Numerical Analysis of Inverted-F Antenna on Side of Small Rectangular Conducting Plate in Vicinity of B5-sized Conducting Plate

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Abstract: The inverted-F antenna on side of rectangular conducting plate of 182mm by 18mm is analyzed by using WIPL-D and IE3D based on the method of moment. This antenna is located in the vicinity of the B5-sized conducting plate. The numerical results by both simulators are compared.

Keywords: Inverted-F antenna, method of moment, WIPL-D, IE3D

1. Introduction

The inverted-F antenna is usually used as the antenna for the mobile communication terminal such as cellular phone, since it is low profile and its input impedance can be arranged to have an appropriate value to match the feed line [1]. The characteristics of this antenna may be affected by the conducting materials in the vicinity of antenna. Therefore, in the design of such antenna, the existence of surrounding material must be considered.

In this paper, the inverted-F antenna mounted on side of rectangular conducting plate of 182 mm by 18 mm is analyzed by using the electromagnetic simulators WIPL-D [2] and IE3D [3]. The conducting plate is located parallel to the B5-sized conducting plate.

2. Analytical model

Figure 1 shows the inverted-F antenna mounted on side of rectangular conducting plate #1 of 182mm by 18mm. This small conducting plate is located parallel to the conducting plate #2 of 182mm by 252mm. The width of antenna element is 2 mm. This antenna is fed by the coplanar waveguide on the conducting plate #1. The calculation frequencies are from 400 MHz to 700 MHz.

In the numerical calculation by WIPL-D, the elements of inverted-F antenna are modeled by the solid cylindrical antennas with its radius 0.5 mm. The conduction plate #1 is divided into three parts. This antenna is excited by the delta-function generator at the junction between the feed element and the corner of conducting plates 1 and 3. Figure 2 shows the segmentation of wire and conducting plate #1. The orders of current expansion polynomials are 2, 3, 1 and 2 for wire 1, 2, 3 and 4, respectively. The orders of polynomials are 4, 3, 1 and 4 for the plate 1, 2, 3 and #2, respectively. Since the coplanar waveguide on the conducting plate #1 does not work as the radiating element, the coplanar waveguide is not considered in the calculation.

In the calculation by IE3D, the antenna is excited by the delta-function generator. The cell size is 21.43 mm, that is 1/20 wavelength at the frequency of 700 MHz. The edge cell is located at the edge of antenna elements and conducting plates in order to consider the singularity of current at edge. The width of edge cell is 0.22

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mm. This is one percent of cell size.

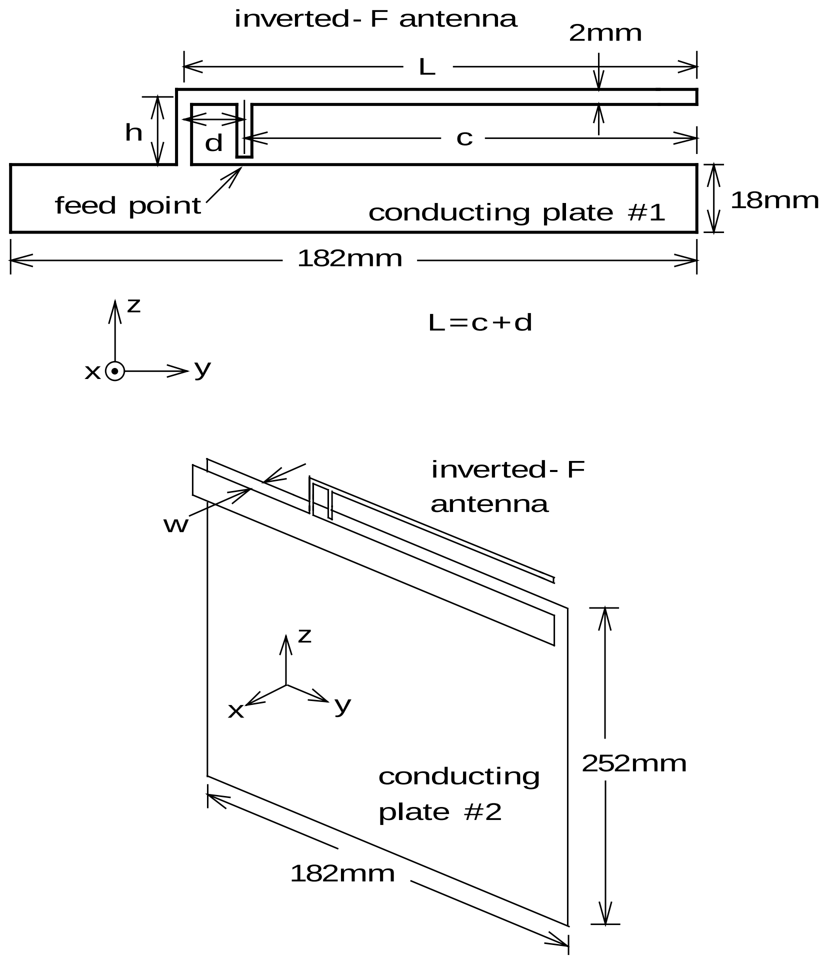

Figure 1 Inverted-F antenna mounted on side of small conducting plate.

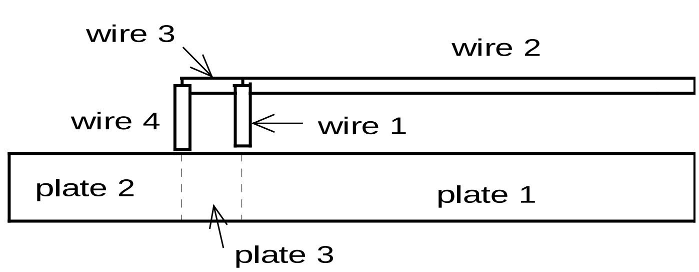

Figure 2 Segmentation of antenna elements and conducting plate #1.

3. Numerical results and discussion

Figure 4 and 5 show the input impedance characteristics calculated by WIPL-D and IE3D. The parameters of antenna are L = 120 mm, h = 11 mm, d = 5 mm, and w = 2mm. The calculated results by IE3D with including the edge cell almost agree with those without the edge cell. This may be that the width of antenna element is very narrow compared with the wavelength. The input resistance of this antenna without conducting plate #2 becomes very low. The difference between the calculated impedance by WIPL-D and IE3D may be due to the difference of modeling on antenna element.

4. Conclusion

The inverted-F antenna mounted on side of rectangular conducting plate of 182 mm by 18 mm has been analyzed by using the electromagnetic simulators WIPL-D and IE3D. The conducting plate is located parallel to the conducting plate of 182 mm by 252 mm. The measured characteristics of this antenna will be shown at the conference. Although this antenna is small, the actual gain of this antenna becomes higher by loading the amplifier circuit between the feed point and the coplanar waveguide on conducting plane [4], [5] .

References

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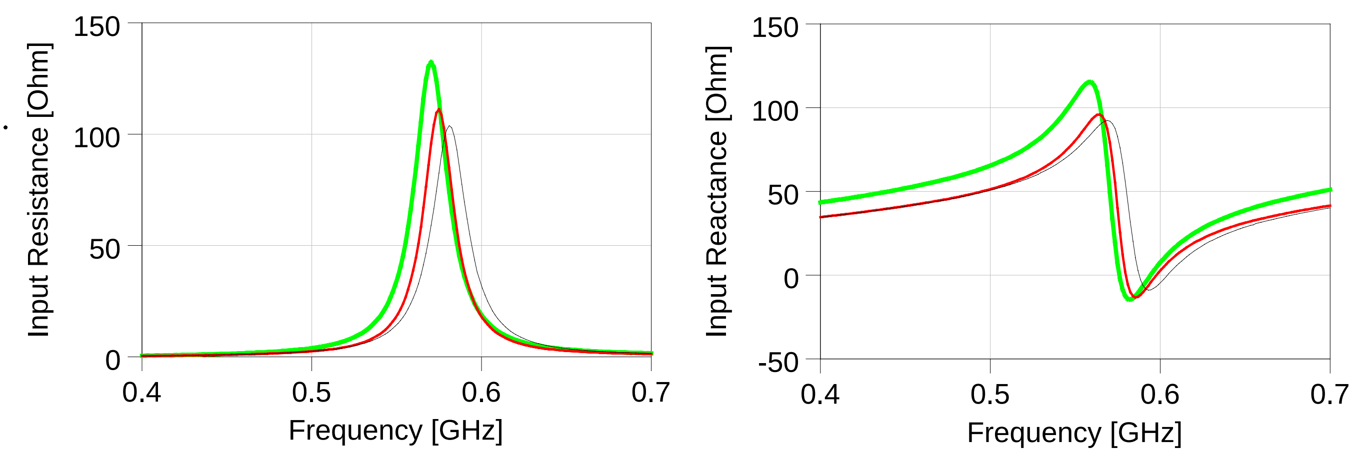


Figure 3 Calculated input impedance characteristics.
L=120mm, h=11mm, d=5mm, w=2mm
—— WIPL-D —— IE3D —— IE3D (without edge cell)

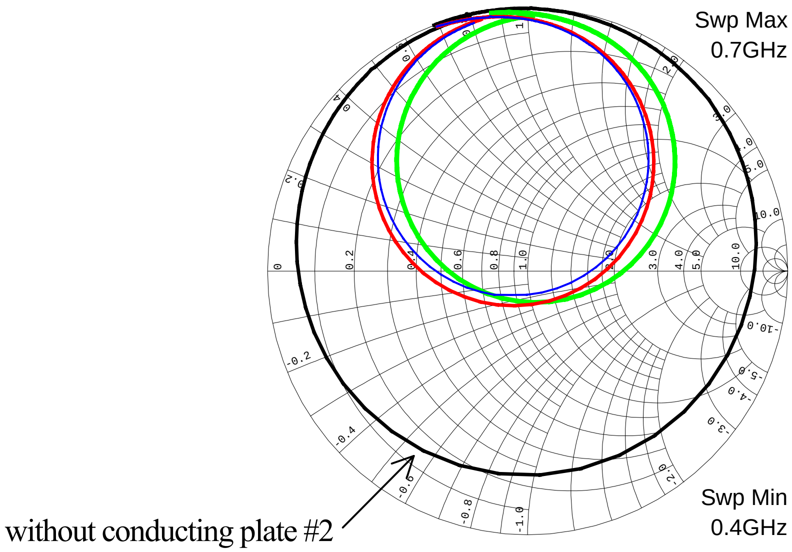
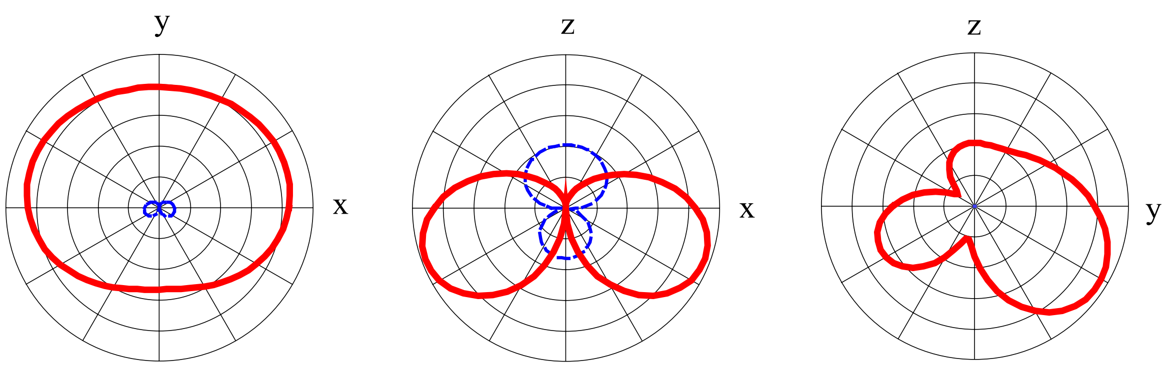
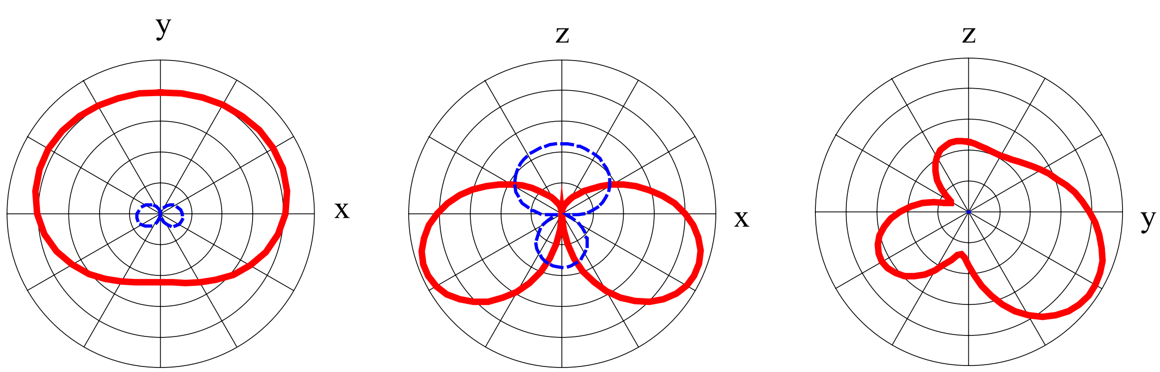


Figure 4 Calculated input impedance characteristics.
L=120mm, h=11mm, d=5mm, w=2mm
—— WIPL-D —— IE3D —— IE3D (without edge cell)



(a) Calculated by WIPL-D



(b) Calculated by IE3D

Figure 5 Electric field radiation patterns. Frequency=550 MHz
—— θ component - - - ϕ component