Active Frequency Selective Surfaces

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Abstract. Frequency selective surfaces (FSSs) are commonly employed in the millimeter and sub-millimeter wave antenna systems as the filters. There are many investigations have been conducted into the passive FSSs, however, the less attention has been paid to the active FSSs. In this paper, a brief introduction about the FSSs and active FSSs are described.

Keywords: frequency selective surface (FSS), active FSSs.

1 Introduction

Frequency selective surfaces (FSS) have found widespread applications as filters for microwave and optical systems. These areas where FSS have been applied include frequency separation in quasi-optical systems, multi-banding Cassegrain reflectors, and providing frequency windows in radomes. The frequency selective properties are usually based on two frequency sensitive processes: the first is the resonant interaction of waves with segments of conductor – normally periodic arrays of conducting elements or slots in conducting screens, the second is the multiple scattering and interlayer interference of the fields between cascaded arrays (broadly similar to the Fabry Perot interferometers well know in optics).

There are two basic types of FSSs: dipole and slot arrays [1]. The dipole FSSs are composed of multilayered arrays of metal patches of arbitrary shape (typically dipoles, rings and crosses) embedded in a stratified dielectric medium. The dipole FSSs usually exhibit band-stop performance. The slots FSSs are composed of single or multiple thick metal screens perforated periodically with arbitrary shape holes (typically squares, circles and crosses). The slots FSSs are mostly used as band-pass filters. The dipole and slot arrays with elements of identical shape are defined as complementary arrays. The transmission and reflection characteristics of the FSSs depend on the shape and size of the patches or apertures, on the lattice geometry and element periodicity, and on the electrical properties of the substrate material.

Numerical methods have been used to analyze FSSs, such as equivalent circuit model method and modal method. Each method has its own merits and drawbacks.
Among these numerical techniques, the periodic method of moments (PMM) is one of the most popular methods for analyzing planar, multi-layered periodic structure [2].

2 Active frequency selective surfaces

While a lot of research has been conducted on the design and analysis of passive FSSs (as shown in Fig. 1), far less work has been done on the analysis of active FSSs (as shown in Fig. 2). With electronic devices embedded into the periodic elements, not only the traditional passive functions of frequency-selective and polarization-selective can be achieved, but a broader range of functions can be accomplished. These include signal generation, signal amplification, power combining, switching, imaging, remote identification, and beam controlling [3].

The frequency properties of active FSSs can be varied with time. For example, at a particular time the FSS could be switched from a reflecting to a totally transparent structure or alternatively the reflectivity could be varied with time. Usually there are two methods to design the active FSSs: one is incorporating semiconductor devices into the periodic elements of the passive FSS; the other is printing the passive FSS on the substrates whose properties may be adjusted under the control of external bias.

Fig. 1. The passive FSS

Fig. 2. The active FSS [4]
References