Input and Radiation Characteristics of 120^o Beam Antenna Covered with Cylindrical Radome

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1 Introduction

Interaction between radiation element and dielectric radome is known as a complicated problem. In design and development of mobile communication's base station antenna, because the frequency band till now is low to ignore the influence of dielectric radome, there isn't big problem occurred. But the next generation system, which is famous known as IMT-2000, because the frequency band is around 2GHz, it is necessary to count the effect of radome in antenna's design. And the far field radiation pattern of antenna with dielectric radome also will change from the case of element only. It is necessary to investigate the change of antenna's input characteristic and radiation pattern due to cylindrical radome.

In previous papers, in order to estimate the basic characteristic due to cylindrical radome, we reported input characteristic of $\lambda/4$ monopole antenna due to parameters(radius, thickness, permittivity constant) of dielectric cylindrical radome.

To reduce the influence of cylindrical radome, install radiation element away from dielectric radome is usually adopted. But this will lead increases of radius and weight of radome directly. For base stations that is installed at the outdoor environment, the suitable characteristic on corrosion resistance and loading because of wind pressure are required. In this paper, we investigate input and radiation characteristics of print dipole antenna with reflector due to installation location in cylindrical radome. And from the measurement result, we propose the most suitable installation way of radiation element and the most effective radius of radome.

2 Measurement Model

Fig. 1 shows the measurement model. Radiation element is constructed by printed dipole antenna on a substrate($\epsilon_r = 2.6$) and reflector with $\lambda/2$ in width. The resonant frequency of radiation element is around 2.0GHz. And the HPW(Half Power Width) is around 120^o. The radiation element is installed in a cylindrical radome($\epsilon_r = 4.7$). Thickness of dielectric radome(T_c) is 4[mm]. Radius of radome(R_{in}) are 46[mm] and 76[mm], respectively. The parameter *Offset* is defined as radiation element's location. By moving the radiation element parallel to the x-axis, input and radiation characteristic due to installation location can be obtained. Value of *Offset* > 0 and *Offset* < 0 mean the radiation element is located on the positive and negative direction of x-axis, respectively.

3 Input and Radiation Characteristics due to *Offset*

By using parameters as mentioned previously, the measurement is carried out. Fig. 2 and Fig. 6 show the return loss characteristics due to *Offset* when radius of radome (R_{in}) are 46[mm] and 76[mm]. We notice that both resonant frequency and bandwidth change greatly in most cases.

In order to estimate the input characteristic, the bandwidth ratio of VSWR < 2.0 and VSWR < 1.5 is examined. The bandwidth ratio is defined as $(f_{high} - f_{low})/f_0$. Fig. 3 and Fig. 7 show the bandwidth ratio due to *Offset* when radius of radome (R_{in}) are 46[mm] and 76[mm]. Dash lines show at level of 32% and 21% are bandwidth ratio of without radome case. In order to examine the change of half power width(HPW) due to *Offset*, we select the half power width of element only(without radome) HPW_r as the reference.

From the result of cylindrical radome has a small radius(Fig. 3), we notice that as the increase of *Offset*, in other words, as we move the radiation element toward the inside wall of radome, the bandwidth ratio is increasing. And when *Offset* is larger than 0.02[m], the bandwidth ratio that is over the level of without radome case is obtained. The case of we install radiation element near the inside wall of radome got the largest bandwidth ratio. The reason is considered that dielectric radome resonate with radiation element when we install radiation element near by the radome. Next the radiation characteristic is carried out. Fig. 4 and Fig. 5 show H-plane radiation pattern and half power width HPW_0 normalized by reference level, characteristic of HPW_0/HPW_r due to *Offset*. From figures, we notice that as *Offset* increase, HPW_0 also increases. This result indicates that the dielectric radome resonate with radiation element when we move element toward the inside wall of radome.

Next, measurement of case of cylindrical radome has a large radius is carried out. We examine cases of radiation element installed on positive and negative direction of x-axis. From result of the location is on negative direction of x-axis(*Offset* < 0), we notice that bandwidth ratio obtains a higher level compare to the case of radiation element is on the center position(*Offset* $= 0$). And case of bandwidth ratio larger than without radome case are also observed(Fig. 7). From results of radiation pattern(Fig. 8 and Fig. 10), same changes are observed. The reason is considered that when we install radiation element on negative direction of x-axis, distance between element and side wall is enough small to lead resonant of radome. And when we focus the input and radiation characteristic of case of we install radiation element on positive direction of x-axis(Fig. 7, 9 and 10), we got as same result as case of radome that has a smaller radius.

It is well know that because the wavelength propagated in dielectric material is shorter than in the free space, dielectric material will cause a lower frequency and narrower bandwidth compare to without radome case. But from curves be shown in this paper, we notice that the bandwidth ratio reaches to high level compare to without radome case when we install radiation element near by the radome. So we conclude that the most suitable installation location of element is inside wall of dielectric radome. And the radius of cylindrical radome also can be reduced greatly.

4 Conclusion

In this paper, we reported input and radiation characteristic of printed dipole antenna with 120^o beam covered with cylindrical radome due to installation location in radome. From measurement results, we conclude that input impedance is easily influence by parameters of radome. The most suitable installation location of element is near by inside wall of dielectric radome. And the radius of cylindrical radome can be reduced greatly.

References

[1] R. Orta, etc., IEEE Trans. on Antenna & Propag., Vol. 36, No. 12, Dec. 1988.

[2] S. R. Rengarajan etc., IEEE Trans. Antenna & Propag., Vol. 36, No. 3, March 1988.

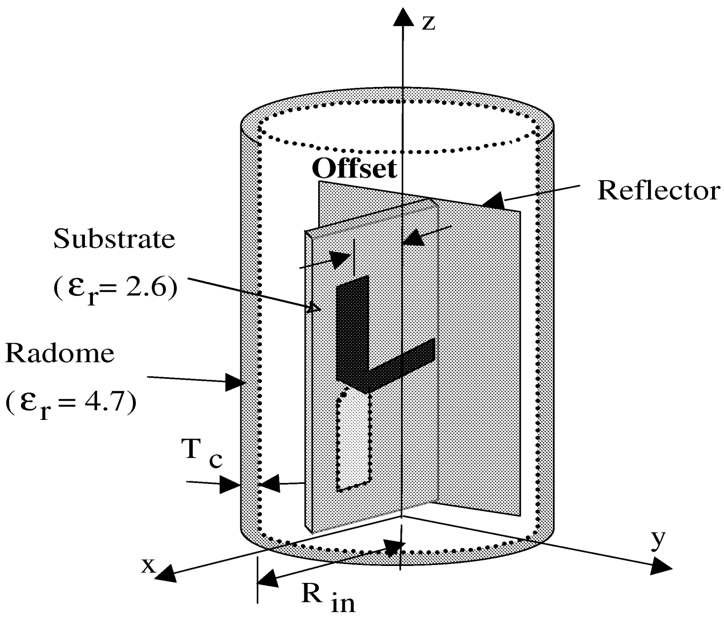

Figure 1: Measurement model

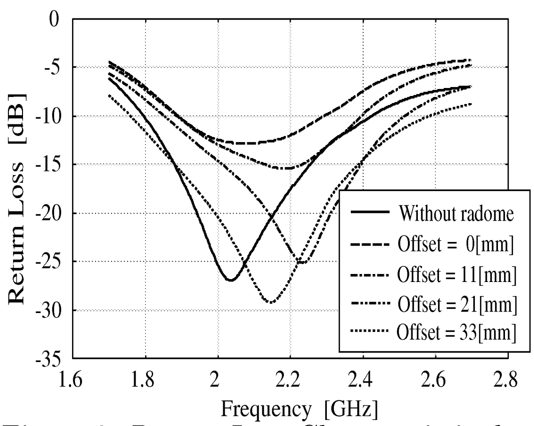

Figure 2: Return Loss Characteristic due to Offset from center of Radome(f_r = $2.0[GHz], \epsilon_r = 4.7, R_{in} = 46mm(0.31\lambda_0)$)

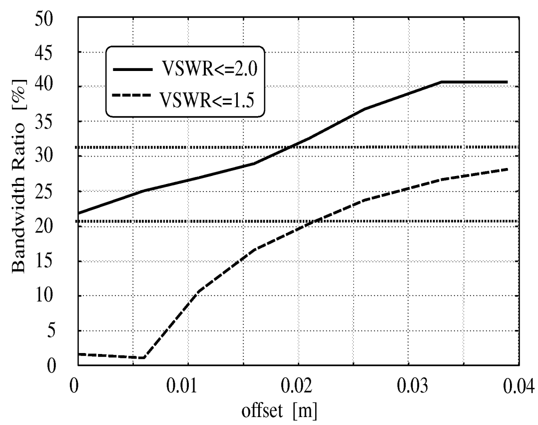

Figure 3: Bandwidth Ratio due to Offset from center of Radome(f_r = $2.0[GHz], \epsilon_r = 4.7, R_{in} = 46mm(0.31\lambda_0)$)

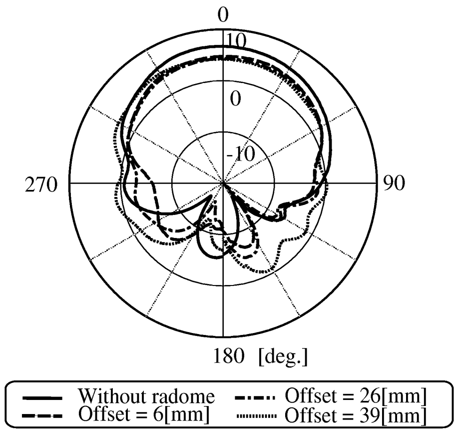

Figure 4: Radiation Pattern of x-y plane(f_r = $2.0[GHz], \epsilon_r = 4.7, R_{in} = 46mm(0.31\lambda_0)$)

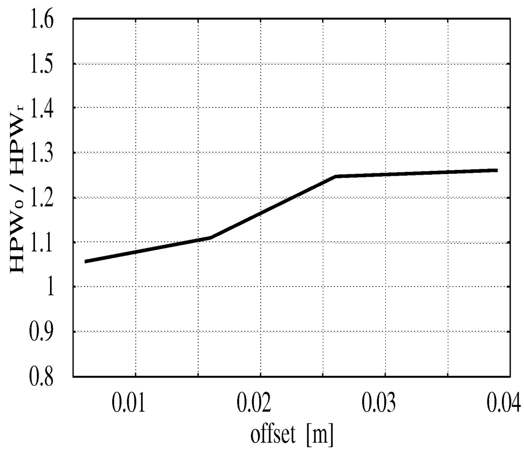

Figure 5: Half Power Width due to Offset from center of Radome(f_r = $2.0[GHz], \epsilon_r = 4.7, R_{in} = 46mm(0.31\lambda_0)$)

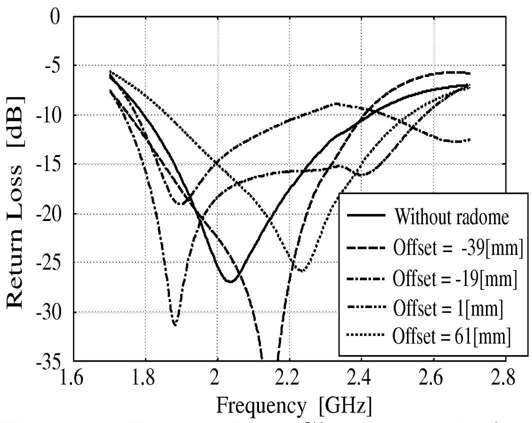

Figure 6: Return Loss Characteristic due to Offset from center of Radome($f_r = 2.0[GHz], \epsilon_r = 4.7, R_{in} = 76mm(0.51\lambda_0)$)

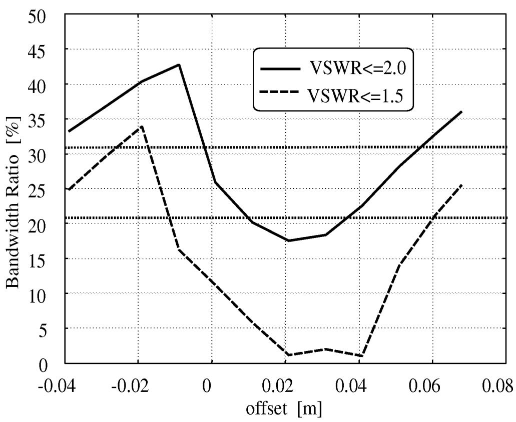

Figure 7: Bandwidth Ratio due to Offset from center of Cylindrical Radome($f_r = 2.0[GHz], \epsilon_r = 4.7, R_{in} = 76mm(0.51\lambda_0)$)

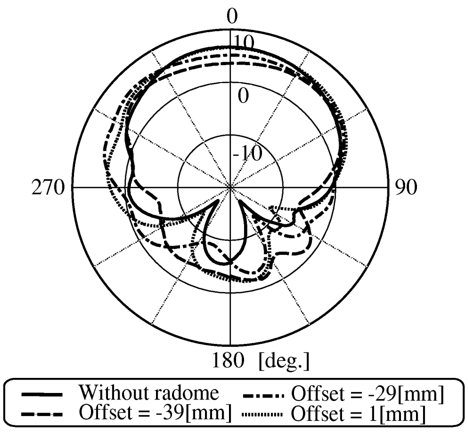

Figure 8: Radiation Pattern of x-y plane($f_r = 2.0[GHz], \epsilon_r = 4.7, R_{in} = 76mm(0.51\lambda_0)$)

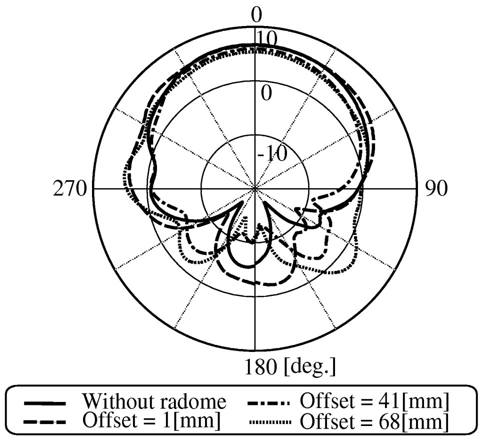

Figure 9: Radiation Pattern of x-y plane($f_r = 2.0[GHz], \epsilon_r = 4.7, R_{in} = 76mm(0.51\lambda_0)$)

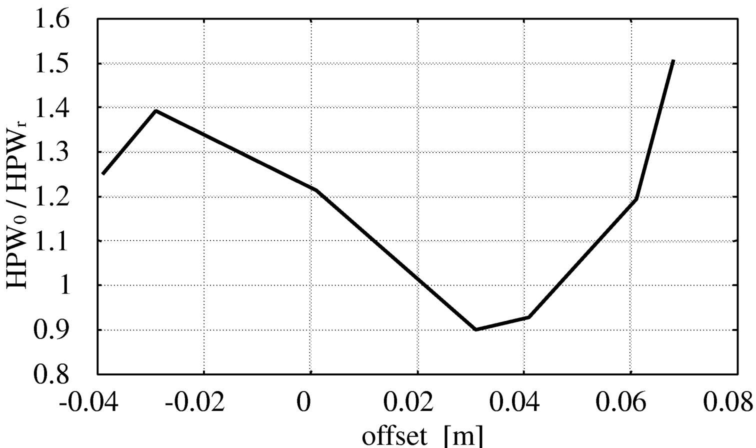

Figure 10: Half Power Width due to Offset from center of Radome($f_r = 2.0[GHz], \epsilon_r = 4.7, R_{in} = 76mm(0.51\lambda_0)$)