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Strip, slot, air, inverted patch (SSAIP): A cavity-backed alternative to broadband communication antennas

A. Alvarez Melcón and Juan R. Mosig

Laboratoire d'Electromagnetisme et d'Acoustique, Ecole Polytechnique Fédérale de Lausanne
Lausanne, Switzerland

Abstract. In this paper, a new cavity-backed antenna configuration, called strip, slot, air, inverted patch (SSAIP) is proposed. The SSAIP is the cavity-backed version of the standard strip, slot, foam, inverted patch (SSFIP) antenna concept, and this paper compares the electrical performances of both types of antennas. Results reveal that similar to their SSFIP counterparts, SSAIP antennas also exhibit large frequency bandwidth but now combined with clean and versatile radiation patterns and can thus be used in broadband communication applications. The analysis of these antennas is carried out with a specific integral equation formulation, described in the paper. To facilitate the physical understanding of the new structure, an equivalent filter model of the real SSAIP antenna is also derived. This equivalent model allows standard filter design techniques to be used for an easy electrical design of the antenna. In addition to theoretical results, experimental results are also presented showing good agreement between numerical predictions and measurements.

1. Introduction

Since their introduction in the early 1970s, microstrip antennas have become a popular and useful alternative in many technical areas (satellite and mobile communications, collision avoidance, hyperthermia treatment). However, their expansion has been severely restrained by their narrow bandwidth, an intrinsic feature on any resonant device. To overcome this limitation, two main techniques have been proposed, namely, the use of thicker substrates and the use of aperture coupled patch antennas [*Pozar,* 1985; *Zürcher and Gardiol,* 1995]. Both strategies have been combined in the strip, slot, foam, inverted patch (SSFIP) concept, which was successfully introduced 10 years ago as a useful and inexpensive broadband microstrip antenna [*Zürcher,* 1988; *Zürcher and Gardiol,* 1995]. With these structures, relative bandwidths in the range of 10-30% can be easily obtained, and recently an impressive 50% bandwidth has been reported [*Targonski et al.,* 1996].

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The use of thick substrates and multilayered rearrangements, however, enhances the propagation of the so-called surface wave modes, especially when frequency increases. As a result, the electrical thickness of substrates must be kept within reasonable values, and at higher frequencies the excitation of surface wave modes might represent a considerable reduction in the radiation efficiency of the antennas. Another unwanted consequence of the excitation of surface wave modes is the increment in the mutual coupling between different elementary radiators when disposed in array configurations. To avoid these undesirable effects, the use of metallic cavities to enclose the microstrip patches has been known for some time as a valid solution, and numerous contributions for the analysis of these structures can be found in the technical literature [*Jin and Volakis,* 1991; *Jin and Volakis,* 1993; *Gong et al.,* 1994; *Lee et al.,* 1994; *Zavosh and Aberle,* 1994; *Cheng et al.,* 1995; *Gentili et al.,* 1997]. In addition, the cavity-backed configuration has other advantages, such as reduction of the mutual coupling between elementary radiators when disposed in array configurations, reduction of spurious radiation, improvement of heat dissipation (a critical problem in space applications),