The Positional Effect of Array Curved Strip Dipole On Electromagnetic Band Gap Reflector Plane

N. Fhafhiem , P. Krachodnok , and R. Wongsan
School of Telecommunication Engineering,
Suranaree University of Technology, Nakhonratchasima, Thailand 30000
M5140732@g.sut.ac.th

Abstract

This paper proposes the array antenna for RFID reader by using two curved strip dipole, which are mounted on mushroom-like electromagnetic band gap (EBG) and the feed point is excited at the center of each one. The EBG is capable of providing a constructive image current within a certain frequency band. In this study, the array position has the effect of the antenna's performance.

Keywords : Curved Strip Dipole Antenna, Electromagnetic Band Gap, Array Antenna

1. Introduction

In recent years, the communication community showed a very particular interest of a new technology for the improvement of the performances of antenna. Its matter of the technology of EBG structure is providing a constructive image current periodical cell which is composed of metallic and dielectric elements. When the EBG structure is excited by external source, it can be suppress the surface wave and will be coupled the wave out from the slots, which is equivalent to the leaky wave radiation [1]. Because the operational frequency band is the overlap of the input-match frequency band and the surface-wave frequency band, the reflection phase curved can be used to identify the input-match frequency band inside of which a curved strip dipole exhibits a return loss [2]. In [3], we show the good performance single curved strip dipole on EBG ground plane. This paper is a sequel and study an array curved strip dipole elements. The array is analyzed using the CST Microwave studio 2009. The appropriate position of the array radiating elements is presented and discussed. The proposed antenna is usually placed at the top of pole on expressway for RFID reader that the way has the bad field of vision such as foggy, smoke and raining.

At first, we present about configuration geometry of propose curved strip dipole antenna and EBG structure (Sect. 2). Next, the positions study of the radiators array with two elements on EBG surface in Sect. 3. Finally, the conclusions are given in Sect. 4.

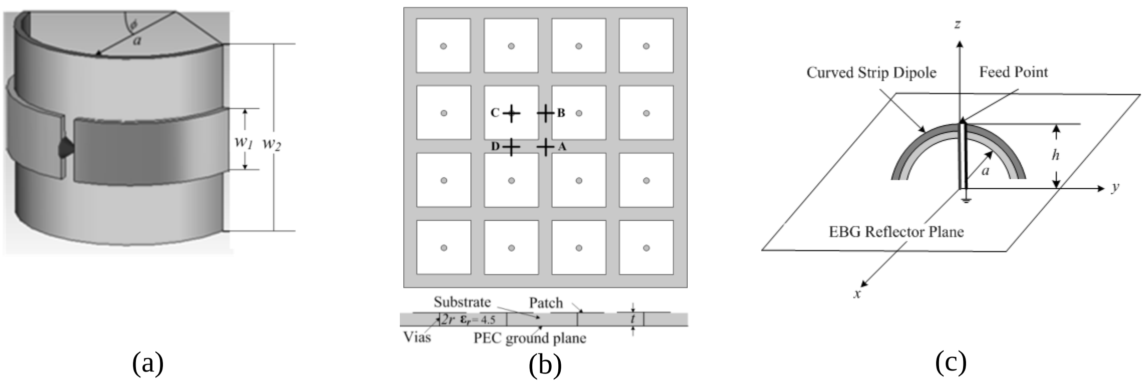


Figure 1: The Compositions of Array Antenna (a) Curved Strip Dipole, (b) Mushroom-like EBG Structure and (c) 3D View of Curved Strip Dipole on EBG.

2. Geometry of a Curve Strip Dipole Antenna and Mushroom-like EBG

The curved strip dipole structure designed with rectangle PEC (at 1 mm thickness) on the polyvinyl chloride (PVC) with the dielectric constant of 3.4 is shown in Fig. 1(a). The resonant frequency is 2.45 GHz which the initial parameters of curved strip dipole antenna are illustrated in Table 1 [3]. The feed point of curved strip dipole is connected at the center of dipole ($\phi = \pi / 2$) and the spacing between two arms of dipole is assumed that it has minimum width. Fig. 1(b) shows the EBG structure which is composed of patches, dielectric, and ground plane which is designed to have a reflection phase of zero at 2.45 GHz. Moreover, we optimize the reflection phase value that is proper with the *h* parameter. The physical dimension of 4×4 elements EBG structure desiged on 1.6 mm thickness FR-4 substrate with dielectric constant 4.5, which the parameter of EBG are concluded in Table 1 [3]. From previous paper, the distance between radiating element and EBG surface is $h = 0.24\lambda$ which is shown in Fig. 1(c).

The return loss results shown in Fig. 2 are for curved strip dipoles whose centers are located between EBG patches at position A, B, C, and D as shown in Fig. 1(b). Curved strip dipoles with different center locations have been simulated to test the positional effect of the curved strip dipole model. Although the return loss may change a bit for each curved strip dipole, it still exhibits a return loss better than -10 dB inside the input-match frequency band obtained in Fig. 2.

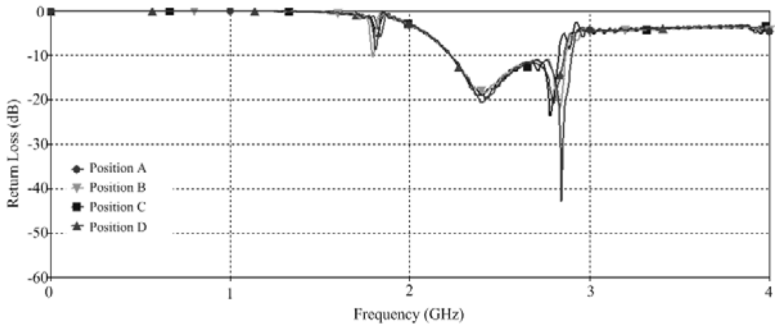


Figure 2: The Positional Effect of the Curved Strip Dipole on EBG

(a) (b)

Figure 3: Feed Center of Radiator (a) 1×2 Array Elements and (b) 2×1 Array Elements.

3. The Positions Study of Curved Strip Dipole Array on EBG Surface

In Fig. 3, a curved strip dipole antenna array with 1×2 elements and 2×1 elements, the feed center of radiating elements are placed over EBG ground plane in the location between EBG patches where is position A in Fig. 1(b). For optimized the distance of two array elements, the parameter *d* is begun of 0.6λ , and then, it is reduced from 0.6λ to 0.4λ .

On the basis of array antenna, the distance between the two elements of curved strip dipole antenna (*d*) is 0.5λ . In this study, *d* is changed for the proper length EBG surface. When, $d = 0.4\lambda$, 0.44λ , 0.47λ , 0.5λ , 0.55λ , 0.58λ and 0.6λ , the simulation results are shown in next sub-headings. These are return loss, near-field levels and radiation patterns.

3.1 **Return Loss**

Fig. 4(a) illustrates the return loss of 1×2 array element case, the length between two element will be adjusted. It obvious that the return loss may change a bit for each location. All of lengths are matching but the length of 0.58λ is the appropriate distance that yields the minimum return loss at -36.64 dB. In Fig. 4(b), the 2×1 array element case is used. Because the current at the both ends of curved strip dipole is not zero and the ends of each radiating elements are very close, the mutual coupling is occurred a lot. The length of 0.55λ is the is the appropriate distance that yields the minimum return loss at -22.63 dB, it has poor performance more than 1×2 array element case.

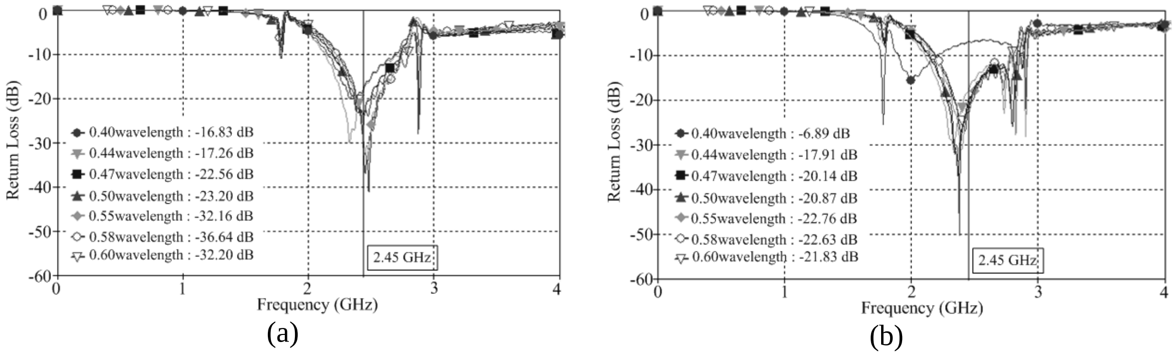


Figure 4: Return Loss (a) 1×2 Array Elements and (b) 2×1 Array Elements.

3.2 **Near-fields Distribution on Ground Plane**

This section is illustrated the near fields that occurred on ground plane with 1×2 elements and 2×1 elements array antenna on EBG surface at the resonant frequency 2.45 GHz. The results of near-field found that the near-field levels at the ends of EBG surface will be increase if the length *d* is increased. Anywise, if the distance between two radiating elements is decreased, the mutual coupling will be increase. From simulation, when the distance *d* of 1×2 and 2×1 elements array antenna are 0.58λ and 0.55λ, respectively, the near-field levels has the maximum values which are shown in Fig. 5.

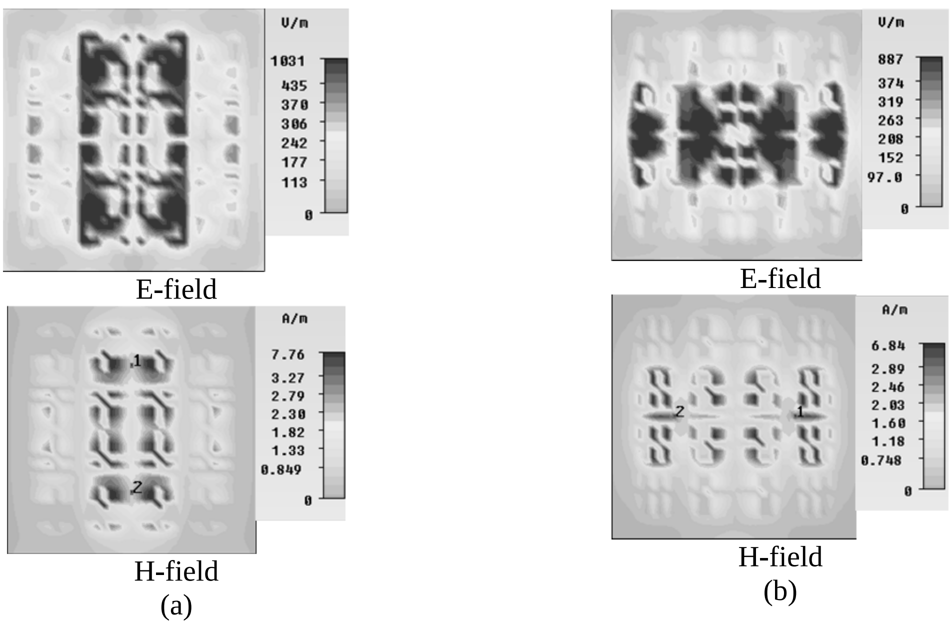
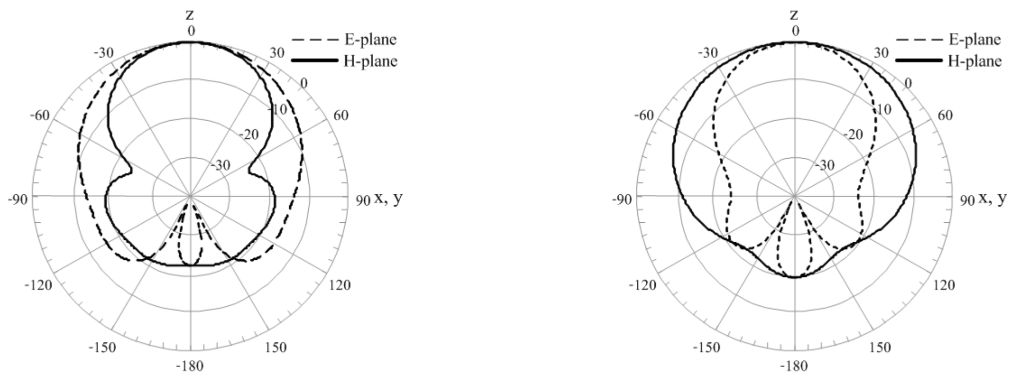


Figure 5: Near-fields on EBG surface (a) 1×2 Array Elements and (b) 2×1 Array Elements.



(a) (b)

Figure 6: Far-field Radiation Pattern (a) 1×2 Array Elements and (b) 2×1 Array Elements.

Table 1: The Directive Gain and HPBW of Array Antennas

Array Antenna Type	$d\,(\lambda)$	Gain (dB)	HPBW degree)	
			E-plane	H-plane
1×2	0.58	10.09	70.7	49.7
2×1	0.55	9.19	47.3	87.0

3.3 **Radiation Patterns**

As mentioned previously, the goal in this study is the good gain of curved strip dipole which is array on EBG ground plane. It has the uni-directional radiation patterns. The pattern of the both array radiating elements are shown in Fig. 6, where it is clearly seen that the radiated power is increased. The directive gain and the HPBW of antenna are shown in Table 1. For an electronic toll collection on expressway, the antenna reader is instated in variety position. Therefore, the appropriate gain and the HPBW are chose.

4. Conclusion

The array of curved strip dipole with difference center locations has been simulated to test the positional effect of the array antenna model. It seems that the position has an effect a bit, but the distance between radiating element has more effect for 2×1 array elements. The simulation found that the proper distance d of 1×2 and 2×1 elements array antenna are 0.58 λ and 0.55 λ , respectively.

References

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