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A Review of Substrate Integrated Waveguide Bandpass Filter for Satellite Application

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Abstract

In modern wireless communication substrate integrated waveguide filters are used for high frequency application. This paper provides the review on Substrate Integrated Waveguide based microwave filter. Substrate integrated waveguide filter technology is implemented for satellite communication uplink and downlink frequency band. Design of substrate integrated waveguide filter can be used to improve various parameter of existing substrate integrated waveguide filter like size, return loss(S11), insertion loss(S21) etc.

Keywords: Satcom Application, Bandpass filter, Substrate Integrated Waveguide

I. INTRODUCTION

In modern wireless communication substrate integrated waveguide filters are used for high frequency application is used for satellite. SIW filter design is based on planar dielectric substrates with up and down metal layers and both rows of metallic vias on its lateral surfaces, separated by a distance proportional to the guided wave length between them. SIW filter offers a compact size, low insertion loss, high Q-factor, low cost, high return loss, light weight.

Filters play an important role in many microwave and radio frequency (RF) applications. Mostly Waveguide based microwave filter is used for satellite application. These filters capable of particular range of frequency pass and another frequency are rejected. Conventional Waveguide filter have excellent performance but with a bulky and very difficult to integrate with another component. Nowadays, SIW filter is used for satellite communication. Benefits of SIW filter is a small size, low insertion loss and low cost.

Manufacturing of high frequency waveguide device is very difficult. So, new concept emerged i.e. SIW. Therefore, hollow waveguide pipes such as a rectangular waveguide. Inside of a rectangular waveguide is usually air. It can be filled with the dielectric material resulting in a smaller cross- section. Hollow- pipe waveguides are usually bulky,

and very difficult to production, and they are not integrable with printed circuit board structures.

Recently, a transition between microstrip structures and waveguides is called as a substrate integrated waveguide (SIW) Filter. SIWs structures fabricated on a dielectric material with up and down layer are conductors, and two linear arrays of metallic vias form the side walls as shown in Fig. 1. When SIW has the characteristics of, cost effective, integrable with planar devices, relatively easy fabrication process.

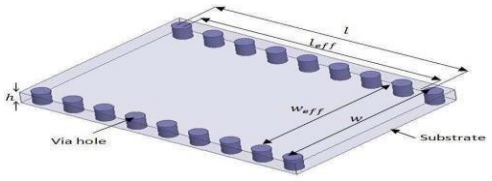

Fig. 1: Substrate integrated waveguide (SIW) [9]

Vias is a metallic cylinder. Any PCB vias is to provide a conductive route for passing an electrical signal from one layer to next layer. Through vias: -

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Hole through from the upper layer to the lower layer. Blind vias: Blind vias is drilled from the upper or lower layer but stop at some point in PCB circuit design. Buried vias: -There are used to connect inside layer structure only. Eight-layer structure in initially drilled as through holes from layer2-layer7 in PCB circuit.

TABLE:1 Difference between Waveguide and Substrate Integrated Waveguide

PARAMETER	WAVEGUIDE	SUBSTRATE INTEGRATED WAVEGUIDE
Integration with another component	Very difficult to integrate with another component	Easy to integrate with another component
Structure Size	Large Size	Small Size
Structure Weight	Bulky Weight	Light Weight
Production Cost	High Cost	Low Cost
Advantage	Good power handling capability	Power handling capabilities are higher, compact size
Disadvantage	Bulky size and high cost	Dielectric losses

II. SIW: REVIEW PAPER

A tri-band bandpass filter (BPF) using a only one substrate integrated waveguide (SIW)filter cavity with offset feed-line is proposed in this paper. A single SIW cavity fed by microstrip- line and L-shape slots with rectangular slot is applied to make a tri-band BPF. The rectangular slot in the SIW is applied to improve the good filtering performance. In this filter has a very compact configuration. Then a second order tri band BPF has been designed and analyzed based on the first order tri band BPF.[4]

This article deals with a novel Substrate Integrated Waveguide (SIW)-based cavity filter. Three metallic vias inside the SIW BPF filter, two of which act as the commanding gate and available moderate Q-factor. The shorting post number one is placed at the center of the design. The place of another two shorting posts, 2 and 3, with respect to the 1 at the center, is critical to the band-pass characteristics of the filter. Same technique is validated for designing a 5GHz applications. [5]

Paper is issue by IEEE. A SIW filter using 4 symmetrically arranged square complementary split- ring resonators. A device that has excellent selection with compact size and innovative structure has been designed and fabricated.[6]

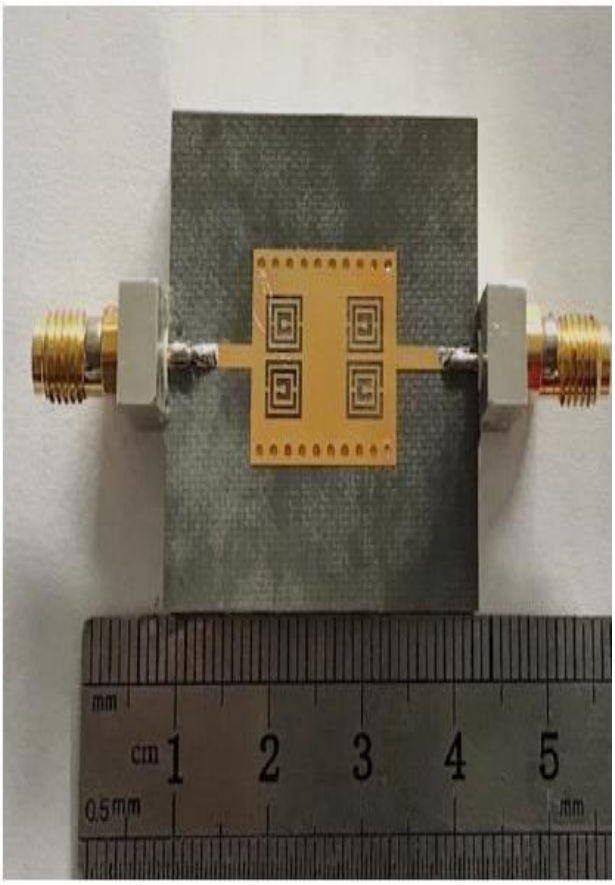

Fig.2. The fabricated SIW filter for VSAT frequency [6]

IEEE paper published in 2017. VSAT or Satellite uses frequencies that consist of uplink and downlink frequency. A substrate integrated waveguide bandpass filter is made on VSAT downlink frequency.[7]

The SIW structure suffers from higher IL compared to WG which is 3.3 dB and less than 0.8 dB respectively. Another important parameter,

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especially for VSAT, is the filter size. The small size makes SIW filters very suitable for VSAT.[8] come to conclude that many advantages of SIW filter compare to conventional waveguide filter like size, loss, packaging and design complexity.

III. COMPARISON OF SIW FILTER

TABLE:2 Comparisons of SIW filter review paper method

Paper/year	Methodology	fo (GHz)
[4]2019	Microstrip line and L-shape slots with rectangular slot	2.62GHz,4.21GHz, 5.25GHz
[5]2018	SIW based 3 shorting posts inside the cavity	2.4GHz,5GHz
[6]2018	Symmetrically arranged square complimentary split ring resonator	5.82GHz
[7]2017	Three cascaded SIW-DGS cells.	3.9GHz
[8]2016	Hollow metallic WG and SIW waveguide	14GHz

TABLE:3 Comparisons of SIW filter review paper parameter

Paper/year	Insertion loss	Return loss	size
[4]2019	1.08dB, 1.55dB 2.91dB	23dB, 13.3dB, 11.6dB	100mmx48mm
[5]2018	0.95dB, 1.27dB	20.4139dB, 15.4551dB	-
[6]2018	2.53dB	Greater than 15dB	17mmx15mm
[7]2017	1.08dB	17.76dB	29.07mmx16.3mm
[8]2016	0.8dB/ 3.3dB	-	124.6mmx48mm/ 48.5mmx16mm

IV. CONCLUSION

The different methods of designing SIW bandpass filter at different applications have been reviewed. This filter shows good performance in terms of insertion loss and return loss. In addition, the size of the designed filters is small and compact, as well as easy to integrate into the planner circuit. SIW filter fabrication work by using PCB which is very beneficial to the low-cost manufacturing process. From review the different SIW filter paper, I have

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