Multiband Antenna Composed of 1 Monopole and 4 Parasitic Poles for In-building Mobile Communication

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Abstract - This paper presents a multiband antenna composed of one monopole and four parasitic poles for the inbuilding mobile system including a firefighting radio band. A center pole is resonated at 450 MHz of the firefighting band, parasitic poles are considered for the multi-resonance and the beam direction control. The measured results such as the reflection coefficients and the radiation patterns of a fabricated antenna are agreed well with the simulation results.

Index Terms — Multiband, Monopole Antenna, Firefighting Radio Service, In-building Mobile Communication.

I. INTRODUCTION

Recently, the mobile communication applications are rapidly developing and also demanded the in-building mobile services [1, 2, 3]. Furthermore, the firefighting radio system at the in-building is strictly required in Korea. A proposed antenna includes the mobile communication band as well as the firefighting radio band. The detailed dimension such as the disc diameter of a ground plane, the height of center pole and parasitic pole, and distance between center pole and parasitic pole creates a considerable impact to the multi resonant frequency of antenna the bandwidth and the matching input impedance. The radiation pattern direction can be controlled by adjustment of the parasitic pole parameters. The simulation results of a proposed antenna are shown reasonable agreement with the measured results.

II. ANTENNA DESIGN

Fig. 1 shows the simulation antenna structure. The main circular pole located on the center of antenna is resonated at 450 MHz of the firefighting band, and four circular parasitic poles are considered for multi-resonance such as 890 MHz band of the LTE, 1.8 GHz band of the PCS, 2.0 GHz band of the WCDMA, and 2.45 GHz band of the Wi-Fi. The FR-4 substrate with the relative permittivity of 4.4+j0.02 is used for antenna design. The limited size of a ground plane is 200 mmØ. The diameter of the whole poles is unified by10 mmØ. Table 1 shows the optimized parameters such as pole length, pole diameter, and distance between center pole and parasitic pole.



Fig. 1. An optimized antenna structure.

TABLE I The optimized parameters by iterative simulation

Parameter	Center	Parasitic	Parasitic	Parasitic	Parasitic
	pole	pole # A	pole # B	pole # C	pole # D
Length	183 mm	76 mm	37.5 mm	40 mm	25 mm
Diameter	10 mm	10 mm	10 mm	10 mm	10 mm
Distance					
between	20 mm	12 mm	12 mm	13 mm	12 mm
center	20 11111	12 11111	12 11111	15 1111	12 11111
pole					

III. MEASUREMENT RESULTS

Fig. 2 shows a photograph of the fabricated antenna structure. Center pole is directly fed by the feeding power and connected by the SMA connector of $3.5 \text{ mm}\emptyset$. Parasitic poles are connected with the substrate on the ground plane.



Fig. 2. A photograph of a fabricated antenna structure.

Fig. 3 shows the simulated and the measured reflection coefficients for the antenna with only center pole, and for the antenna with one center pole and four parasitic poles. The antenna with only center pole is resonated at 450 MHz band in simulation. However, the measured data of the antenna with only center pole show regular interval resonance. The measured results of the antenna with one center pole and four parasitic poles appears a reasonable agreement with the

simulation results. Especially, the measured results are better than the simulated ones at the Wi-Fi band.



Fig. 3. Simulated and measured reflection coefficients.

Fig. 4 shows the measured radiation pattern and the simulation results at the interested band. It shows very good agreement with each other. However, it has a problem of beam pattern variation at higher mode. In order to solve this problem, the ESPAR technology for direction pattern radiation control is considered and the optimization of the parasitic elements are performed [4].



Fig. 4. Simulated and measured radiation patterns.



Fig. 5. Comparison between the simulated and the measured gain when theta equals to 90 ° in the XZ-plane.

Fig. 5 shows Comparison between the simulated and the measured gain when theta equals to 90 $^{\circ}$ in the XZ-plane. It shows reasonable gain at the interested band except for the WCDMA band. It is the future work.

IV. CONCLUSION

The multiband antenna composed of one monopole and four parasitic poles for the in-building mobile system including a firefighting radio band is proposed in this paper. A center pole is resonated at 450 MHz of the firefighting band, parasitic poles are considered for the multi-resonance and the beam direction control. The measured results such as the reflection coefficients and the radiation patterns of a fabricated antenna are agreed well with the simulation results.

The return loss improvement at the Wi-Fi band and the optimum beam direction control by using parasitic elements remain as a future work.

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