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DESIGN OF DUAL BAND SUBSTRATE INTEGRATED WAVEGUIDE BANDPASS FILTER FOR K AND Ku BAND APPLICATIONS

Dr. R. Ranjit Kumar

Associate Professor, Dept.ECE

S. Sirisha, K.Komalika, CH.Sivathathmika, N.Pavani, R.Prakash

Department of Electronics and Communications

PBR VITS, Kavali, Nellore, Andhra Pradesh,

esents the design and simulation of a substrate integrated waveguide band-pass filter for K- Band(12-18 GHz), Ku-Band(18-24 GHz).Band-pass filter is used to receive the desired band of frequencies and to reject the frequencies which is outside the band. Microwave system is generally designed by using fundamental components such as filters, couplers dividers etc. Microstrip based devices can be used upto certain frequencies. The conventional microwave components which are heavy , bulky in size, high cost. In order to overcome these drawbacks we have choosen the substrate integrated waveguide as an approach. The filter is designed on Rogers RT/Duriod 5880 substrate with Ɛ r=2.2, h=0.508 mm. The metallic via-holes have d=1 mm and p=1.6 mm.

Keywords: -Rectangular Waveguide, Substrate Integrated Waveguide, Microwave filters, Transition, SIW- Microstrip Technology.

I. INTRODUCTION

Filters are electronic circuits that remove any unwanted components or features from signal. In simple words, you can understood it as the circuit rejects certain band of frequencies and allows others to pass through. They are widely used in instrumentation, Electronics and Communication Systems. These are essential building blocks of any Electronic and Communication Systems that alter the amplitude and/or phase characteristics of a signal with respect to frequency. Filter is basically linear circuit that helps to remove unwanted components such as noise, Interference and Distortion from the input signal. Ideally Filter alters the relative amplitudes of the various frequency components and the phase chataristics and its gain depends entirely on the frequency.

II. Literature Review

1. X. Zhang et al., "Dual-band SIW bandpass filter using slot-loaded cavity" – IEEE Microwave and Wireless Components Letters, 2019

Summary: This paper presents a **compact SIW bandpass filter** with dual-band operation.

Method: Used **slot-loaded cavities** to generate two passbands.

Outcome: Achieved good **isolation between bands** and low insertion loss.

Relevance: Useful for understanding how to achieve **dual-band response** using a **single cavity**.

2. H. Uchimura et al., "Development of a laminated waveguide" – IEEE MTT-S, 1998

Summary: Introduced the concept of **SIW** as a laminated waveguide.

Contribution: Foundation work on SIW structure, via wall realization, and integration on substrate.

Relevance: Gives a **theoretical base** for SIW technology.

3. S. W. Wong and L. Zhu, "Implementation of Multiband Filters Using Dual-Mode SIW Resonators" – IEEE Transactions on Microwave Theory and Techniques, 2010

Summary: Designed a **multi-band filter** using **dual-mode SIW resonators**.

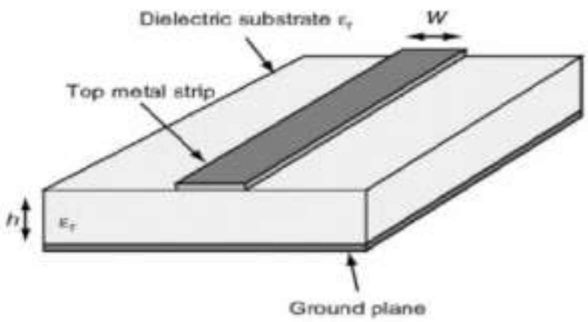
Technique: Mode coupling and perturbation methods used to control resonance.

Outcome: Achieved multiple passbands with **compact size**.

Relevance: Useful for **dual-band/multiband filter design ideas**.

III. EXISTING METHOD

A microwave circuit (or a system) is, in general, an interconnection of many fundamental microwave devices much as filters, couplers, power divider combiners, etc. However, in essential requirement in all these devices is the ability to transfer signal power from one point to another as efficient as possible (i.e., with minimum amount of loss). This requires the transport of electromagnetic energy in the form of a propagating wave. Therefore, all the aforementioned fundamental microwave devices are designed and manufactured in the form of a guiding structure so that electromagnetic waves can be guided from one point to another without much loss.Microstrip lines are among the most widely used guiding structures at relatively lower microwave frequencies because of their simple construction, low cost, and high integrability with surface mount components.



IV. PROPOSED DESIGN METHODOLOGY

Substrate Integrated Waveguide (SIW) is a promising candidate for mm-wave technology because it is easy to fabricate, flexible and cost effective. This technology also preserves most of the advantages of conventional metallic waveguide namely complete shielding, low loss, high quality-factor and high power handling capability. SIW has received tremendous attention at mm wave frequencies of around 60 GHz. SIW structure is fabricated by using two periodic rows of metallic vias connecting the top and bottom ground planes of a dielectric substrate.

SIW HISTORY BACKGROUND

The metalized via holes, though, have been widely used in PCB manufacture long ago for reducing the coupling between electronic elements. The idea of via holes waveguide was first purposed by Shigeki in 1994. The development of SIW post-holes wall is limited to the accuracy of electromagnetic field computation, which further depends on the numerical analysis method and computer processing capability available at the time. Instead to explain the algorithm of post-holes wall, the following description will briefly introduce the milestones in the history of metal post wall development.

Substrate Integrated Waveguide (SIW) and its Derivatives

The RF printed circuit industry has been rapidly grown by the inventions of several controlled impedance transmission lines and waveguides in the printed form. The strip line family, microstrip line and coplanar waveguide family of guiding structures are very common in the modern wireless communication scenario. A new class of printed guiding structures are introduced to the microwave and the millimeter wave range by the invention of the substrate integrated waveguide (SIW) technology.

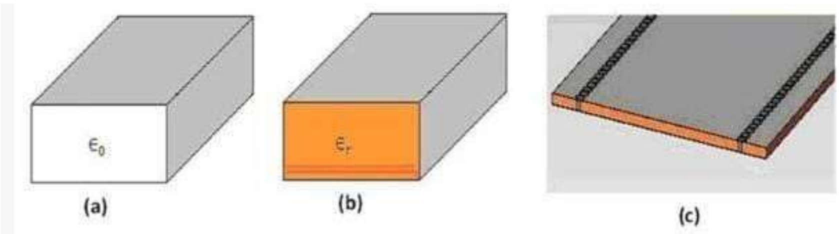


Fig: (a)Air filled waveguide , (b) Dielectric filled waveguide ,(c) SIW

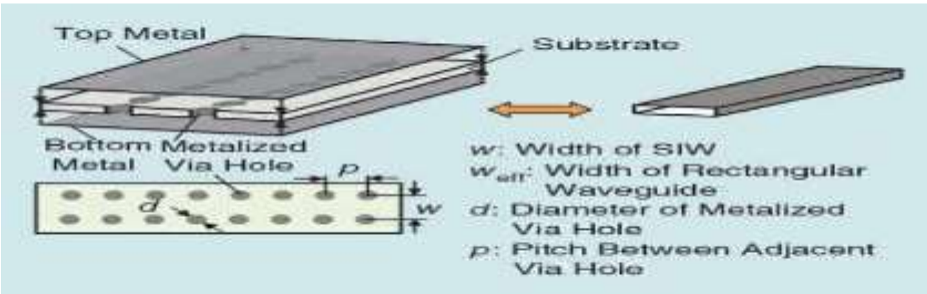


Fig: Rectangular Waveguide and its SIW Equivalent

SIMULATION METHODOLOGY

A well-designed antenna can improve communication links and device performance, but designing an filter is not a trivial task CST Microwave studio offersa complete design solution for filter engineers, to be as efficient as possible at every stage of the filters design process, from initial concept exploration to final antenna integration.

Introduction to CST microwave studio

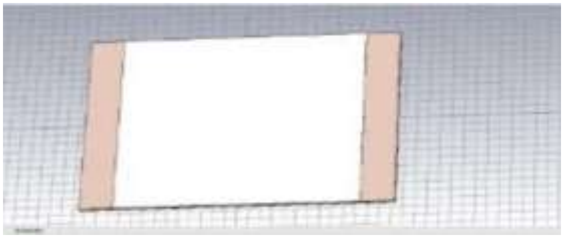
CST Microwave studio is a tool used for simulating 3D structures at high frequency devices such as antennas, filters, couplers, planar and multi-layer structures and we can choose the most appropriate method for the design and optimization of devices operating in a wide range of frequencies. Antennas are used in a vast variety of applications, and thus they come in a vast variety of form factors and radiation mechanisms.

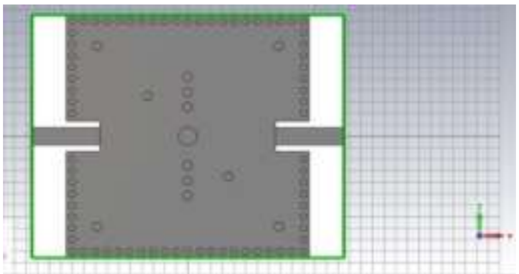
DESIGN STEPS IN CST MW STUDIO

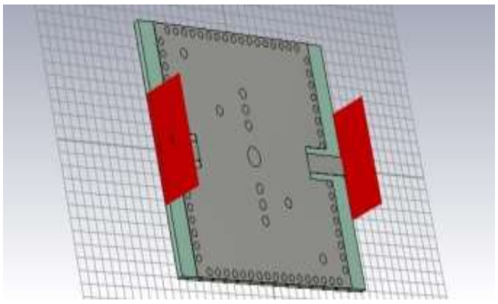
Step 1: Open CST Suite and Click on New Template

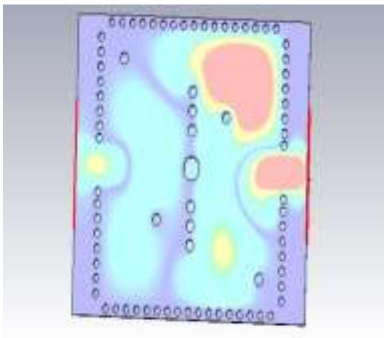
Start by creating a new project in CST microwave studio

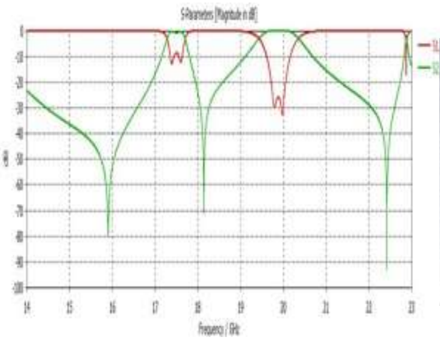
Step 2: Select MICROWAVES & RF/OPTICAL Project Template

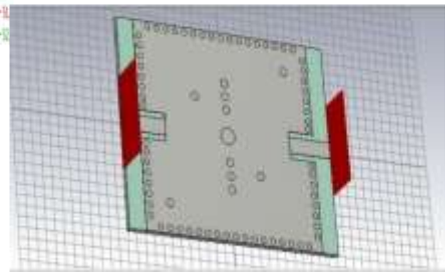












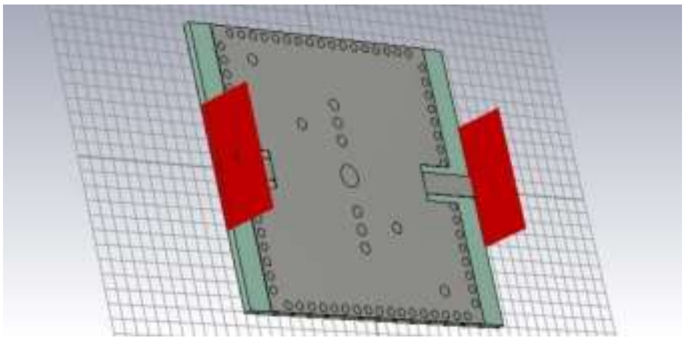
Create a new project by clicking on the new template button in the new and recent page

V. RESULTS AND DISCUSSION

EXPERIMENTAL RESULTS OF THE SIW FILTER

The dual-band filter is simulated and fabricated using the commercial software CST Microwave Studio and the standard printed circuit board (PCB) process, respectively. A prototype of dual-mode dual-R/Duroid 5880 (thickness 0.508) with a dielectric constant e, = 2.2 and a loss tangent of 0.0009.

The dimensions of the cavity for the designed filter are as follows. The size of the cavity is Weff *Weff = 19.4 x19.4 mm, Is = 4 mm, If = 2.9 mm, wmf = 1.55 mm, wf = 0.55 mm, dx = 2.55 mm, p = 1.0 mm, p1 = 1.3 mm, dy = 1.45 mm, d = 0.6 mm, d1 = 1.6 mm, d2 = 0.8 mm, x1 = 3.5 mm, x2 = 7.85 mm, y1 = 3.5 mm, y2 = 7.85 mm.



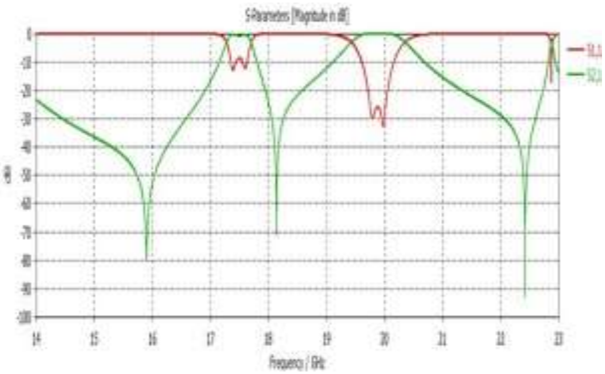


Fig:SIW bandpass filter

VI. ACKNOWLEDGEMENT

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VII. CONCLUSION AND FUTURE SCOPE

A dual-mode dual-band filter with flexible center frequencies is designed and fabricated on a single perturbed SIW square resonant cavity based on the multiple resonant modes present in SIW cavities.Using the suggested perturbation structures, the four resonant modes are engineered to create the two resultant pass bands, such that the first band can be independently tuned by moving the via-holes located at the center of the SIW cavity, while the second pass band is constant. The experimental and simulated results are in good agreement, which supports the design concept. From the above, the proposed model in this research makes it a candidate to work in wireless communication systems that use advanced technologies.

Due to its low cost, easy integration with printed devices, light weight and compact size, it attracts the attention of many researchers and it is widely used in modern and communication applications.In the literature are studied and analyzed for desired frequency bands and the simulation results agree well with the results available in the literature. They work well with good matching and low loss.

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