A Compact MIMO DRA for 802.11n application

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1. Introduction

Multiple Input, Multiple Output (MIMO) has become the key technology for next generation mobile communication. The antennas at each end of the communications circuit are combined to minimize the errors and to optimize the data speed. MIMO-based antennas are of interest in relation to communication such as digital TV, wireless LAN and mobile communications. A lot of research efforts have been paid to this area. Some of standard such as 802.11n has been on the market [1].

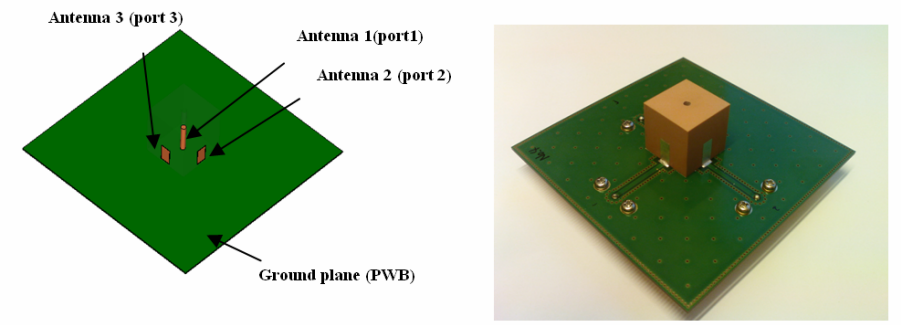
For the MIMO system, one of the main research areas is compact MIMO antenna since it is vital in a mobile device. This means that if the MIMO concept is used for a small portable communication device, it may be difficult to provide antennas that have low incidence of coupling to each other especially if the device is to be kept small. To keep the antenna array to have high efficiency and low correlation and coupling, one way is to use space diversity to separate antenna, which is commonly used in 802.11n terminal. Another way is to use polarization diversity, to use orthogonal polarization diversity branches to realize the independent channels [2].

In recent years, a new type of DRA antenna has evolved that is small and has high radiation efficiency [3]. In a dielectric resonator antenna (DRA), a probe can excite a transmission mode in a resonating dielectric antenna volume. The antenna has three orthogonal polarization modes which can offer three independent channels by using one antenna element. DRA offers several advantages such as wide bandwidth, small size, ease of fabrication and high radiation efficiency [3] [4].

This paper presents characteristics of DRA antenna for 2.5 GHz WLAN band and measurement results of the performance of DRA and dipole array for a 3-port 802.11n terminal in an office environment.

2. Antenna designed structure

The MIMO DRA antenna was designed using the electromagnetic software CST Microwave Studio based on Finite Integration Method (FIM). Proposed antenna structure is shown in Fig.1(a)(b). It consists of a monopole mode antenna and two patch mode antennas in the DRA. The parameters of DRA are: length = width = height =18 mm; dielectric constant $_r$ = 21, tan =0.0001352. Antenna elements are painted silver on dielectric material. Each antenna is optimized to cover the Wireless LAN 2.4GHz. Diameter of antenna (port 1) is 2mm and height is 10.5mm. Size of other antennas (port 2 and 3) are 4 (w) x 7 (h) mm. Ground plane is 80 x 80 x 1 mm. Antenna 2 and 3 are same size and shape.



(a) (b)

Fig.1 (a) Antenna with PWB (if dielectric material is removed) (b) antenna prototype with PWB.

3. Results

S-parameter, mean effective gain and diversity gain have been tested and simulated.

3.1 S-parameters

The S-parameters were measured by VNA (vector network analyzer) and compared to the simulation results in Figure.2. It shows the good bandwidth of each antenna port and good isolation between the ports.

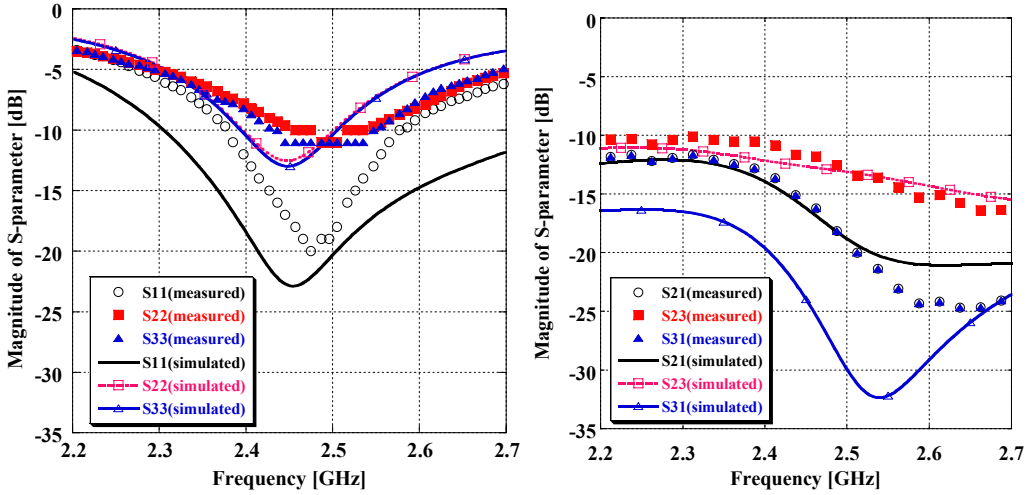
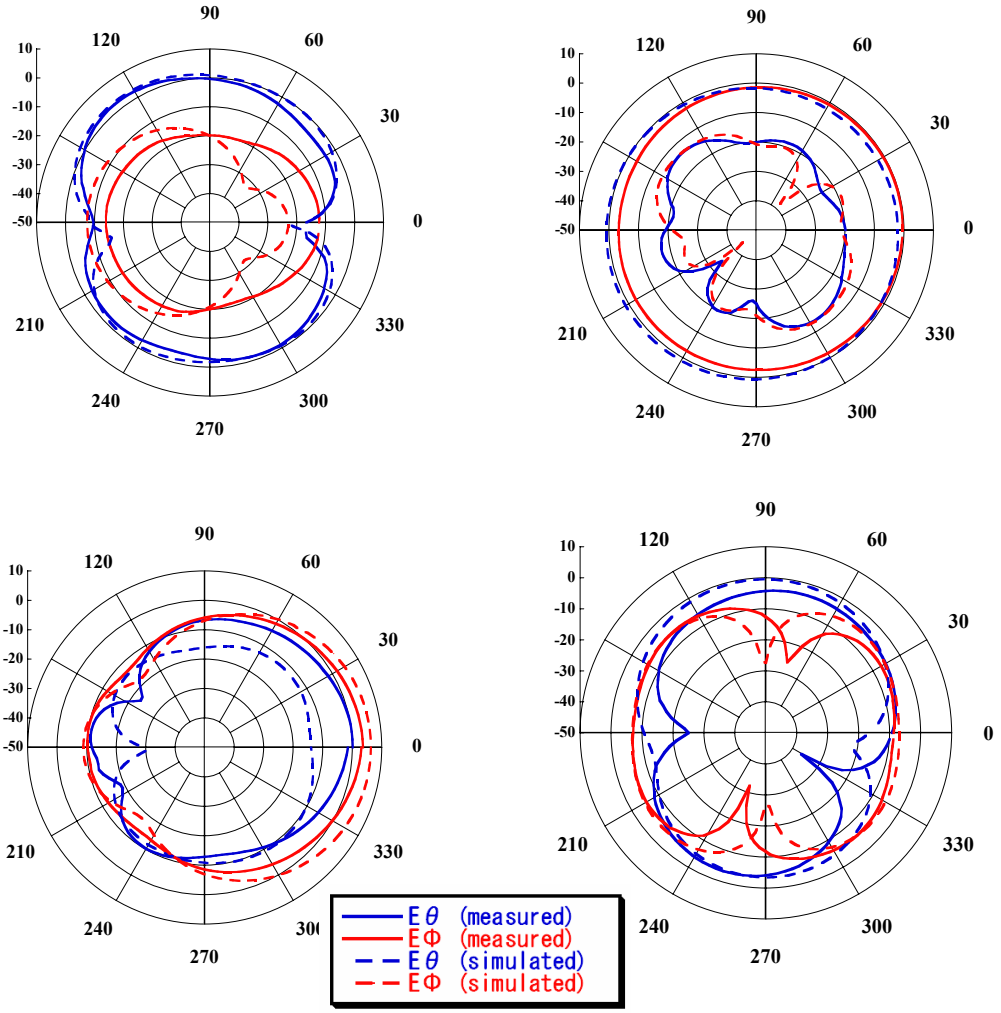


Fig.2 measured and simulated S-parameter of DRA antenna system.

3.2 Diversity gain and radiation patterns

The concept of diversity is that more than two antennas are used to receive a signal and those are combined the replicas of received signal in a desirable way to improve the communication link performance. Each two antennas, port 1-2, port 2-3 and port 1-3 (por1) diversity gain were performed in a scattering field chamber. Actual diversity gain are 9.3dB (port 1-2), 9.8dB (port 2-3) and 9.6 dB(1-3). Those values are very close each other and show a very good MIMO antenna.

Figure.3 shows radiation pattern on both vertical plane horizontal plane for each antenna port. The monopole mode port 1 shows a conventional dipole pattern; and port 2 and port 3 are orthogonal patch mode and has more directive patterns with different polarizations, the peak gain can achieve 5 to 6 dBi.

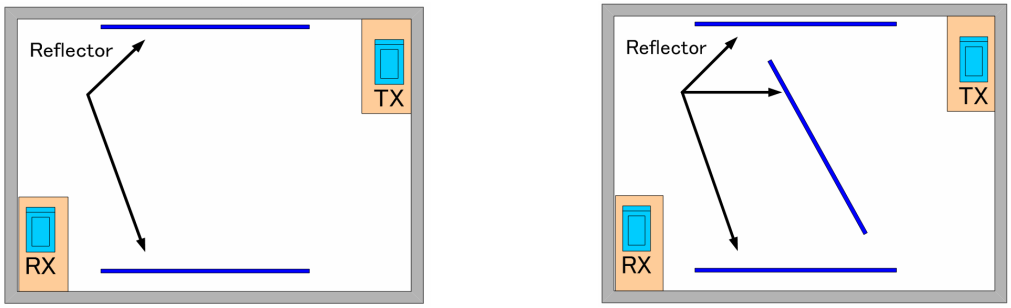


(b-1) (b-2)

Fig.3 Radiation pattern of antenna 1 and 2.(a-1) E cut of antenna 1, (a-2) H cut of antenna 1, (b-1) E cut of antenna 2, (b-2) H cut of antenna 2.

3.3 Experiment system of 810.11n MIMO system and test results

The throughput of 802.11n Wireless LAN was measured for comparing DRA and reference antenna. A router was connected with a network cable to a stationary computer, which was acting as the transmitter. A laptop was used as the receiver. Then a local network was setup between the two computers and a 320 MB file was sent between the computers. TX antenna is used 3 dipole antennas as reference antenna and this MIMO DRA antenna. Two measurement scenarios were prepared with without refractor in the middle of experiment room. Those are Line of sight (LOS) and non line of sight. Figure 4 shows the overview of experiment room. Figure 5 shows throughput speed measurement results.



(a) (b)

Fig.4 The experiment room (a) line of sight – LOS, (b) non line of sight – NLOS

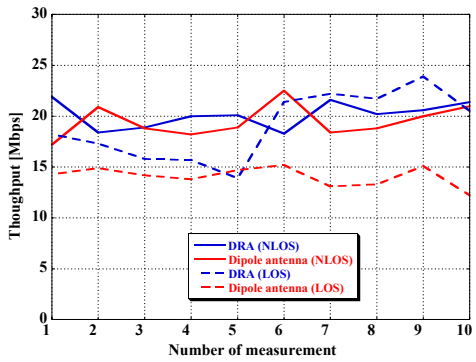


Fig.5 Throughput speed measurement result.

4. Conclusion

We have developed new compact MIMO DRA for 802.11n system. The antenna has three independent orthogonal channels which can offer high efficiency and high diversity gain. The simulation result closely matches with measured result in S-parameter and radiation pattern. The new DRA antenna is compared with three spaced dipoles in a commercial 802.11n terminal in an office environment. The measurements show the compact DRA antenna has similar data throughput in NLOS case and better data throughput in LOS case due to his higher gain. All results show the usefulness of a very compact antenna solution to achieve very efficient antennas at the terminal of MIMO system. Further work is to reduce size of antenna and keep good performances.

Acknowledgment

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