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Broadband V-Band Angular Transition

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Abstract—A model of broadband V-band transition from a rectangular air-filled waveguide to substrate integrated waveguide has been proposed. Theoretical principles used for constructing the model of transition are also presented.

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INTRODUCTION

At present the trend is in evidence of utilizing the millimeter wave spectrum in the 30–300 GHz band by commercial communications systems where the information transmission rate can essentially exceed 1 Gbit/s.

One of the advantages in using this frequency band lies in small size of antenna (half-wave transmission length at 60 GHz amounts to 2.5 mm). It allows us to form the antenna elements on the basis of standard structure for creating phased arrays with a very high gain. Phased arrays make it also possible to form an adaptive directional pattern for establishing communication in the line-of-site area. Such antennas can be mounted on small printed circuit boards, small substrates and silicon chips.

The millimeter wave band is already used in the state-of-the-art equipment. For example, frequencies 60 and 80 GHz are used for relaying in cellular and other networks. Car radar detectors operate in the 77 GHz band similar to other military space systems. Communications channels of unmanned aircraft landing systems operate at frequency 35 GHz. However, the real capabilities of this band can be implemented in commercial and consumer devices and systems.

This paper considers the use of Industrial Scientific and Medical Band (ISM-band) (57–64 GHz) allocated in accordance with Radio Regulations for the use in industrial, scientific and medical areas [1].

PROBLEM STATEMENT

There is a considerable number of measuring components implemented on standard air-filled rectangular waveguide (RWG) operating in the millimeter wave band. These components possess a series of advantages: high transmit power, small losses and completely shielded structure. Compatibility of such systems with components built on the basis of printed-circuit techniques represents a fairly grave and complicated task.

Modern design and production integrated circuit technologies brought about an opportunity of implementing three-dimensional elements based on the printed-circuits techniques [2]. Substrate integrated waveguide (SIW) represents a waveguide structure consisting of two rows of metallized cylindrical holes that exercise a function of narrow walls of waveguide connected by two metal plates functioning as wide walls of waveguide. The SIW peculiarity is the fact that it possesses a majority of advantages inherent to rectangular waveguide. In addition, SIW features advantages inherent to planar structures: small sizes and weight, low production cost. The main advantage of SIW is the possibility of integrating all system components, including antennas, passive and active components, on one substrate. Utilizing the multilayer structure, SIW-technology can be used for creating directional couplers, filters, transitions, etc.

In view of the above the investigation and development of different types of transitions implemented on the basis of different technologies, for example SIW–RWG, for matching separate parts of radioelectronic devices is an urgent problem. The characteristics of such transitions play an important part in the efficiency of the entire system where they are used as constitutive elements.