A Novel Substrate Integrated Waveguide Filter for the Application of Bandpass Filter at Ku band

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Abstract— **This letter proposed a novel structure of microstrip tapered Substrate Integrated Waveguide (SIW) behave as bandpass filter whose aim is to pass Ku band microwave signal. SIW consist rectangular waveguide with dominant mode TE10 mode having metallic sheets on both bottom and top of the waveguide. As To achieve bandpass filter at Ku band, 4th order iris topology has been used. For the simulation of the proposed work, CST Microwave studio software is used. The simulated results presented in the letter which have shown that the bandpass filter have bandwidth from 12.9 GHz to 15.3 GHz. The simulated insertion loss is 2 dB where return loss is better than 10 dB over the entire passband. The Rogers RO3003 dielectric has been used which have dielectric constant 3 and electric tangent 0.001. The purpose of designing this substrate integrated waveguide as bandpass filter to enhance the working quality of the transmission for Ku band application.**

Keywords: **Substrate Integrated Waveguide (SIW); Iris bandpass filter; SIW resonator; CST Microwave Studio Ku band.**

I. INTRODUCTION

With the rapid development of substrate integrated waveguide (SIW) employed implementation and integration of both microwave and millimeter wave wireless communication system. It is a hybrid structure between microstrip and waveguides. SIWs are consists waveguides (rectangular waveguide or circular waveguide) like dielectric fabric and the same two components of metallic vias at top and bottom create side walls. The advantage of SIW over micro strip is cost effective, relatively easy fabrication process, integrable with planar devices. Consequently, a significant number of SIW based microwave components such as filters, couplers, power divider/combiners has been reported so that they can replace their microstrip and/or waveguide counterparts at appropriate frequencies. As already mentioned, SIW is best used as filter so at the same time SIW is used as both bandpass filter and bandstop filter. According to the application of the filter SIW is designed in which placement of iris are the most important. A complete review of SIW circuits as well as the theoretical background with the design equations is available for the particular band application. [1] & [2]

A microwave filter is a two-port network. In a microwave system, it is necessary to control the frequency response for the certain application by allowing transmission at frequencies within the passband of the filter, and rejecting the signal flow within the stopband of the filter [3]-[18].

This letter works on the SIW behave as bandpass filter whose aim is to pass Ku band microwave signal. SIW consist rectangular waveguide with dominant mode TE10 mode having metallic sheets on both bottom and top of the waveguide. As To achieve bandpass filter at Ku band, 4th order iris topology has been used. The simulated results presented insertion loss is 2 dB and return loss is better than 10 dB over the entire passband from 12.9 GHz to 15.3 GHz (lie in Ku band). The Rogers RO3003 dielectric has been used which have dielectric constant 3 and electric tangent 0.001.The letter also presented surface current at resonating frequencies. To achieve desire bandpass bandwidth parametric analysis is also presented in the paper at the different paramters. The purpose of designing this substrate integrated waveguide as bandpass filter to enhance the working quality of the transmission for Ku band application.

II. DESIGNING OF SIW FILTER

In this letter, Rogers RO3003 substrate is used whose dielectric constant εr =3, electric tangent = 0.001 and height h = 0.254 mm. SIW filter consists rectangular waveguide whose length Ls = 69.93 mm and width Ws= 13.5 mm having two parallel metallic sheets on the top and bottom. The rectangular waveguide has TE10 dominant mode. The metallic sheets are connected through two metallic iris that are periodically in an insulating substrate with the diameter D = 0.5 mm and the period of the vias P =1.5 mm and pitch is 1.1 mm. The distance between the rows of the centres of via is width =7.5 mm. A microstrip taper is used to interconnect SIW to the planar transmission lines. The purpose of using tapered segment is to match the impedance between a 50 Ω microstrip line having dominant mode quasi-TEM and SIW whose dominant mode TE10. The structure of SIW bandpass filter in the Ku-band with iris topology of 4th order. The final dimensions of the structure are discussed in Table 1.

The structure of SIW bandpass filter is designed for the Ku band applications purpose. The top view proposed SIW bandpass filter in CST Microwave Studio is as shown in Figure 1.

Table 1: Dimension of proposed Iris Bandpass SIW Filter

Parameter	Dimension (in mm)
W1	5.795
W2	5.03
W3	4.795
L1	4.93
L2	5.67
Lf	16.565
Wf	2.4
Wm	1.5
A	1.1
B	1.1

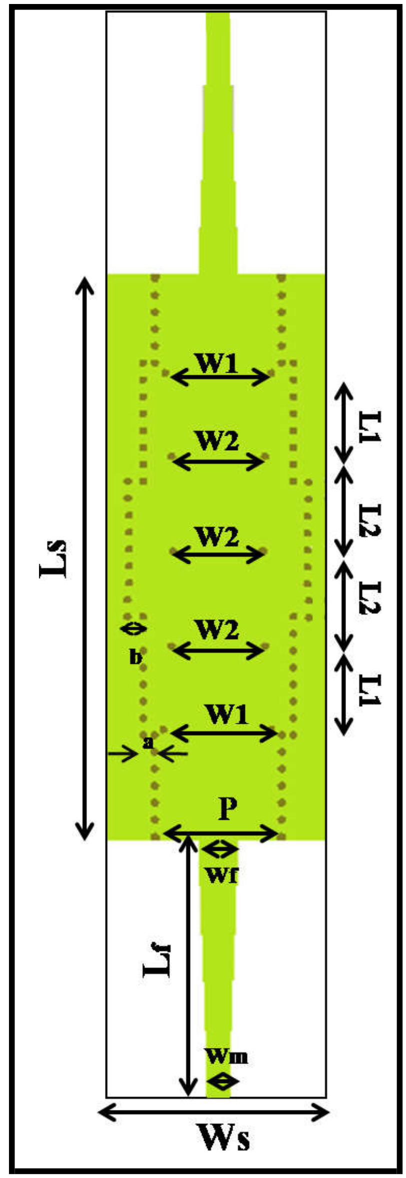

Figure 1: Proposed bandpass SIW filter.

III. RESULTS AND DISCUSSION

In the filter, insertion loss and return loss are the most important parameters. As in this letter bandpass filter is designed, so to simulate the reflection coefficient and transmission coefficient of the proposed bandpass SIW filter CST Microwave Studio is used. The simulated S-parameters of SIW in the frequency band from 12 GHz to 18 GHz are discussed in this section.

A. Reflection coefficient of proposed SIW Bandpass Filter

From the Figure 2, it is observed that the designed SIW bandpass filter resulted reflection coefficient S11 below -13 dB across the entire bandwidth from 12.9 GHz to 15.3 GHz in which resonated at 13.03 GHz, 13.68 GHz and 14.66 GHz.

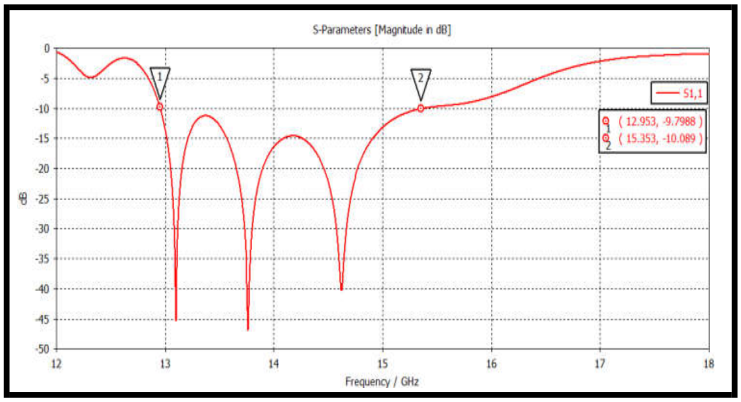

Figure 2: Simulated return loss of proposed SIW filter.

B. -Transmission Coefficient of proposed SIW Filter

From the results, it is investigated that over the entire bandpass frequency band the transmission coefficient is -2 dB which is as shown in Figure 3.

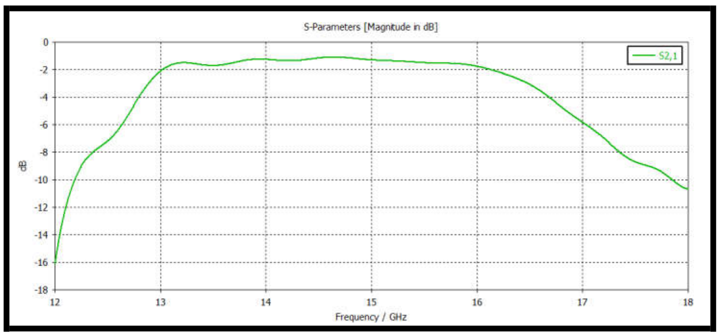

Figure 3: Simulated insertion loss of proposed SIW filter.

C. Surface Current

From the results it is investigated that at 13.09 GHz, 13.7 GHz and 14.66 GHz the proposed SIW filter resonates maximum with high rejection. In the Figure 4, the surface current at 13.09 GHz, 13.7 GHz and 14.6 GHz are presented.

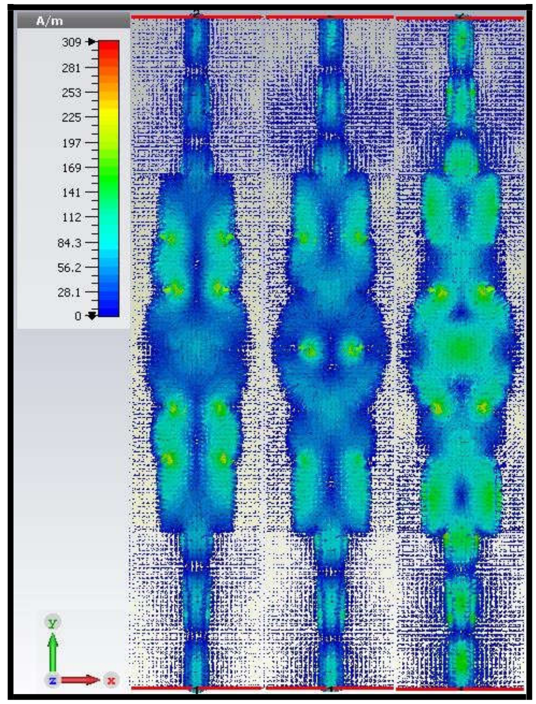

Figure 4: Surface Current at 13.09 GHz, 13.7 GHz and 14.66 GHz.

D.Parametric Analisis

Further in this paper parametric analysis has been presented at different parameters which help in obtaining the requisite frequency bandwidth at particular dimensions of the proposed design. From the Figure 5, it is noticed that on varying width (width = p) between the vias then there is also drift in the pass bands. On increasing the width the pass band shifted towards lower frequencies and on decreasing width the pass band shifted towards higher frequencies.

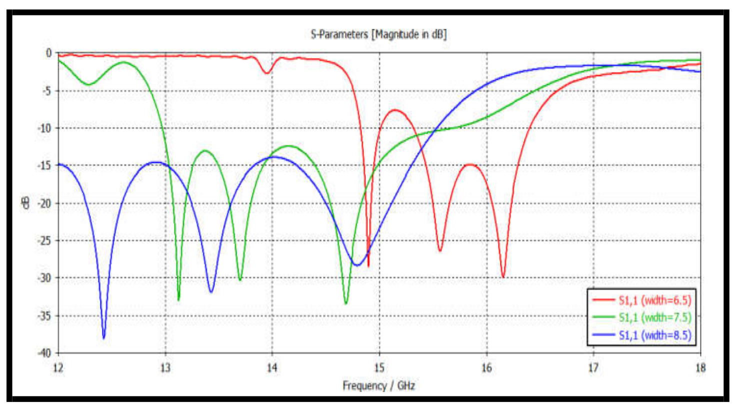

Figure 5: Width variation between via.

From the Figure 6, it is find that on varying diameter of via (diameter = dia) then there is also shifting in the pass bands. On increasing the diameter of the dia then there will be shifting of pass band towards higher frequencies.

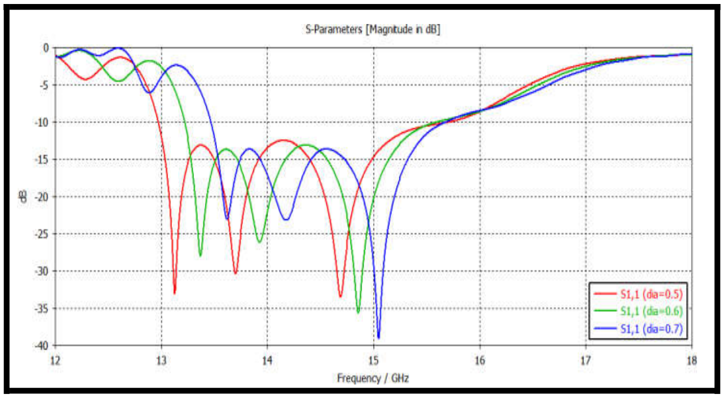

Figure 5: Diameter of via parametric variation.

From the Figure 7, it is examined that on varying thickness of via then there is also some variation in the pass bands. On increasing the thickness of via the pass band becomes narrow and return loss response also becomes poor and on decreasing thickness of via the pass bandwidth will be increased and return loss performance also improved.

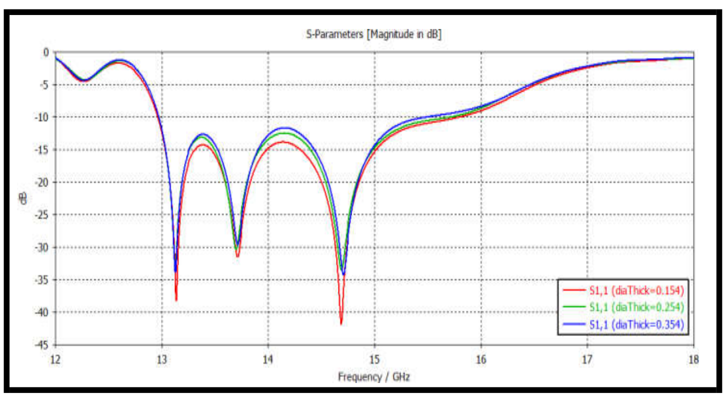

Figure 6: Via Thickness parametric variation.

IV. CONCLUSION

This letter aim is to design microstrip tapered SIW behave as bandpass filter to pass Ku band microwave signal. SIW consist rectangular waveguide with dominant mode TE10 mode having metallic sheets on both bottom and top of the waveguide. As To achieve bandpass filter at Ku band, 4th order iris topology has been used. The simulated results presented insertion loss is 2 dB and return loss is better than 10 dB over the entire passband from 12.9 GHz to 15.3 GHz (lie in Ku band). The Rogers RO3003 dielectric has been used which have dielectric constant 3 and electric tangent 0.001.The letter also presented surface current at resonating frequencies. The purpose of designing this substrate integrated waveguide as bandpass filter to enhance the working quality of the transmission for Ku band application.

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