Compact MMR ultra wideband bandpass filter with improved selectivity

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***Abstract* - In this study a new novel UWB bandpass filter is presented and its design procedure is discussed .The filter consist of multiple-mode resonator(MMR) with equally spaced rectangular slots for providing passband between (3.1-10.6GHz) and connected with stepped impedance resonator for controlling transmission zeros at passband edges. Interdigital coupled lines in the filter helps to improve the coupling at input and output lines.The simulated BPF has insertion loss is less than 1 dB throughout the passband.**

***Keywords*-MMR, UWB, Transmission zeros, Interdigital coupled lines**

I. INTRODUCTION

Ultra Wide Band technology has gained popularity in this era due to its vital applications such as satellites, WLAN, Wi-max etc. Although there are many such devices being employed to satisfy these applications, there is also a requirement of compactness. New novel methods and design structures had significantly advanced the development of Ultra Wide Band filters [1-11].

Compact Bandpass filter [6] had been proposed using Uniplanar Compact-electromagnetic bandgap(UC-EBG) and foliated UC-EBG(FUC-EBG).These structures [6] had considerable size reduction of 20-22% compared to the Multiple-mode resonator. The structure [1] is Photonic band gap(PBG) exhibits slow wave effect due to which PBG lattice is only 0.1λo at the cutoff frequency. Mushroom like electromagnetic bandgap structure [7] brings shorter cell length ,better characteristics and no backward radiation.

Since MMR structure are simple and easier to operate in ultra wideband frequency, MMR is preferred over other structures. The MMR structure in Ref[4] is a embedded EBG MMR structure which consists resonant modes of which first three resonant modes between(3.1GHz-10.6GHz) and fourth mode is being placed at coupling transmission zero of interdigital coupled-lines which helps to operate the MMR structures at two sides. In filter structure[5]MMR is formed by loading three open ended stubs in shunt to a simple stepped impedance resonator in center and two symmetrical locations .Introducing split ring resonator(SRR) in MMR[10] structure separates two band of frequencies. In [8] Ultra wideband MMR filter with dual spur lines and stepped impedance stub resonator makes it possible to achieve dual notch band.

This work attempts to develop a compact and novel bandpass filter structure with minimal insertion loss as well as high selectivity. The filter operates in the range of 3.1GHz-10.6GHz and finding its applications in wireless, satellite etc .The filter design is made on MMR with interdigital coupled lines since it is easier to design less spurious responses and compatible to work in ultra wide band frequency range.

II. RELATED WORK

In Ref[4] the MMR structure to achieves improved out-of-band performance characteristics is a combination of stepped impedance resonator and interdigital lines that are properly tapered to compensate the phase imbalance or group delay near the UWB upper-end relying . The measured insertion losses is less than 1dB and return loss less than 10Db which is quite promising .Ref[10] introduces split ring resonators to reject undesired frequency signals. Ref[2]depicts a multiple-mode resonator which transmits the signal in whole passband(3.1GHz-10.6GHz).In the proposed design there is considerable minimization in insertion loss and enhanced selectivity and results are comparably good with other structures

III. DESIGN OF PROPOSED MMR FILTER

Fig. 1 shows the structure of the proposed UWB filter. The filter consists of a multi-mode resonator (MMR) with interdigital coupled lines for providing less ripple between the ultra wideband frequency range and connected with a stepped impedance structure.

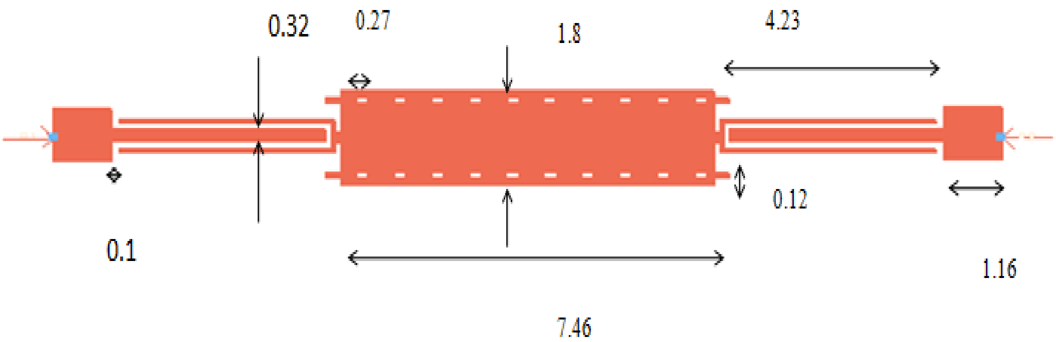

Fig1-Layout design of proposed filter

The stepped-impedance structure comprises of a high impedance section (θ2, Z2) and a low impedance section (θ1, Z1). By varying the dimensions (θ2, Z2,θ1 and Z1) of the stepped-impedance structure, the transmission zero frequencies can be determined thereby improving passband selectivity

Fig. 2 shows the equivalent transmission line model of the proposed filter. The MMR shown in Fig. 1 can represented using the equivalent circuits of even and odd mode . Therefore to analyze the proposed MMR structure odd and even modes are calculated. The even mode input admittance (Yine) can be calculated as

$$Y_{ine} = \frac{B + j\tan(\theta 3/2)A}{Z3(Z3A + j\tan(\theta 3/2)B} \qquad (1)$$

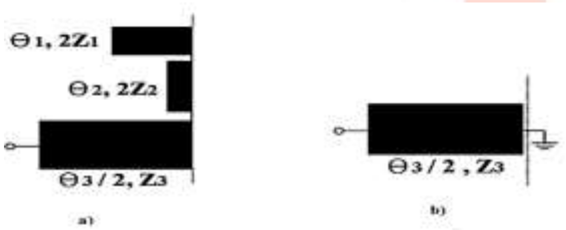

Fig-a)Odd b)even modes

The odd mode resonance input admittance (Yino) can be calculated as

$$Y_{ino} = \frac{1}{jZ3\tan(\theta 3/2)} \qquad (2)$$

where

A= $-jZ_1Z_2 + 8Z_2^2 \tan\theta_1 \tan\theta_2$

B= $4Z_2Z_3 \tan\theta_1 + Z_1Z_3 \tan\theta_2$

The input impedance Z_{in} is given by

$$Z_{in} = jZ_2 \frac{(K_y - \tan\theta_1 \tan\theta_2)(K_y \tan\theta + \tan\theta_2)}{K_y(1-\tan^2\theta_1)(1-\tan^2\theta_2) - 2(1+K_y^2)\tan\theta_1 \tan\theta_2} \qquad (3)$$

Ky-Impedance ratio

$$K_y = \frac{Z_1}{Z_2} \qquad (4)$$

The length of the resonant mode is selected asθ1=θ2=θ. The first three resonant frequencies can be derived as

$$\theta(f_1) = \tan^{-1}\sqrt{K_y}$$
$$\theta(f_2) = \frac{\Pi}{2}$$
$$\theta(f_3) = \Pi - \tan^{-1}\sqrt{K_y} \qquad (5)\text{-}(7)$$

Thus equivalent design gives the proper design of modified MMR structure. These parameters makes possible to construct a compact bandpass filter which is easily operable in UWB range.

IV. RESULTS

The proposed filter is simulated on Rogers 3010 substrate with h=1.27mm thickness with permittivity 10.2 and loss tangent 0.0035 on Advanced Design System(ADS) software .Simulated results in Fig3 exhibit an ultrawide passbsand from 3.1GHz to 10.6GHz.Insertion loss of this structure is less than 1dB and the return loss is lower than 10dB. These results are comparatively better to that of ref[2].

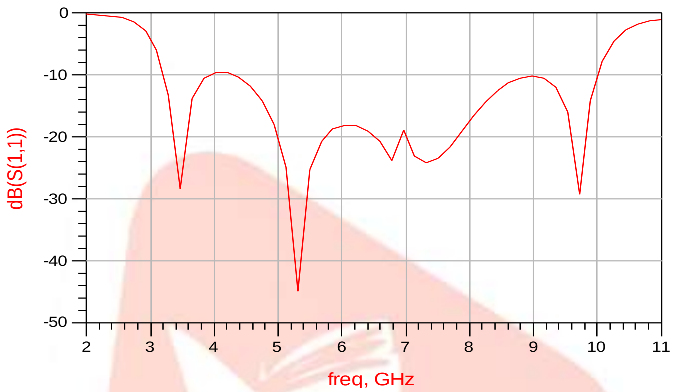

Fig 3-Return loss S(1,1)

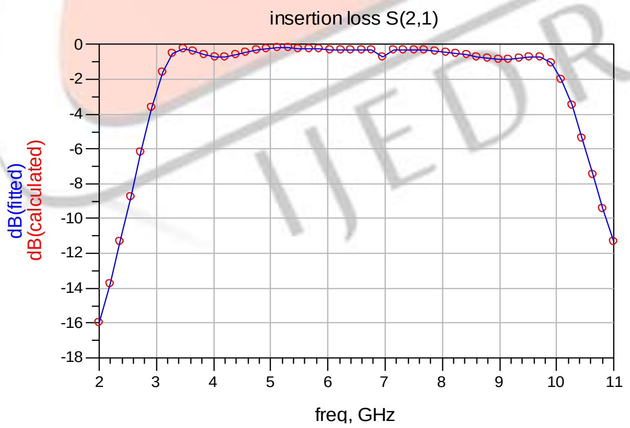

Fig-4 Insertion loss

Table 1

	PROPOSED STRUCTURE	REF[2]
INSERTION LOSS	Lower than 1dB	Nearer to 0dB
RETURN LOSS	Lower than 10dB	Lower than 10dB

V. CONCLUSION

In this paper, a novel bandpass filter has been developed and presented .A new approach of using equally spaced rectangular slots has also been introduced. This technique can be used in UWB communication system without changing its performance characteristics .The slots in MMR regulates ultra wideband frequency to pass through with minimum ripples. The proposed filter can be combined with UWB communication systems.

VI. FUTURE SCOPES

This work presents a new MMR filter with better insertion and return loss. Still methods are to be introduced to minimize the ripples in passband thereby improving the overall performance of the filter and finding its suitable application in various fields.Studies and further research can be made to include four notch bands with novel modified structures with minimized ripples and possibly finding its application in wireless, satellite applications, WLAN, Wi-max etc.

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