

## CHIP ANTENNA FOR 5.2 GHZ WIRELESS LAN

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### 1. INTRODUCTION

The authors have proposed two types of microstrip antennas printed on the parallelepiped dielectric chip for the Bluetooth system and the 5.2 GHz wireless LAN. These antennas are excited by the electromagnetic coupling. For the Bluetooth system, the rectangular patch conductor is printed on the chip and excited by the monopole antenna printed on the sidewall of chip [1]. The size of dielectric chip is 12 mm by 12 mm by 4 mm. For the 5.2 GHz Wireless LAN, the shorted rectangular patch microstrip antenna is excited by the three monopoles composed of through holes within the chip [2]. The size of this antenna is 8 mm by 6 mm by 2 mm.

In this paper, the chip antenna for 5.2 GHz wireless LAN is numerically and experimentally analyzed and the reason for its small size is discussed. In the numerical analysis, the electromagnetic simulator "Fidelity" based on the FDTD method is used [3].

### 2. ANALYTICAL MODEL

Figure 1(a) and (b) show the structure of chip antenna. The patch conductor is printed on the surface of chip and the patch is short-circuited at the opposite side of the feed monopoles. This antenna is excited by three monopole antennas connected to the microstrip line on the lower substrate. The relative permittivity of lower dielectric substrate is  $\epsilon_{r1} = 4.4$  and that of upper chip is  $\epsilon_{r2} = 3.9$ . For the space diversity, two chip antennas are mounted on the lower dielectric substrate.

In the numerical analysis by Fidelity, the calculation region is 75 mm by 75 mm by 45 mm in dimensions. The space steps are from 0.1 mm to 1 mm (non-uniform mesh). The perfectly matched layer of six-layer and fourth-order is used as the absorbing boundary condition.

### 3. RESULTS AND DISCUSSION

Figure 2 shows the return loss characteristics of chip antenna. The calculated resonant frequency of chip antenna is 5.27 GHz. The calculated resonant frequency agrees well with the measured result. The length of patch conductor (6 mm) is smaller than a quarter wavelength. Therefore, the resonant frequency of chip antenna is compared with that of probe-fed shorted microstrip antenna on the same chip. Figure 3 shows the structure of probe-fed shorted microstrip antenna to be mounted on the lower dielectric substrate. The second resonant frequency 5.925 GHz of chip antenna is close to the resonant frequency of probe-fed shorted microstrip antenna.

Figure 4(a) and (b) show the electric field distributions of chip antenna in the vertical plane

including the central monopole at the first and second resonant frequencies 5.27 GHz and 5.925 GHz, respectively. Figure 5 shows the electric field distribution of probe-fed microstrip antenna in the vertical plane including the feeding probe. At the first resonant frequency 5.27 GHz of chip antenna, the electric field is strongly excited at the region between the feeding monopole and the edge of patch conductor. Due to this fringing field, the effective size of this antenna becomes larger. Therefore, the resonant frequency of chip antenna becomes lower than that of probe-fed microstrip antenna.

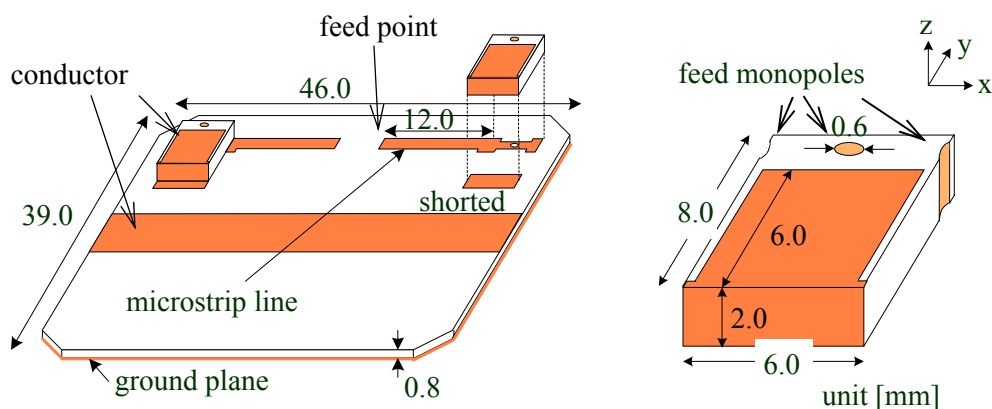
Figure 6 and 7 show the calculated and measured electric field radiation patterns of chip antenna at the resonant frequency, respectively. The calculated radiation patterns agree well with the measured results.

#### 4. CONCLUSION

The shorted microstrip antenna on the parallelepiped rectangular chip has been numerically and experimentally analyzed. This antenna is electromagnetically excited by three monopoles connected on the microstrip line on the lower dielectric substrate. Due to the fringing field between the feeding monopoles and the patch conductor, the resonant frequency of chip antenna becomes lower than the probe-fed shorted microstrip antenna.

#### REFERENCES

- [1] M. Taguchi, R. Nakamura, H. Shimoda and K. Tanaka, "Rectangular microstrip antenna excited by monopole antenna on finite dielectric substrate," Proc. of 2002 Interim International Symposium on Antennas and Propagation, 2A2-2, Nov. 2002.
- [2] M. Taguchi, T. Okajima, H. Shimoda and K. Tanaka, "Shorted rectangular microstrip antenna on dielectric chip for 5.2 GHz Wireless LAN," Proc. Of 2004 IEEE Antennas and Propagation Society International Symposium, vol.4, pp.3812-3815, June 2004.
- [3] "Fidelity User's manual Release 3," Zeland Software, Inc., April 2000.



(a) Structure of chip antenna on lower dielectric substrate (b) Enlargement of chip

Figure 1 Chip antenna

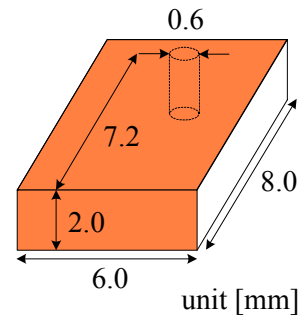
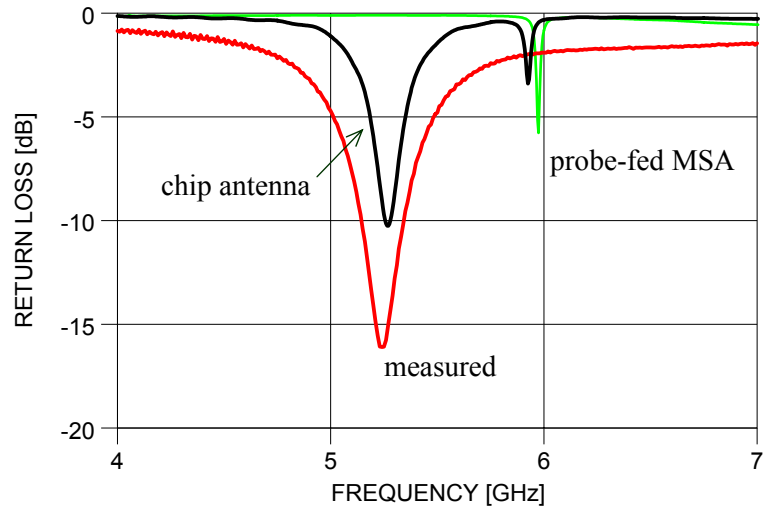


Figure 3 Probe-fed shorted microstrip antenna

Figure 2 Return loss characteristics

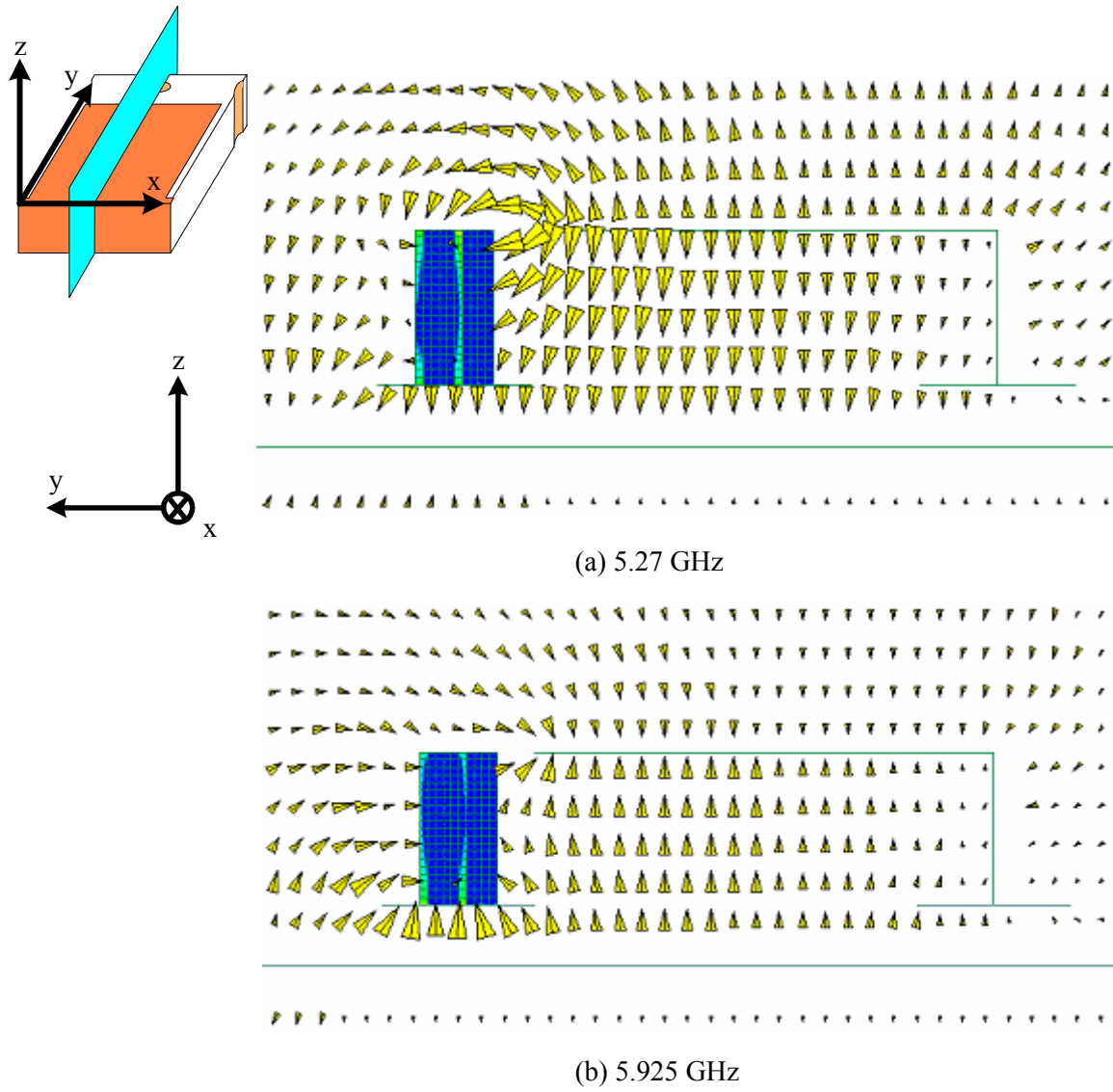


Figure 4 Electric field distribution of chip antenna in vertical plane including central monopole.

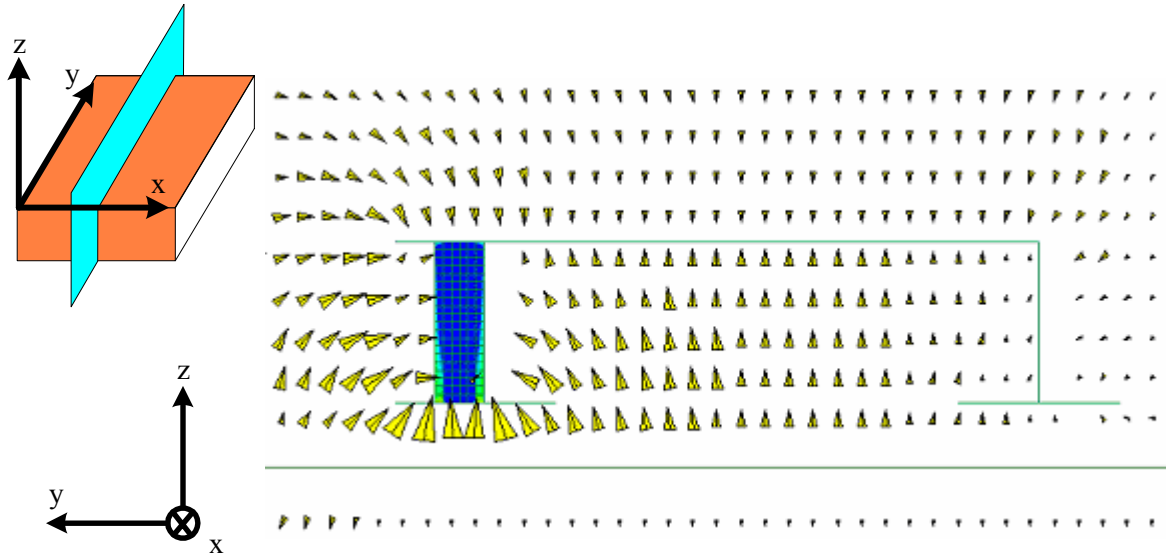


Figure 5 Electric field distribution of probe-fed microstrip antenna in vertical plane including probe at 5.975 GHz.

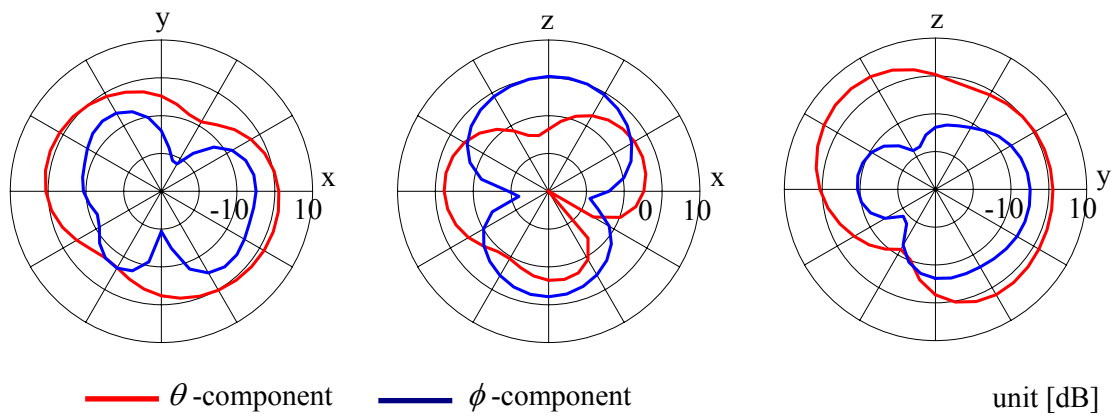


Figure 6 Calculated electric field radiation patterns.

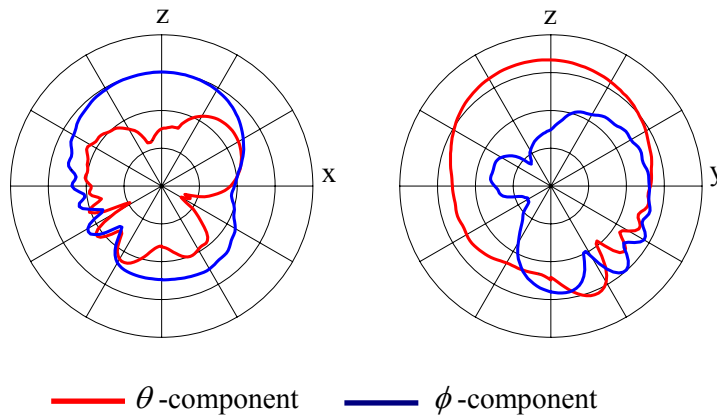


Figure 7 Measured electric field radiation patterns.