UNIVERSITI TEKNOLOGI MARA

SUBSTRATE INTEGRATED WAVEGUIDE CIRCULAR CAVITY WITH PROBE EXCITATION

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ABSTRACT

A new substrate integrated waveguide circular cavity (SIWCC) band-pass filter with probe excitation has been designed and developed, which in C-Band frequency range that has potential applications in satellites and wireless communication systems. Some SIW structures suffer additional loss and are incompatible with smaller devices. Three different configurations of SIWCC cavity filters are proposed to contribute to tuning ability, low losses, and compact size. The first configuration consists of a SIWCC resonator interconnected with a triangle probe at both input and output ports. The design exhibits single-mode resonance in the passband, which operates at TM_{110} mode propagation. In the second configuration, to further investigate the performance of the SIWCC design, a rectangular perturbation slot was attached with the circular structure at both sides on the top layer. The design contributes towards an improvement in the electrical characteristic's performance. Furthermore, the third configuration involved in the SIWCC design was tuned by perturbing via a hole connected to the cavities on the top metallic layer of SIW. This led to the advantage of simplicity in the design synthesising the SIWCC was applicable. Based on the low-pass equivalent network and low-pass prototype, the transformation from the equivalent circuit to the band-pass equivalent circuit was done. This allows the electrical characteristics controls for the resonator at the operating frequencies and the integration of the addition cavity into the initial design topology for the higher-order band-pass filter. As a result, cascading two circular cavities in the design exhibit dual-mode resonance frequency and excite at TM_{110} mode with more selective performance, compact, smaller devices size realization, and good electrical response. The design with a double layer printed circuit board (PCB) was fabricated using Rogers RO4350B™ substrates to achieve a multi-layer structure in the coupling between the vertically coupled SIW cavity resonator. Finally, the simulations and experimental results in planar technology are also presented using an Ansoft High-Frequency Structure Simulator (HFSS) simulator to validate the proposed design of the filters at various configurations. It operates at frequencies 3.75 GHz and 4.75 GHz with fractional bandwidth (FBW) greater than 0.1 GHz, and average performance with insertion loss (IL) being less than 2 dB.

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TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Research Background

The advent of several millimetre-wave (mm-wave) applications has emerged from the advancement of communications in wireless and radar systems such as satellite applications, Wireless Local Area Network (WLAN) as well, as Long Term Evolution (LTE). In general, this technology used microwave devices in the front-end and back-end of the operating systems [1]-[2]. Difficulties in achieving small and compact designs have been a great challenge for researchers. Microwave filters are made using a variety of acclaimed structures and processes, for instance, coplanar waveguides, microstrip, rectangular, and circular waveguides [3], [4]. The introduction of the new substrate integrated waveguide (SIW) cavity resonator technology has sparked interest within the wireless communication community due to the technical advantages in both waveguide and planar. It also has generated various recognition since it supports both the waveguide and planar [5].

There are many planar resonators that can be used to form SIW cavities. SIW cavities have been widely applied to filter designs that take advantage of the significant benefits that offer much better performance. For instance, high-quality variables, high power capacity, better losses characteristic, and effective integration into platform circuits such as planar microwave circuits [6]–[8]. Two rows of vias on a dielectric substrate form the SIW, which is formed on the basis of an integrated waveguide. With this technology, it is possible to produce a complete circuit in a planar form. In addition, losses can be reduced by using the same substrate when assembling many chipsets [9]–[12].

Apart from this, the SIW resonant cavity can be used to analyse various aspects of the waveguide performance, including the flexibility in the higher-order mode of the SIW, the excitation of the SIW cavity, and better band loss characteristics [13]. Cavity resonators exhibit a large number of unique modes, but these modes correspond to very specific and limited frequency ranges. The fundamental mode is the mode with the lowest resonant frequency, f_0, while the other modes are called higher modes, which