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Slotted Substrate Integrated Waveguide Filter in X-band at 10 GHz Using TE_{10} Mode

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Abstract

This paper presents a slotted substrate integrated waveguide filter in X-band at 10 GHz Using TE_{10} mode for X - band applications with a range of frequency from 6.7GHz to 12.5GHz. .Return loss, S_{11} is achieved to be -23.04 dB and Insertion loss, S_{21} is lower to 0.5 dB. We used Rogers RT/ droid 5880 (TM) material. All the simulation has been performed using HFSS tool. The microstrip line is modeled as a perfect electric conductor (PEC) surface on a 0.060-inch thick dielectric substrate, with another PEC surface below that acts as the ground plane. The width of the microstrip line is initially set to that of 50-ohm line.

Keywords: Substrate integrated waveguide (SIW), mixed electric and magnetic coupling.

I .Introduction

Filter Design for a wireless communication system such as 5G applications and more challenging radar is preferred. Substrate integrated waveguide based filter structures are promising to meet the requirements of such systems with low cost, easy fabrication, and high insertion loss. A filter such as a stopband and low pass filters have also been widely used in any system. The loss goes to infinity at the lower cutoff frequency. Here's a plot of the loss of WR-90 X-band waveguide. Note that it blows up at the lower cutoff frequency of 6.557 GHz. ... In order to get the lowest loss, choose the waveguide that has the largest dimensions. However, the design of such filters is generally perceived as less critical with respect to bandpass filters.SIW Electric and magnetic coupling structure made of the rectangular waveguide requires broadly transitions from planar to nonplanar circuits. Assorted set about to solve this problem had been projected [1] The speedy ontogenesis of modern mobile and satellite communication systems means there is swell exact for bandpass filters with high quality, low insertion loss, compact size, and low cost. Although waveguide filters have fantabulous insertion loss, copious and disbursement to construct. Not be well fixed mixed coupling with the electric and magnetic planar circuit. Also, a high preciseness mechanical accommodation or subtle tuning mechanics is required to obtained appreciated filters[2]. It has been understanding that both positivistic and negativistic coupling is requisite to bring forth transmission zero at finite frequency accomplish a high pick out cross-coupled filter positive coupling can formally be obtained by a magnetic coupling structure[2]- [3].A waveguide type structure can be fabricated on a substrate by adding vias between the microstrip line and the ground plane. Such a device will behave as a high pass filter and is attractive because it is easy to fabricate. A model is set up that shows the s-parameter as a function of frequency. A sharp cutoff is shown at the expected frequency[4]. Both electric coupling and magnetic coupling is ordinarily used in the designing of quasi-elliptic filter this is to a greater extent commodious to enclose magnetic coupling in the one layer substrate integrated waveguide by employs a magnetic and electric coupling. we suggest an electric coupling structure in a one layers substrate integrate waveguide accomplish a high coupled coefficient and spacious coupled effectiveness roll.

show examples, the construction together substantial electric coupled or encompassing electric coupled[5] Its coupling were characterized by simulating this complex figure. Symmetry contrives into the double cavity has changed, on first together with an electrically outline magnetic border. Status to severally indicate f and f the resounding frequency the entire formation, the coupling coefficient.

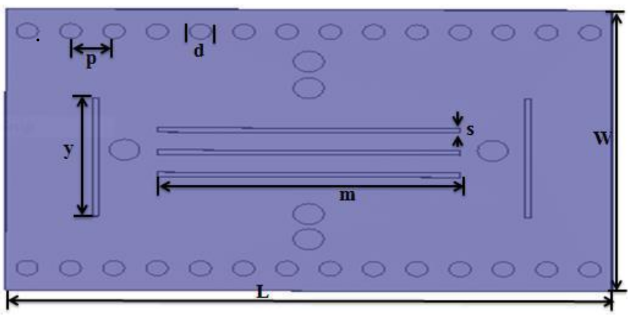

Fig 1. The proposed bandpass filter structure

TABLE I. DIMENSIONS OF PROPOSED BANDPASS FILTER

Symbols	Optimized value
W	19 mm
L	28 mm
D	0.7 mm
H	0.5 mm
m	14 mm
y	7 Mm

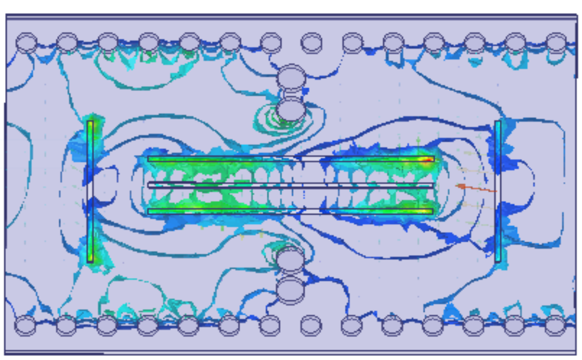

Fig 2. E- field of the proposed TE_{10} mode

II. The Proposed Structure

Fig 1. shows the proposed mixed electric and magnetic coupling structure. The structure is designed on Rogers RT Duroid 5880. In this model, we have created three horizontally slots etched on an upper metallic plate of SIW and two vertically slots. We have used copper metal with substrate thickness h= 0.5mm. The diameter,d of metallic cylinders embedded on the sidewalls of SIW is 0.7mm and distance between two adjacent via-holes p is fixed to be 1mm. Length of each horizontal slots is 14mm and the vertical slot is 7mm.

The central resonant frequency of the proposed bandpass
a filter is decided using (1) and the extent of coupling is determined by (2).

$$f_o = \frac{c_o}{2\sqrt{\varepsilon_r}}\sqrt{\frac{1}{a^2{}_{ff}}+\frac{1}{b^2{}_{ff}}} \quad (1)$$

$$a_{eff} = a - \frac{d^2}{0.95p} \quad (2)$$

$$K = \frac{w^2{}_{odd} - w^2{}_{even}}{w^2{}_{odd} + w^2{}_{even}} \quad (3)$$

$$K = \frac{M_c - E_c}{1 - M_c E_c} \quad (4)$$

$$M_c = \frac{L_m}{L} = \frac{1}{2}\left[\frac{w^2{}_{odd} - w^2{}_o}{w^2{}_{odd} - w^2{}_m} + \frac{w^2{}_{even} - w^2{}_o}{w^2{}_{m} - w^2{}_{even}}\right] \quad (5)$$

$$E_c = \frac{C}{C_{mm}} = \frac{w^2{}_m}{2w^2{}_o}\left[\frac{w^2{}_o - w^2{}_{odd}}{w^2{}_m - w^2{}_{odd}} + \frac{w^2{}_o - w^2{}_{even}}{w^2{}_{even} - w^2{}_m}\right] \quad (6)$$

$$\frac{w_o}{w_m} = \sqrt{\frac{M_c}{E_c}} \quad (7)$$

III.Method

We suggest a most going towards to theory of cross-coupled adjective gradiently suffix optimizable approach. The gradient of the cost function with respect to changes in the coupling elements between the resonators is determined analytically the topology of the structure is strictly enforced at each step in the optimization thereby eliminating the need for similarity transformations of the coupling matrix

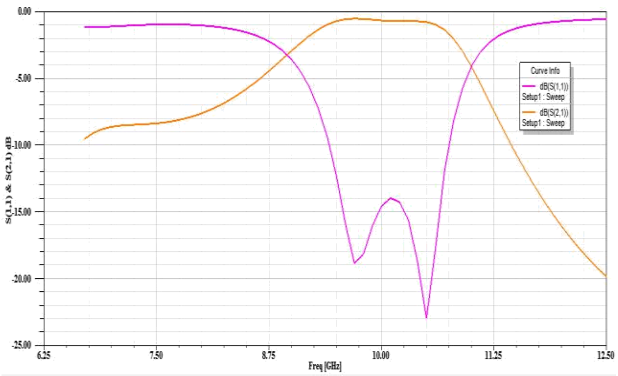

Fig 3. A frequency response of the proposed bandpass filter

III. Results and discussion

The bandpass filter achieves an insertion loss better than 0.9 dB and returns loss higher than 14 dB at a frequency of around 10 GHz.The insertion loss is improved by reducing the distance between metallic copper cylinders lower than twice the diameter of the cylinder. Simulated frequency response is shown in fig 3.

IV. Conclusion

In this clause, a substrate integrates waveguide structure with mixed electric and magnetic coupling enforced on a single layer substrate has been bestowed. Three - slot lines are inserted with a cylinder between progress mixed coupling. The electrical and magnetic coupling durability can be severally restricted by adapt the dimensions of the slot lines takedown and take up stopband can be produced. Using mixed coupling has been done to demonstrate the validity of K-band mixed coupling.

V. Reference

[1] Deslandes D and Wu K (2003) Single-substrate integration technique of planar circuits and waveguide filters. IEEE Transactions on Microwave Theory and Techniques 51, 593–596.

[2] Chen X-P, Hong W, Cui T, Hao Z-C, and Wu K (2005) Substrate integrated waveguide elliptic filter with transmission line inserted inverter. Electronics Letters 41, 851–852.

[3] Chen X-P and Wu K (2008) Substrate integrated waveguide cross-coupled filter with negative coupling structure. IEEE Transactions on Microwave Theory and Techniques 56, 142–149.

[4] Wang R, Zhou X-L and Wu L-S (2009) A folded substrate integrated waveguide cavity filter using novel negative coupling. Microwave and Optical Technology Letters 51, 866–871.

[5] You CJ, Chen ZN, Zhu XWand Gong K (2013) Single-layered SIW post loaded electric coupling-enhanced structure and its filter applications. IEEE Transactions on Microwave Theory and Techniques 61, 125–130.

[6] Potelon B, Favennec J-F, Quendo C, Rius E, Person C and Bohorquez JC (2008) Design of a substrate integrated waveguide (SIW) filter using a novel topology of coupling. IEEE Microwave and Wireless Components Letters 18, 596–598.

[7] Yan T, Tang X-H, Xu Z-X and Lu D (2016) A novel type of bandpass filter using complementary open-ring resonator loaded HMSIW with an electric cross-coupling. Microwave and Optical Technology Letters 58, 998–1001.

[8] Shen W, Sun X-W, Yin W-Y, Mao J-F and Wei Q-F (2009) A novel single-cavity dual mode substrate integrated waveguide filter with non-resonating node. IEEE Microwave and Wireless Components Letters 19, 368–370.

[9] Shen K, Wang G-M, Fu S-H and Gu G-D (2009) Highly selective bandpass filter based on substrate integrated waveguide. Electronics Letters 45, 746–747