 5 GHz (5.15 – 5.825 GHz), and 6 GHz (5.925 – 7.125 GHz). Fig. 6 and Fig. 7 present the simulated and measured isolation parameters of the design. In simulation, S12 is slightly above -10 dB, but it drops below -10 dB on measurement. Others are all less than -10dB at 2.4 GHz bands, and the isolation parameters are all less -15dB for 5GHz and 6GHz.

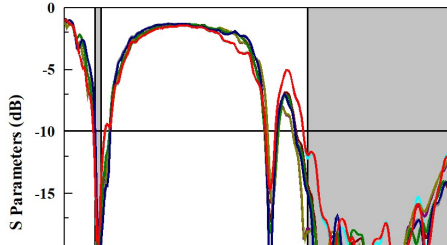


Fig.4. Simulated S11 - S88 for Wi - Fi 7 antennas

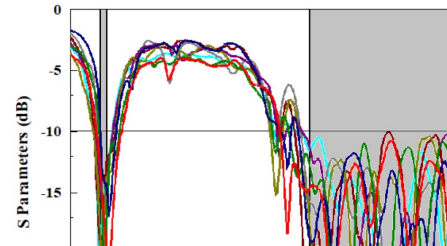


Fig.5. Measured S11 - S88 for Wi - Fi 7 antennas

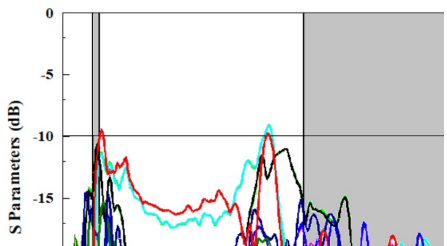


Fig.6. Simulated isolation parameters for Wi - Fi 7 antennas

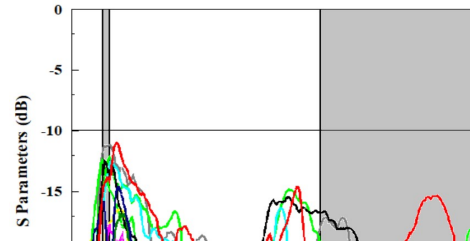


Fig.7. Measured isolation parameters for Wi - Fi 7 antennas

IV. CONCLUSION

This paper presents a Wi-Fi 7 MIMO antenna designed for laptops with a metal frame. The antenna is integrated into the frame, utilizing a microstrip line to excite an open slot on the backside for the Wi-Fi 2.4 GHz frequency band. The Wi-Fi 5/6 GHz bands are achieved through a combination of microstrip lines and a grounded L-shaped strip, forming a loop structure. This integration of the antenna into the metal frame not only improves the laptop's aesthetic but also reduces the overall antenna size, allowing for a narrow bezel design. Furthermore, this approach enables the deployment of multiple antennas, enhancing MIMO performance.

REFERENCES

- [1] J. Wu, G. -M. Yang and Y. Wang, "An Omnidirectional Hinge Antenna for Laptop Computer with Metal Housing Operating at the WLAN/Wi-Fi 6E Bands," 2024 IEEE International Conference on Microwaves, Communications, Antennas, Biomedical Engineering and Electronic Systems (COMCAS), Tel Aviv, Israel, 2024, pp. 1-4.
- [2] J. Wu, G. -M. Yang, Y. Wang, N. Yan and Y. -Q. Jin, "Metal-Frame Slot Antenna with a Small Ground Clearance for the Wi-Fi 6E Operation in Laptop Applications," in IEEE Transactions on Antennas and Propagation.
- [3] W. Yan et al., "Multimode Balanced Mu-Near-Zero Loop Antenna for Wi-Fi 6/6E Applications in Full Metal Housing Tablet Computers," in IEEE Transactions on Antennas and Propagation, vol. 72, no. 7, pp. 5469-5478.
- [4] S. -W. Su and C. -C. Wan, "Asymmetrical, Self-Isolated Laptop Antenna in the 2.4/5/6 GHz Wi-Fi 6E Bands," 2021 International Symposium on Antennas and Propagation (ISAP), Taipei, Taiwan, 2021, pp. 1-2.
- [5] S. -W. Su, D. P. Yusuf and F. -H. Chu, "Conjoined, Wi-Fi 6E MIMO Antennas for Laptops," 2021 International Symposium on Antennas and Propagation (ISAP), Taipei, Taiwan, 2021, pp. 1-2.