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New Hybrid Microstrip Patch Antenna Fed by Half-Mode Substrate Integrated Waveguide Cavity

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ABSTRACT— A novel design of feeding Microstrip Patch Antennas (MPAs) using Half Mode Substrate Integrated Waveguide (HMSIW) technique is proposed. The design is based on the half-mode circular SIW cavity operating at TM_{010} mode. The proposed antenna structure is made of a single-layer substrate and fed by a 50 Ω microstrip line. This antenna has attractive features including wide bandwidth, low profile, and high radiation efficiency. Also, it is easy to integrate the MPA with planar circuits. The whole structure is numerically evaluated using HFSS software package. Results show a simulated impedance bandwidth (S_{11}(dB) ≤ -10 dB) of 9.6%, gain up to 7.5 dB and radiation efficiency is around 95%.

KEYWORDS: Substrate Integrated Waveguide (SIW), Circular Cavity, Microstrip Patch Antenna.

I. INTRODUCTION

In recent years, demands for low profile antenna with suitable radiation performance have been greatly increased. MPAs are attractive due to their small size, low-profile, light weight and planar structures [1-2]. The main drawback of these antennas is the inherent limited bandwidth [1]. Many researches attempt to enhance the impedance bandwidth of the MPA using the traditional feeding mechanism such as microstrip lines and coplanar waveguides, which suffer from conduction loss at millimeter frequency [3].

Substrate integrated waveguides (SIWs) technology have been greatly applied in microwave circuits and antenna engineering. This technique provides the advantages of conventional metallic waveguide along with low-cost and integration with planar form [4].

In this paper, for the first time, a novel feeding structure using the SIW technology for the MPA is proposed. A half-mode circular SIW cavity is used to couple energy to the MPA without any external matching circuit. By this technique a low profile, single layer MPA is designed with improved bandwidth. The proposed antenna is designed and simulated by using the electromagnetic full-wave solver HFSS [5]. Good antenna characteristics such as wide bandwidth, high gain and high radiation efficiency is obtained.

II. ANTENNA STRUCTURE

Geometry of the proposed antenna is shown in Fig. 1. It consist of a rectangular patch located on the top surface of the substrate layer which coupled by a semi-circular cavity. This structure is made of single layer and an inset microstrip feed line is used for feeding the cavity. The semi-circular cavity is formed by metallic vias and a dielectric aperture. In fact,