Influence of Side Effect of EBG Structures on the Far-Field Pattern of Patch Antennas

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Abstract

The electromagnetic band gap structure always used as a part of antenna structure in order to improve the performance of the antenna especially for improves the gain and radiation pattern. In this paper, microstrip antenna is used due to the advantages such as easy and cheap fabrication, light weight, low cost, easy to feed, and better isolations among array elements, by suppressing surface wave modes. The two dominating side effects are the parasitic loading effect and cavity effect. The first causes the multi resonances antenna resulting in large bandwidth, the second effect is due to reflecting energy from EBG toward antenna and so decreasing the bandwidth. The EBG structure parameters and number of EBG rows is related to these effects.

In this paper, we propose a rectangular microstrip patch antenna with EBG substrate of different structure EBG parameters and number of EBG rows; we compare the performance of the proposed antenna with a conventional patch antenna, in a same parametric analysis with HFSS simulator.

Keywords: *Patch antenna, surface wave, EBG structure, gain and bandwidth.*

1. Introduction

With the drastic demand of wireless communication system and their miniaturization, antenna design becomes more challenging. Recently microstrip patch antennas have been widely used. In spite of its several advantages, they suffer from drawbacks such as narrow bandwidth; low gain and excitation of surface waves [1], to overcome these limitations of microstrip patch antennas two techniques have been used to suppress surface wave propagation, namely micromachining [2] and periodic structures called the electromagnetic bandgap (EBG) structures [3]. However, the effects of EBG structures surrounding the antenna can be considered as two effect, namely parasitic loading effect and cavity effect. The parasitic loading effect increases the bandwidth, whereas cavity effect is due to reflecting energy from EBG toward antenna results in a larger Q value and so decreasing the bandwidth. The EBG structure parameters and number of EBG rows is related to these effects.

In this paper, the influence of the EBG structures parameters and number of EBG rows on the far-field pattern of patch antennas is investigated. The changes in the far-field radiation patterns are discussed.

2. Theory of EBG

The parametric study on mushroom-like EBG structure is presented in [4]. It focused on four main parameters that affecting the overall performance of the antenna design. The parameters namely, patch width W, the spacing between mushroom-like EBGs, substrate thickness h and substrate permittivity εr. In this paper, the study is focusing not only on W, s and h as in [4], but also on the spacing between patch element, g and the number of rows of the EBG inserted between the patch elements.

Mushroom-like EBG consists of a ground plane, a dielectric substrate, metallic patches and vias that connecting the patches to the ground plane. The structure of this EBG and its equivalent lumped LC elements is shown in Figure 1. The inductance and capacitance of the circuit are due to the shorting vias and the spacing between the adjacent metal patches [5].

The central frequency of the band gap is

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad (1)$$