

Adaptive Antenna Composed of Six Dipole Elements for Wireless LAN

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1. Introduction

Recently, the demand for Broadband Internet Connection has been expanded and it becomes to be indispensable for the people's lives. However, a lot of digital divide areas still exist in the rural areas in Japan. In these areas, the optical fiber and public wireless LAN is difficult to introduce in terms of the profitability. As the countermeasure to these digital divide, the introduction of "Wireless LAN Mesh Networks" has been discussed in Japan [1]. The authors have analyzed the adaptive antenna composed of six printed dipole elements for 2.4 GHz band wireless LAN [2]. Dipole elements are radially located and fed by parallel line printed on both sides of the dielectric substrate. The radiation pattern of this antenna is controlled by turning on/off switching diodes connected near feed points of six dipoles [3]. Since six dipoles elements are connected in parallel, however, the input impedance of this antenna varies depending on the number of excited elements. Therefore, the actual gain deteriorates when two or more elements are excited.

In this paper, the adaptive antenna composed of six printed dipole elements with the varactor diode is proposed for improving its input impedance. The switching diode is installed near the feed point of each dipole element. The varactor diode is connected at the feed point of all elements. In the numerical analysis, the electromagnetic simulator "WIPL-D" based on the method of moment is used [4].

2. Antenna Structure and Analytical Method

Figure 1 shows the structure of the antenna composed of six printed dipole elements. The dipole elements are fed by the parallel line printed on both sides of the dielectric layer with thickness of 0.8 mm. The relative permittivity and the loss tangent of dielectric material are 4.2 and 0.015, respectively. At the root of parallel line on the backside of dielectric layer, the V-shaped reflector is printed. Each dipole element is independently turned on/off by a diode connected between two conductors of parallel line near its feed point. In Figure 1, the diode and their bias line are not shown. The varactor diode is also connected at feed point in parallel. Figure 2 shows the structure of feed region of this antenna on the backside of substrate.

The total number of combination of radiating elements is 63. Figure 3 show 13 independent patterns analyzed in this paper. Since the operating frequencies of Wireless LAN are from 2.4 GHz to 2.4835 GHz [5], the antenna characteristics are calculated at the frequencies from 2.4 GHz to 2.5 GHz.

3. Simulation Results and Discussion

Figure 4 shows the examples of the return loss characteristics of the antenna. By changing the capacitance of the varactor diode, the return loss less or equal to -10 dB is achieved at the frequency band from 2.4 GHz to 2.4835 GHz. Figure 5 show the input impedance characteristics of the antenna with and without capacitor. The same capacitance is used in the case of which the number of excited dipole elements is equal. The good

return loss characteristics are obtained by loading the varactor diode at the feed point. Figure 6 show the electric field radiation patterns in the xy plane. The amplitude of radiation patterns are indicated by the actual gain. As the number of excited dipole elements is increased, the actual gain is improved by loading the varactor diode.

4. Conclusion

In this paper, the adaptive antenna composed of six printed dipole elements with the varactor diode for the wireless LAN has been analyzed numerically. Six dipole elements are printed on the both side of the dielectric layer. The radiation pattern of this antenna is controlled by turning on/off the switching diode of the dipole elements. The input impedance is improved by the changing the capacitance of varactor diode loaded at the feed point in the case that the excited dipole elements are two or more.

In the next step, the calculated results will be compared with the measured results.

References

- [1] http://www.soumu.go.jp/joho_tsusin/broadband/index.html
- [2] M. Taguchi, T. Yamashita, and D. Iwanaka, "Study on antenna of 6 dipole elements for wireless LAN", ITE Technical Report, BCT2008-4, Jan. 2008 (in Japanese).
- [3] <http://www.ruckuswireless.com/>
- [4] <http://www.wipl-d.com/>
- [5] Wi-Fi Alliance; <http://www.wi-fi.org/wifi-protected-setup>

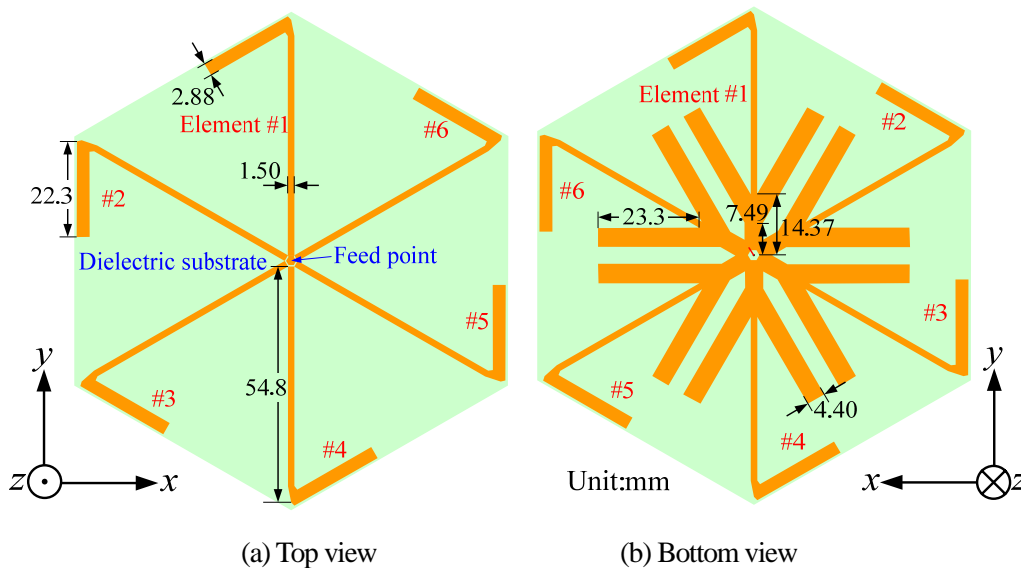


Figure 1: Structure of analytical model.

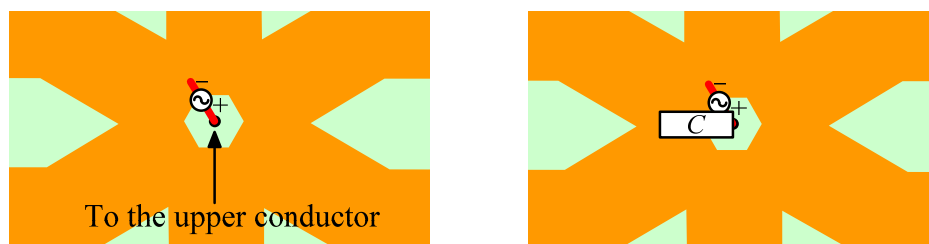


Figure2: Structure of central region of antenna (bottom view).

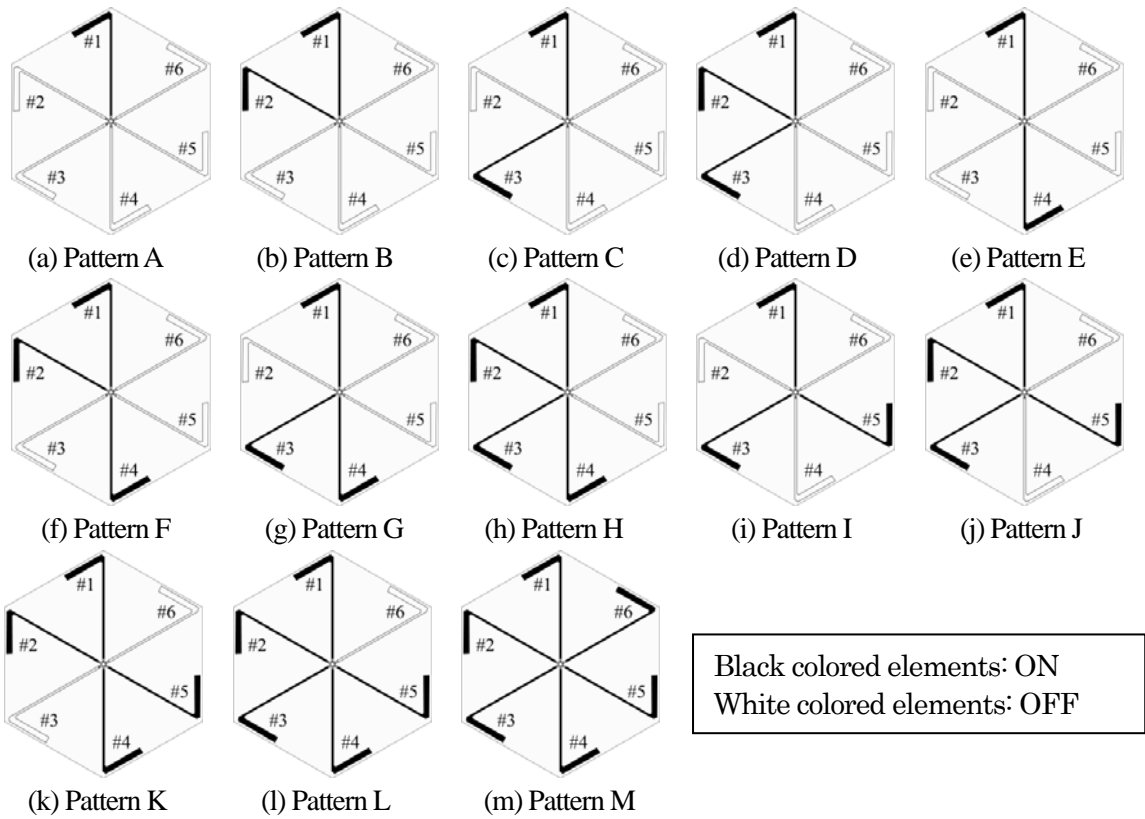


Figure 3: Antenna patterns.

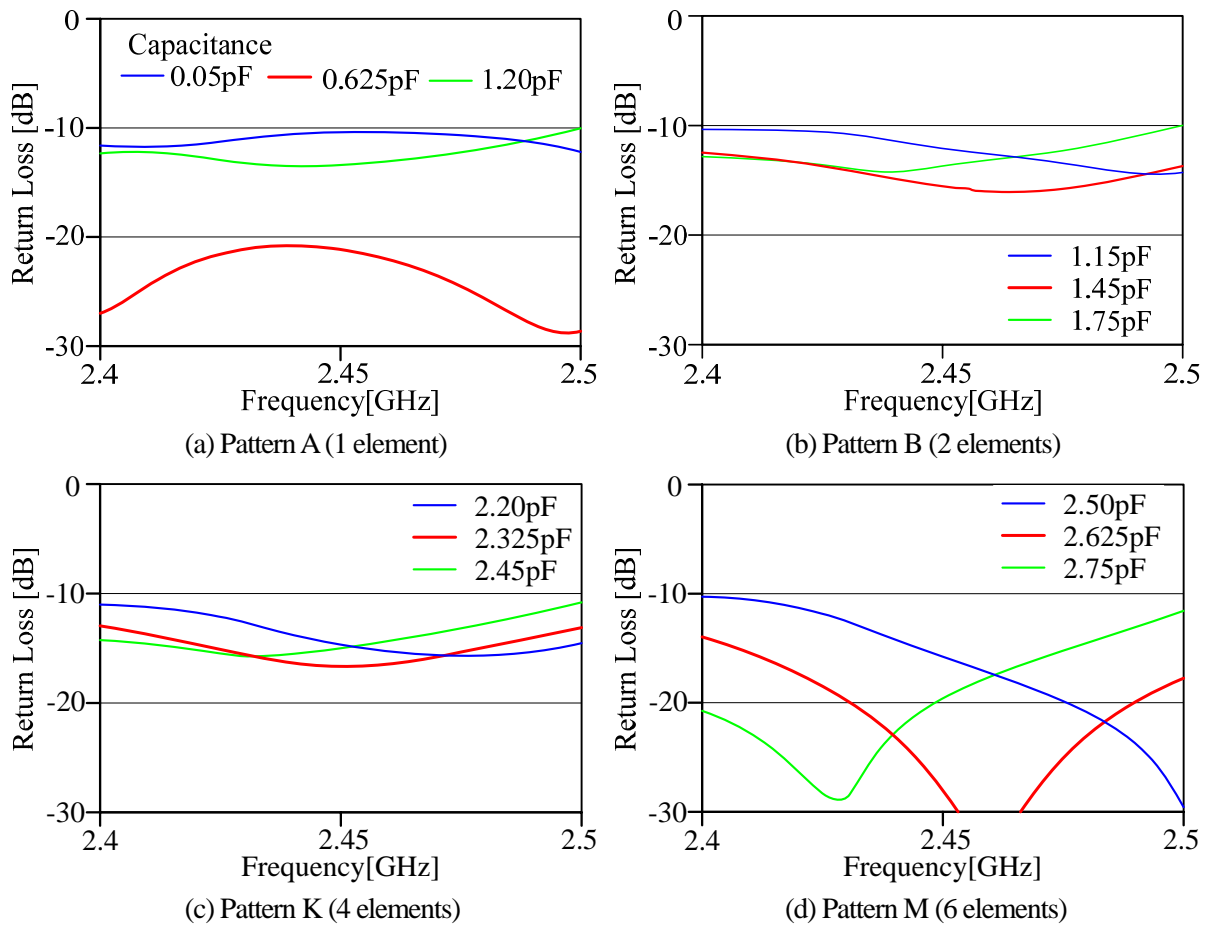
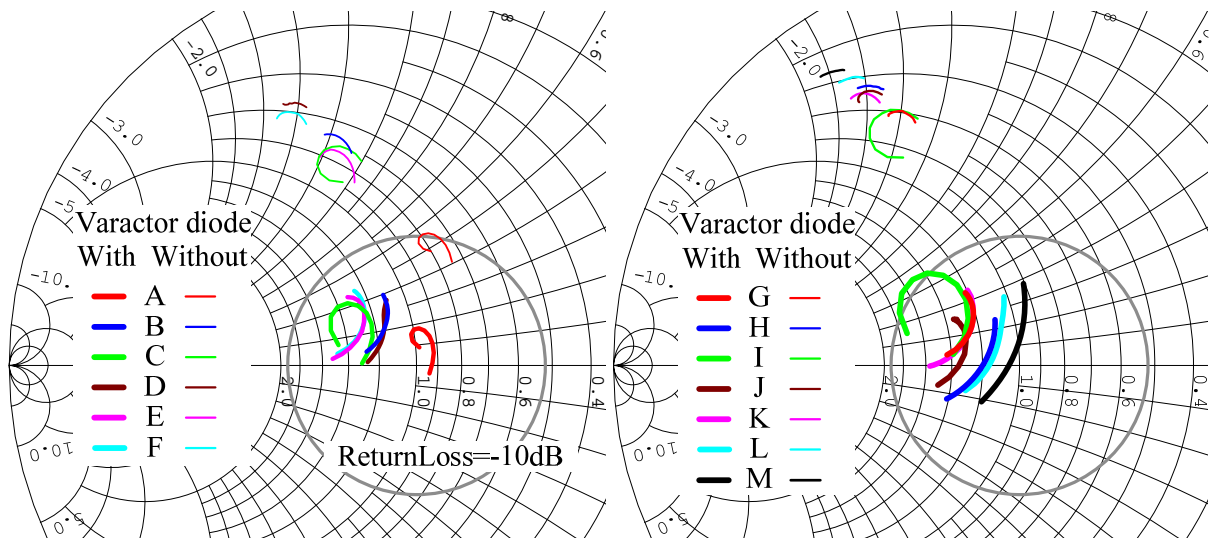


Figure 4: Return loss characteristics for different varactor diode.



(a) Pattern A to F (b) Pattern G to M

Figure 5: Input admittance characteristics at 2.4GHz to 2.5GHz.
 Capacitance of varactor diode A: 0.625 pF, B, C and E: 1.45 pF, D, F, G and I: 1.925 pF, H, J and K: 2.325 pF, L: 2.475 pF, M: 2.625 pF

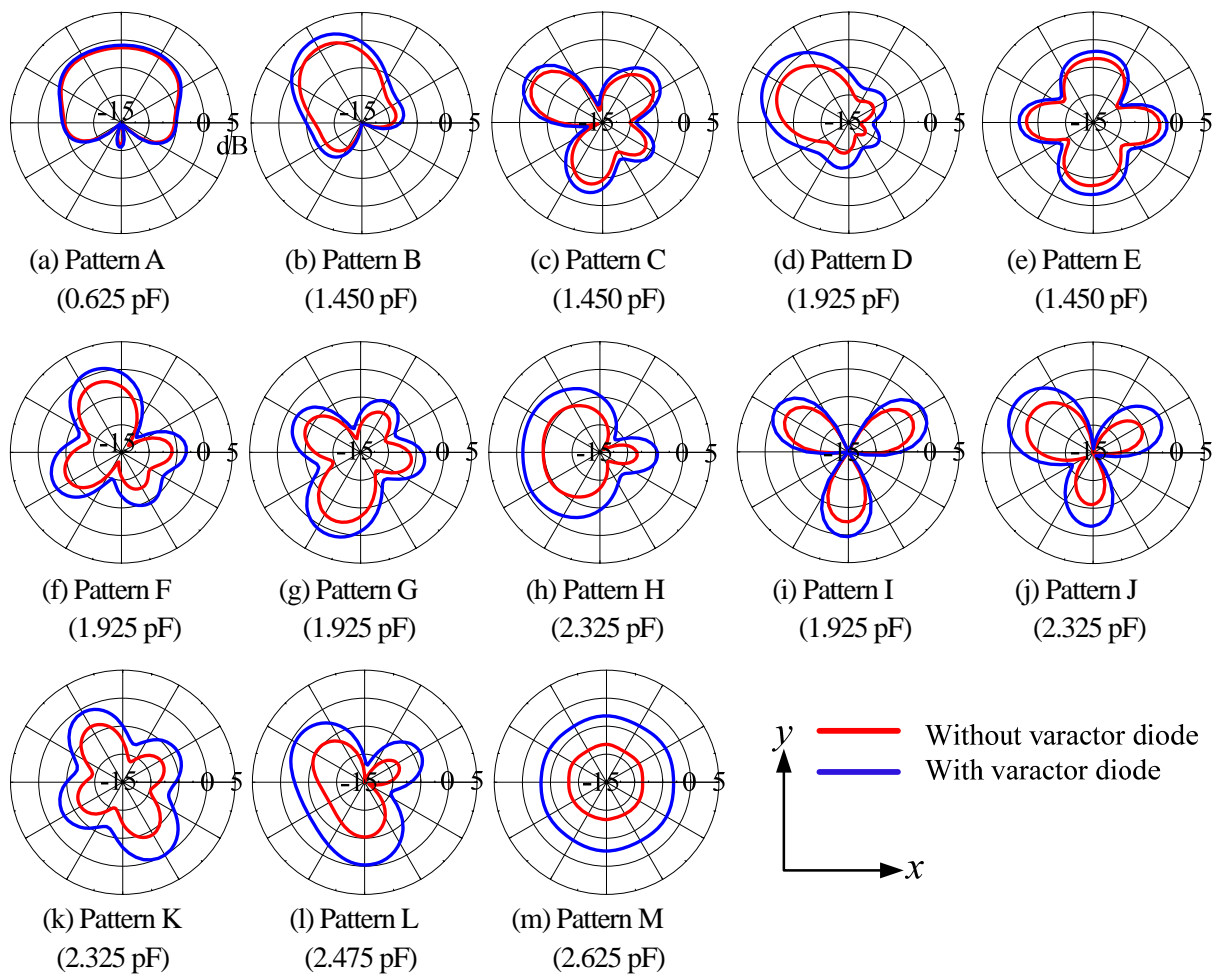


Figure 6: Electric field radiation patterns at 2.45 GHz.