POS2-3

Application of Planar Folded Dipole Antenna with Feed Line to Small Terminal for WiMAX

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1. Introduction

Planar folded dipole antenna (PFDA) with feed line which is approximately quarter wavelength has been reported [1]. However, the feed line is too long to be mounted on a small terminal. In this paper, in order to amount the antenna to a small terminal for WiMAX, we investigate miniaturization of the feed line and characteristics of the antenna on the small ground plane (50 mm×80 mm). The planar folded dipole antenna on the ground plane has two resonance mode. Moreover, the impedance characteristic can be modified by adjusting the width of antenna and feed line. A proposed antenna has wideband characteristic which covers the bandwidth of 2.5 GHz band and 3.5 GHz band (2.3 GHz ~ 3.8 GHz) for WiMAX with a feed line of approximately one eleventh wavelength.

2. Antenna Structures

Figure 1(a) shows the configuration of PFDA with feed line. The antenna length is *la*, and the widths of the upper and lower element are wa_1 and wa_2, respectively. The spacing between them is wa_3. Also, the feed line consists of two parallel lines with length *lf*, width *wf*, and spacing between the two lines *sf*. The desired frequency is set to be 3 GHz, which is almost the same as the center frequency of WiMAX bandwidths of 2.5 GHz band and 3.5 GHz band. Then, since the wavelength λ_0 is 100 mm, the values of *la* and *lf* are set to be 50 mm and 25 mm, respectively. The others parameters are set to 3 mm. Figure 1(b) shows PFDA with feed line which is mounted on a ground plane. The ground plane is 50 mm×80 mm. We call this model planar model. Furthermore, Figure 1(c) shows the FDA with feed line which is folded at the feed line. We call this model 3D model.

3. Results

3.1 The effect of the ground plane

Figure 2 shows the comparison of the impedance characteristics when PFDA with feed line is mounted to the ground plane. The VSWR characteristics do not change so much between 2.3 GHz~3.8 GHz. Therefore, we can investigate the antenna characteristics on the ground plane.

3.2 Parameter study

Figure 3 shows the impedance characteristics when *wf* is changed from 3 mm to 9 mm. As *wf* is increased, the impedance is moved to the left on the smith chart, where the impedance is smaller. This is because the characteristic impedance of the feed line becomes small according to the width of *wf*. As a whole, the antenna impedance becomes small as shown in Fig.3. Figure 4 also shows the impedance characteristics when wa_2 is increased from 3 mm to 9 mm. The impedance rotates clockwise, and antenna impedance is transformed to larger impedance. The antenna impedance becomes smaller than 300 Ω when the wa_2 becomes larger than wa_1 because the step-up ratio [2] of PFDA is changed.

3.3 Investigation of 2D and 3D model

We shorten the feed line from 25mm to 9mm. Then, antenna parameters which are studied in the previous section are changed in order to match the input impedance. Figure 4 shows the changes of the impedance characteristics. *wf* and wa_2 are adjusted from 3 mm to 10 mm and from 3 mm to 6 mm, respectively. Then, the values of VSWR become less than 3 from 2.06 GHz to 4.18 GHz.

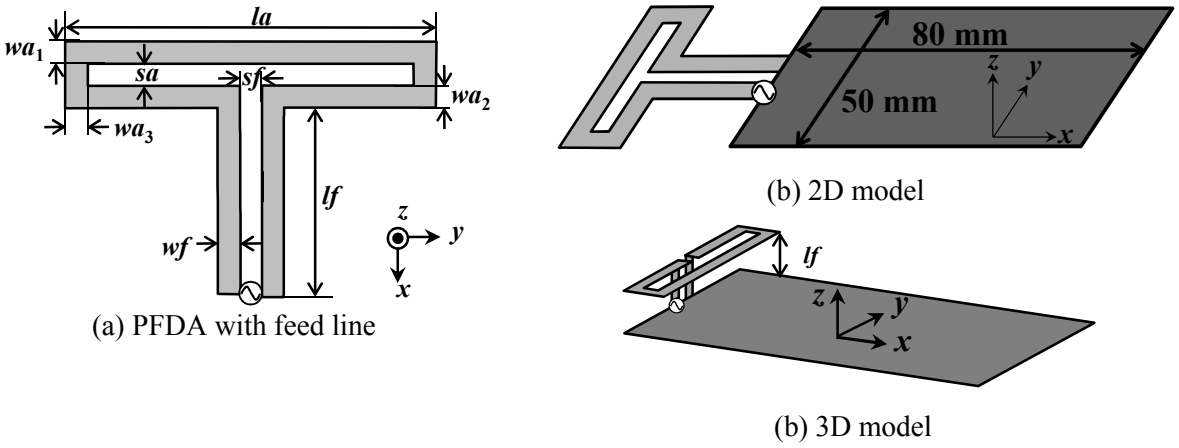
Figure 5 shows the comparison of impedance characteristics when the feed line is folded like Figure 1(c). Because of the effect of the ground place, the adjustment of antenna parameters is needed. When wa_2 is changed from 6 mm to 10 mm, VSWR becomes less than 3 in the desired bandwidth. Figure 6 shows the measured and calculated values of VSWR. The characteristics are very similar, and VSWR becomes less than 3 from 1.47 GHz to 3.93 GHz by the measure values, which means the relative bandwidth is about 90% and satisfies the desired bandwidth.

3.4 Radiation characteristics

Figure 7 shows the radiation patterns. Frequencies are 2.3 GHz and 3.8 GHz, where the lowest and highest frequency of the target band. The patterns are very similar between measured and calculated values, and the gain is more than 1 dBi at each plane.

4. Conclusion

In this paper, we have studied on application of PFDA with feed line to a small terminal for WiMAX. It has been confirmed that the characteristics of PFDA are not affected by the ground plane, and miniaturization of the feed line is possible by changing the parameter wa_2 and *wf*. Also, when wa_2 and *wf* are changed to 10 mm, the proposed antenna covers the bandwidth from 1.47 GHz to 3.93 GHz, which completely satisfies the 2.5GHz band and 3.5GHz band of WiMAX.

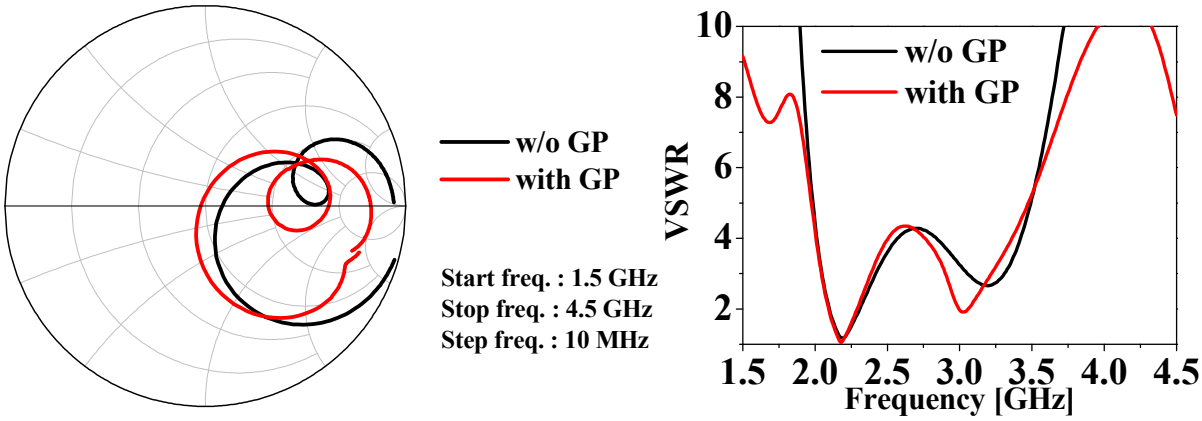


(a) PFDA with feed line

(b) 2D model

(b) 3D model

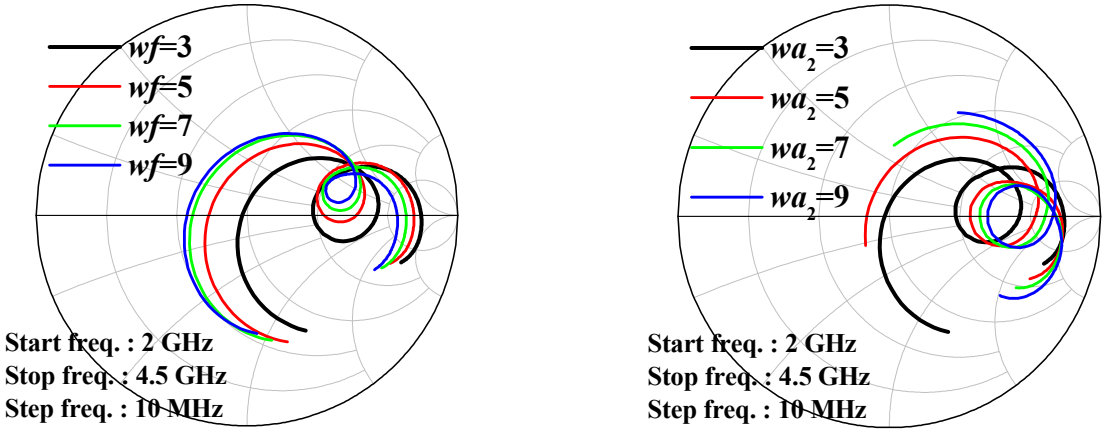
Figure 1: Antenna structures



(a) Smith chart

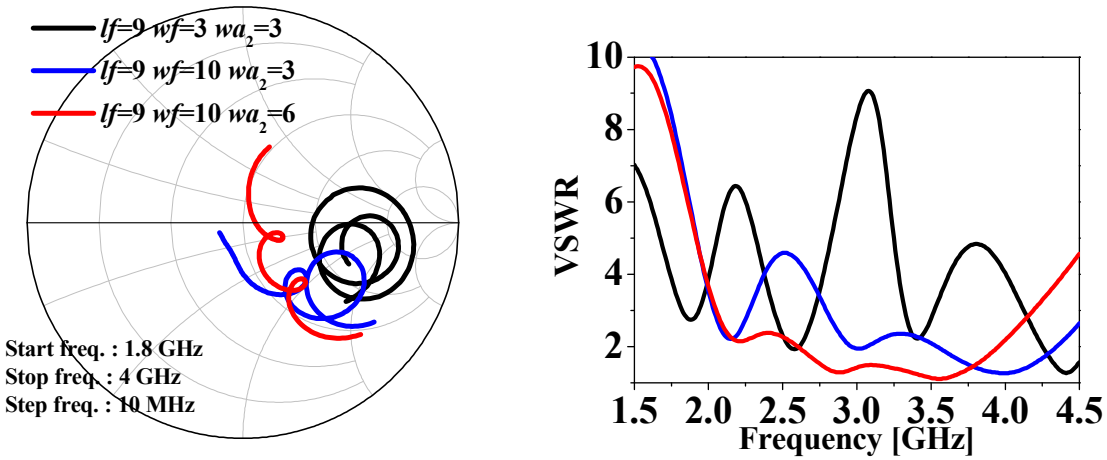
(b) VSWR characteristic

Figure 2: Impedance characteristics



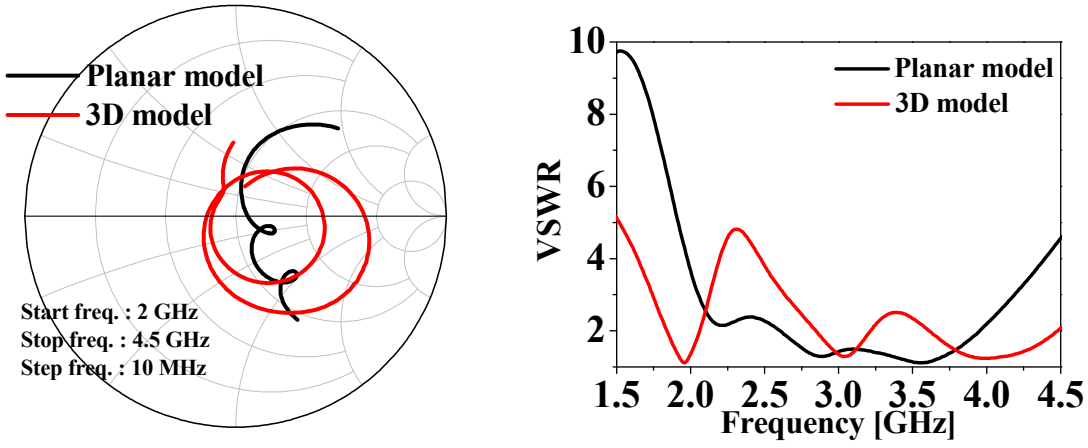
(a) When wf is changed (b) When wa2 is changed

Figure 3: Parameter study



(a) Smith chart (b) VSWR characteristics

Figure 4: Impedance characteristics



(a) Smith chart (b) VSWR characteristics

Figure 5: Impedance characteristics

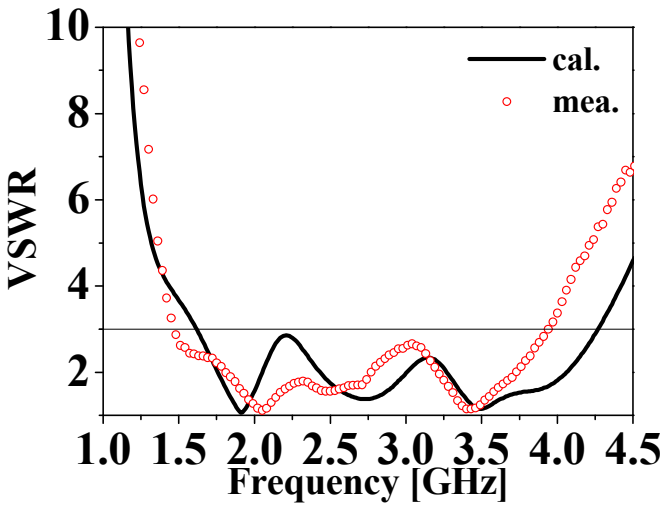


Figure 6: VSWR characteristics of proposed antenna

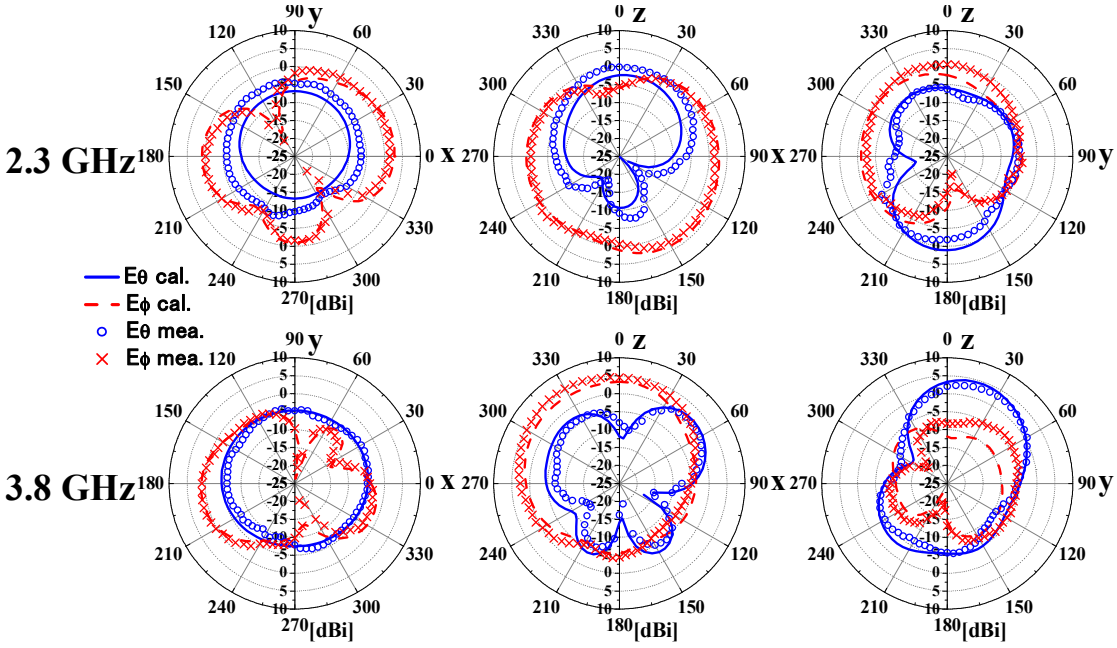


Figure 7: Radiation Patterns

References

[1] M. Nagatoshi, S. Tanaka, S. Horiuchi and H. Morishita, "Broadband characteristics of a planar folded dipole antenna with a feed line", IEICE Trans. Commun., vol.E94-B, no.5, pp.1168-1173, May 2011.

[2] C.A. Balanis, Antenna Theory Analysis and Design, 3rd ed,. John Wiley & Sons, 2005.