Proceedings of ISAP 2014, Kaohsiung, Taiwan, Dec. 2-5, 2014

Bandwidth Characteristics of Printed Dipole Antenna with Artificial Magnetic Conductor Reflector

Yasutaka Murakami, Toshikazu Hori and Mitoshi Fujimoto
[1] Graduate School of Engineering, University of Fukui, 3-9-1, Bunkyo, Fukui, 910-8507 Japan

***Abstract* – This paper describes the printed dipole antenna impedance that is calculated using the ideal reflection phase of the AMC. Moreover, the optimum reflection phase of the AMC reflector for best relative bandwidth is described. From the result, the wide *RBW* was realized by the low distance of the printed dipole antenna and *RBW*$_{PMC}$ = 20 ~30%. Moreover, the printed dipole antenna distance that had the widest *RBW* was shown.**

***Index Terms* — Impedance, Reflector, Artificial Magnetic conductor, printed dipole antenna.**

I. INTRODUCTION

An antenna with an AMC (Artificial Magnetic conductor) reflector can realize the higher gain and low-profile [1] [2]. Therefore, the study of the antenna with AMC reflector is actively. However, research of the impedances of the printed dipole antenna with the AMC reflector is not enough yet. Moreover, the impedance of printed dipole antenna with AMC reflector depends on the reflection phase and many factor of configuration of AMC. For example, the factors are the AMC thickness, the unit size and the shape of unit. Therefore, the design of reflection phase of AMC for best bandwidth characteristics is hard.

This research describes the printed dipole antenna impedance that is calculated by the approximate equation and ideal reflection phase of AMC. Moreover, the reflection phase of AMC reflector for best relative bandwidth will be described.

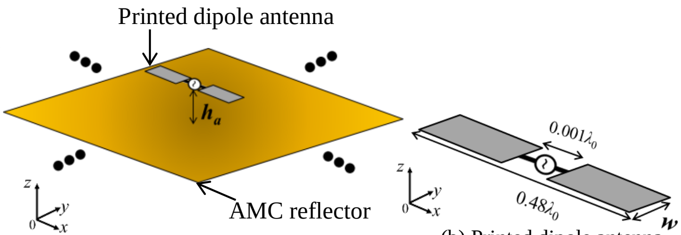
II. STRUCTURE OF PRINTED DIPOLE ANTENNA WITH AMC REFLECTOR

Fig. 1 shows the configuration of the printed dipole antenna with the AMC reflector. Here, the frequency f_0 is resonant frequency (λ_0 : wavelength). Moreover, the impedance of printed dipole antenna with AMC reflector is leaded by Eq. (1) [3].

$$Z = Z_{11} + Z_{12}e^{i\phi} \quad (1)$$

Here, Z_{11} and Z_{12} are self-impedance and mutual impedance, respectively. There are analyzed by the MOM (EEM-MOM). And ϕ is the reflection phase of reflector. In the case of a PMC (Perfect Magnetic Conductor), ϕ is 0° at all frequencies. On the other hands, the ideal reflection phase is calculated by Eq. (2) and Eq. (3).

$$\phi = 2\tan^{-1}\left(\frac{1}{\beta k} - \frac{2RBW_{PMC} \cdot f}{f_0}\right) \quad (2)$$



(a) Bird view (b) Printed dipole antenna
Fig. 1 Printed dipole antenna with AMC reflector

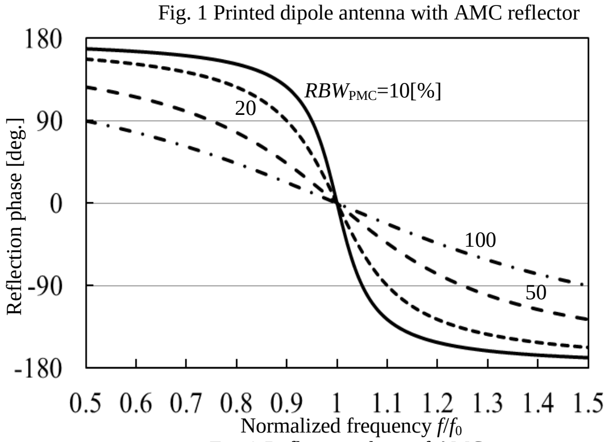


Fig. 2 Reflection phase of AMC

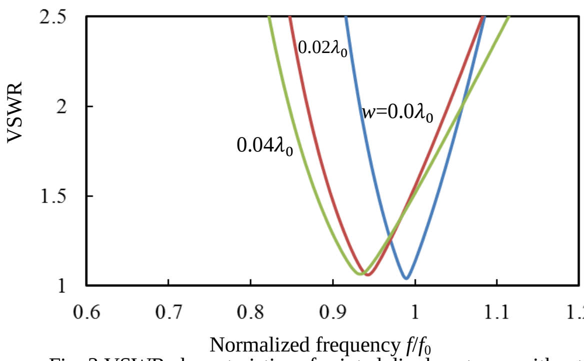


Fig. 3 VSWR characteristics of printed dipole antenna without reflector

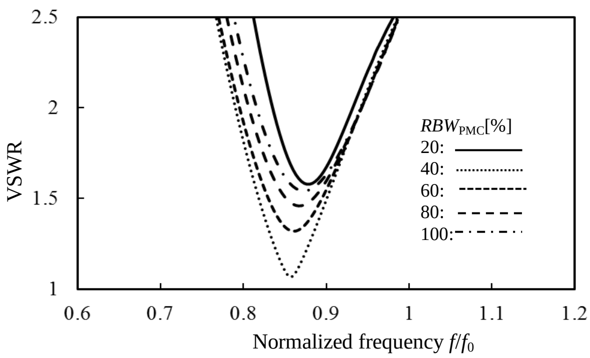


Fig. 4 VSWR characteristics of printed dipole antenna with reflector

$$k = 4\pi\lambda_0 \cdot RBW_{\mathrm{PMC}}/\tan(\pi/4) \qquad (3)$$

Here, RBW_{PMC} is the relative bandwidth of the AMC of the reflection phase within $\pm$ 90°. And β and f are the propagation constant and the frequency, respectively. Fig.2 shows the reflection phase by the Eq. (2). Moreover, the frequency characteristics of the printed dipole antenna is changed by the width w. Fig. 3 shows the VSWR characteristics of printed dipole antenna without the AMC reflector. From Fig. 3, the relative band width (VSWR < 2.0) increases by the wide w.

III. Relationship between Reflection Phase and Antenna Impedance

Fig. 4 shows the VSWR characteristics of the printed dipole antenna with the AMC reflector that is calculated by Eq. (1) and (2). In Fig.4, the parameter is the RBW_{PMC}. The printed dipole antenna width w is $0.02\lambda_0$ and distance h_a is $0.02\lambda_0$. From Fig. 4, it is found that the VSWR depends on the reflection phase of the AMC. The VSWR < 2.0 is realized at all AMC.

Fig.5 shows the influence of the RBW_{PMC} on the *RBW*. Here, the *RBW* is the relative bandwidth of the printed dipole antenna with the AMC reflector that realizes VSWR < 2.0. From Fig. 5, it is found that the *RBW* has the peak at RBW_{PMC} = 40%. Moreover, the *RBW* of the printed dipole antenna with AMC reflector is wider than *RBW* of the printed dipole antenna without reflector.

Fig. 6 shows the relationship between the reflection phase of AMC and the *RBW*. In Fig. 6, the vertical and horizontal axes are RBW_{PMC} and the distance h_a, respectively. And the brightness shows the *RBW* of the printed dipole antenna with the AMC reflector. From Fig. 6, it is found that the *RBW* is wide when the distance h_a is low and RBW_{PMC} = 20 ~30%. Moreover, the Fig. 6(a) and (b) have same tendency.

Fig. 7 shows relationship between the optimum distance h_a and the RBW_{PMC}. Here, the optimum distance is the distance that has the widest *RBW* each RBW_{PMC}. From Fig. 7, it is found that the optimum distance doesn't change in the case of the dipole antenna. On the other hands the optimum distance changes in the case of w = 0.02 and $0.04\lambda_0$. The optimum distance is $0.01\lambda_0$ when the $RBW_{\mathrm{PMC}} \leq 40\%$. And the optimum distance is $0.06\lambda_0$ when the $RBW_{\mathrm{PMC}} > 40\%$.

IV. Conclusion

This paper described the printed dipole antenna impedance that was calculated using the ideal reflection phase of the AMC. Moreover, the optimum reflection phase of AMC reflector for best relative bandwidth was described. From the result, the wide *RBW* was realized by the low distance of the printed dipole antenna and RBW_{PMC} = 20 ~30%. Moreover, it was shown that the optimum distance changed in the case of w = 0.02 and $0.04\lambda_0$. The optimum distance was $0.01\lambda_0$ when the $RBW_{\mathrm{PMC}} \leq 40\%$. And the optimum distance was $0.06\lambda_0$ when the $RBW_{\mathrm{PMC}} > 40\%$.

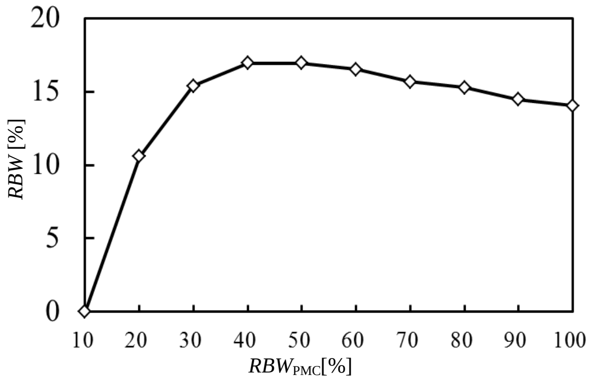
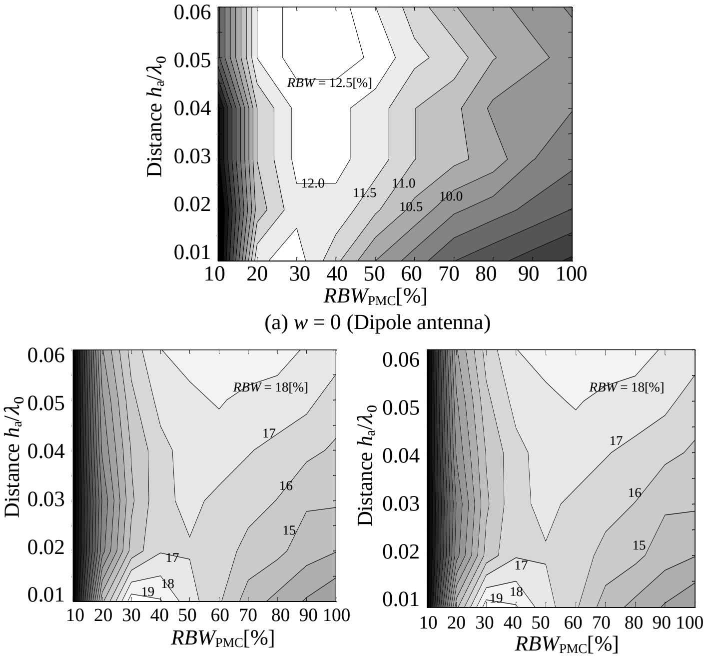


Fig. 5 *RBW* of printed dipole antenna with reflector (h_a=$0.02\lambda_0$)



(a) w = 0 (Dipole antenna)

(b) $w = 0.02\lambda_0$ (c) $w = 0.04\lambda_0$

Fig. 6 Relationship between reflection phase of AMC and *RBW*

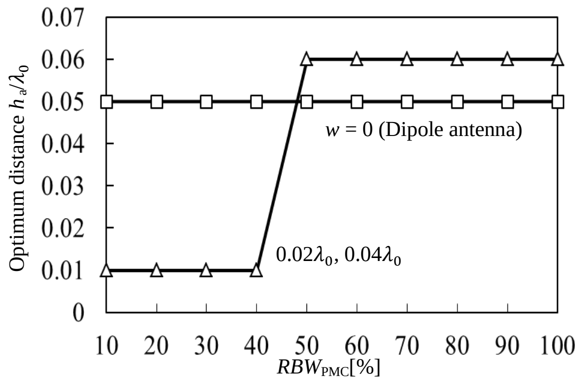


Fig. 7 Optimum distance for widest *RBW*

References

[1] A.P.Feresidis, G.Goussetis, S.Wang, and J.C.Vardaxoglou "Artificial magnetic conductor surfaces and their application to low-profile high-gain planer antennas," *IEEE Trans. AP*, vol.53, no.1, pp. 209-215, Jan.2005.

[2] Y.Murakami, T.Hori, and M.Fujimoto, "Optimum reflector configuration for dipole antenna by using artificial magnetic conductor," *Proc. iWAT2013*, Karlsruhe, Germany, pp. 279-282, Mar. 2013.

[3] M. Faisai Abedin, M. Ali, "Effect of EBG reflection phase profiles on the input impedance and bandwidth of ultrathin directional dipoles," *IEEE Trans. AP*, vol.53, no.11, pp. 3664-3672, Nov., 2005.