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Mutual Coupling Reduction in Patch Antenna Arrays Using a Planar Compact EBG Structure

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ABSTRACT— An important issue in antenna array design is reduction of mutual coupling. In microstrip antennas this reduction can be achieved by using electromagnetic band-gap (EBG) structures. These structures prevent the propagation of surface waves on the substrate of a microstrip antenna array. This paper presents a new configuration of a planar compact electromagnetic bandgap structure to reduce mutual coupling between array elements. First, the bandgap feature of the EBG structure is studied by obtaining the dispersion diagram. Next, the EBG structure is placed between two antennas to reduce the mutual coupling level. Simulation results show that a significant value of mutual coupling reduction, more than 22 dB, can be obtained by using the proposed structure.

KEYWORDS: Dispersion diagram, electromagnetic bandgap structures, microstrip antenna arrays, mutual coupling, surface wave.

I. INTRODUCTION

Mutual coupling in arrays is considered to be very import problem for antenna design engineers. In arrays of microstrip antennas, this coupling is especially critical. This coupling can be due to radiated waves or due to surface waves [1]. Surface waves can become dominant if high dielectric constant substrates are used [2]. When the antenna is operating in the fundamental mode (TM_{10} for rectangular patches), surface waves are strongly excited in E-plane. In this mode, the field distribution can excite the TM_0 mode of the surface waves E-plane [1]. A commonly used method for reduction of mutual coupling effect is using EBG structures between two adjacent antenna ellements [1-4]. Different forms of EBG structures such as mushroom-like EBG structure or dielectric rods and holes have been introduced [5]. Later on, several other novel EBG structures were presented such as planar compact EBG (UC-EBG) [6] and fork-like EBG [2]. Due to the capability of these structures for reducing the surface waves, they can improve the antenna performance. This improvement can be achieved in reduction of back-lobe radiation, increasing the antenna gain and increasing the antenna efficiency [7].

In this paper we propose a new, compact and easy to fabricate, EBG structure, based on totally planar layout without via. Bandgap feature of the EBG structure is studied using dispersion diagram and performance of two mutually coupled patch antennas, separated by the EBG structures is also tested.

II. EBG STRUCTURE CONFIGURATION

When periodicity of structure is small compared to the operating wavelength, the operation mechanism of EBG structure can be