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A Quarter Mode SIW (QMSIW) Cavity based Band Pass Filter (BPF) for 5G Wireless Applications

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Abstract—In this paper, a band pass filter has been designed using quarter mode substrate integrated waveguide technology. This filter offers ease of integration, high Q-factor, and high-power handling capacity. A square cavity is designed where vias are at the both side of the closed ended edges that are used to create electrical wall within the structure. This second order band pass filter which provides a roll-off rate of ± 40 dB/decade (or ± 12 dB/octave), which is steeper than the ± 20 dB/decade of a first-order filter. The structure exhibits a return loss of 14.2dB followed by stop band attenuation of 56.2dB. The experiment is carried on Rogers RT Duroid 5880TM with $\epsilon_r=2.2A$ and thickness of 30mils.

Keywords—Quarter mode substrate integrated waveguide (QMSIW), band pass filter, 5G wireless applications.

I. INTRODUCTION

Substrate Integrated Waveguide (SIW) is a waveguide configuration implemented in planer form and integrated in the dielectric substrate in which the walls are constructed from rows of metalized via holes and metal layers on the upper and lower layers are illustrated in Fig.1. Substrate Integrated Waveguide (SIW) filters merge the benefits of conventional metallic waveguides with the compact design of planar circuits, making them well-suited for high-frequency microwave and millimetre-wave applications. They provide enhanced performance compared to coaxial and traditional metal waveguide filters due to their low production cost and easy integration with planar active components. In comparison to microstrip lines, SIW filters also have a greater Q-factor and less gearbox loss [1].

Utilization of metallized vias and slotlines provides independent control over several resonant modes, which results in flexible and compact filter structures [2]. Multilayer arrangement [3] improves compactness and response versatility and is ideal for modern microwave applications. The location of the coupling iris [4] is utilized to adjust filtering responses which allows design flexibility and improved field confinement.

Control over the transmission passbands and good isolation at the stopbands are primary considerations for effective filter design. Moreover, return loss greater than 10dB throughout the transmission bandwidth with minimal IL is required for good filter response. Full-mode SIW is a structure resembling the conventional metallic waveguides where the

propagation of the electromagnetic wave takes place which is built in a planar substrate. The FMSIW enables the propagation of conventional TE mode configurations. These modes are symmetrical to the centreline envelope. HMSIW is created by placing a row of metallic vias on a low-loss substrate with metal cladding on both sides, producing a structure that takes up only half the area of a conventional SIW and supports a fundamental mode roughly equivalent to half of the TE₁₀ mode [9]. By further dividing the HMSIW along two vertical centerlines [7], a quarter-mode substrate integrated waveguide (QMSIW) is achieved just 25% the size of a full SIW cavity while still offering excellent quality factor and minimal loss. This eliminates the need for bulkier, conventional components and allows researchers to incorporate high-performance filters within limited dimensions [10]. In [13] cross and circular features as perturbation elements for mode splitting as a way of improving coupling between resonant modes. Here, the electric field distribution is discussed while presenting a highly localized nature in the quarter-mode cavity with symmetric distribution makes the field useful and efficient. The field maxima lie on the resonator and service regions that relate to the perturbation areas, showing appropriate mode excitation.

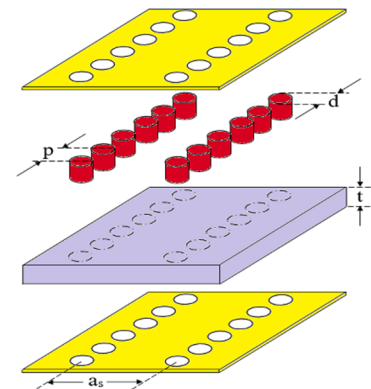


Fig. 1. The SIW layout is defined by parameters like via diameter (d), spacing between vias (p), substrate thickness (t), and the effective SIW width (a_s).

Present study introduces a compact bandpass filter design utilizing Quarter Mode Substrate Integrated Waveguide (QMSIW) technology, with a focus on critical performance

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