

Microstrip Band Pass Filter At 6 GHz For WiMAX

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Abstract - Modern microwave communication system requires mainly in satellite and mobile communications, high performance wide- band pass filter having low insertion loss and high selectivity with linear phase in the passband . Usually this criteria are fulfilled using dielectric resonator cavity filters because of their less loss. In order to reduce size, weight and cost ,there will be grown interest in their planar structure .The disadvantages of high conductor loss of planar filters using conventional conducting thin films can be less by replacing with high- temperature semiconducting (HTS) thin films .These can have a very low conductor loss. An another way by combining with active MMIC devices compensate the loss.Under those driving force many types of microstrip filter can be develop. In this paper we discuss end couple band pass filter at millimeter wave frequency for same permittivity same condition .Both equal-ripple and butterworth end couple band pass filter are designed at 6 ghz for 3.02 for permittivity value and having a FBW of 0.083 .The cost and fabrication problems are much less since it uses as thick film process. The design and simulation are performed using 3D full wave electromagnetic stimulator IE3D.

Index Terms- Band pass filter ,wiMAX ,Coupled lines ,Micro strip filter,Milimeter wave filters.

I. INTRODUCTION

The advances of telecommunication technology arising hand in hand with the market demands and governmental regulation push the invention and development of new applications in wireless communication . In this paper, filters are optimised for high performance and efficient cost and effective fabrication method is proposed Microstrip technology is used for simplicity and ease of fabrication.The design and stimulation are performed using 3d full wave electromagnetic stimulator IE3D. This filter is mostly used in radar ,satellite and terretersial communication application.

II. MICROSTRIP FILTER DESIGN

The general configuration of an end couple microstrip band pass filter is illustrated in fig. where each end of microstrip resonator approximately is half wave guided is long as the midband frequency f_0 of the band pass filter [1]. The coupling from one resonator to other is through the gap between the adjacent the open ends, hence it is capacitive . the gaps can be represented as inverters[1].These J-inverters tend to reflect the high impedance levels to the ends of each of the half wavelength resonators ,and it can be shown that this cause the resonator to a shunt type resonance . Thus the filter under consideration operates like the shunt resonator type of filter whose general equations are considered as given as follow:

$$J_{01}/Y_0 = \sqrt{(\prod \text{FBW}/2g_0g_1)} \quad (1)$$

$$J_{j,j+1}/Y_0 = (\prod \text{FBW}/2)^{1/n} (g_jg_{j+1}) \quad j = 1 \text{ to } n-1 \quad (2)$$

$$J_{n,n+1}/Y_0 = \sqrt{(\prod \text{FBW}/2g_n g_{n+1})} \quad (3)$$

Where $g_1, g_2, g_3, g_4, \dots, g_n$ are the element of a ladder low pass prototype with a normalized cut off $\Omega_c=1.0$ and FBW is the fractional bandwidth of band pass filter. The $J_{j,j+1}$ are the characterise of J-inverters and Y_0 is the admittance of the microstrip line [3]

Considered the capacitive gaps act as a perfect series capacitance discontinuities of susceptance $B_{j,j+1}$ as

$$B_{j,j+1}/Y_0 = (J_{j,j+1}/Y_0) / (1 - (J_{j,j+1}/Y_0)^2) \quad (4)$$

$$\Theta_j = \prod -1/2 [\tan^{-1} (2 B_{j,j+1}/Y_0) + \tan^{-1} (2 B_{j-1,j}/Y_0)] \text{ radians} \quad (5)$$

Where the $B_{j,j+1}$ and Θ_j are evaluated at f_0 . Note that the second hand on the right side of second equation indicates the absorption of the negative electrical length of the J-inverters associated with the j th half wavelength resonator .

As refer the equivalent circuit of microstrip gap, the coupling gaps $s_{j,j+1}$ of the microstrip end coupled resonator filter can be determined as

$$C_g^{j,j+1} = B_{J,J+1}/\omega_o \quad [6]$$

Where $\omega_o = 2\pi f_o$ is the angular frequency at the midband.

These new application offer certain application in telecommunication services that in turn offer three important items to the customers. The first is the coverage, meaning each customer must be supported with a minimal signal level of electromagnetic waves, the second is capacity that means the customer must have sufficient data rate for uploading and downloading of data, and the last is the quality of services (QoS) which guarantee the quality of the transmission of data from the transmitter to the receiver with no error. In order to provide additional transmission capacity, a strategy would be to open certain frequency regions for new applications or systems. WiMAX (Worldwide interoperability Microwave Access) which is believed as a key application for solving many actual problems today.

In realization of such a system like WIMAX we want a complete new transmitter and receiver .A bandpass filter is an important component must be found in the transmitter and receiver .Band pass filter is a passive component which is able to select signals inside a specific bandwidth at a center frequency and rejects signals in another frequency region mainly in frequency region which have the potential to interfere the information class .In designing the bandpass filter we are faced the question ,what is the maximum losses inside the pass region and the minimum attenuation in the reject region .

In the process to fulfil these requirement there are

Type	Physical Length	Width	Gap
Equal-ripple BPF	$l_1=l_3=9.47$ $l_2=10$	$W=1.6$	$s_{01}=s_{34}=0.038$ $s_{12}=s_{23}=0.81$
Butterworth BPF	$l_1=l_3=8.21$ $l_2=8.47$	$W=1.6$	$s_{01}=s_{34}=0.075$ $s_{12}=s_{23}=0.810$

several strategies taken in realization of the filter , for example, the choice of waveguide technology for the filter is preferred in respect to the minimal transmission loss (insertion loss). This strategy is still actual in satellite applications. The effort to fabricate waveguide filters prevents its application in huge amounts. As alternative, microstrip filter based on printed circuit board (PCB) offers the advantages easy and cheap in mass production with the disadvantages higher insertion losses and wider transition region. In this work we would like to give a way to conceive, design and fabricate bandpass filter for the WiMAX application at the frequency 6 GHz with end-coupled microstrips, which designed filter for wireless local area network 6.25 GHz, and which used the capacitive resonators and stepped impedance resonators for filter realization. Therefore, by extension, the RF/microwave applications can be referred to as communications, and other that explore the usage of frequency spectrums; some of these frequency spectrums are further divided into many frequency bands.

$$l_j = (\lambda_{g0}/2\pi) \Theta_j - \Delta l_j^{e1} - \Delta l_j^{e2} \quad (7)$$

where $\Delta l_j^{e1,e2}$ are the effective lengths of the shunt capacitances on the both ends of the resonator j . because the shunt capacitances $C_p^{j,j+1}$ are associated with the series capacitances $C_g^{j,j+1}$ as defined in the equivalent circuit of microstrip gap, they are also determined once $C_g^{j,j+1}$ in equation are solved for the required coupling gaps. The effective lengths can then be found by[1]

$$\Delta l_j^{e1} = (\omega_o C_p^{j-1,j} / Y_0)(\lambda_{g0}/2\pi) \quad (8)$$

$$\Delta l_j^{e2} = (\omega_o C_p^{j,j+1} / Y_0)(\lambda_{g0}/2\pi) \quad (9)$$

III. STIMULATION RESULTS

In order to verify the validity of the above expression in millimeter wave regime a simulation study was performed using IE3D. To get the exact response for our purpose of an optimized filter was performed using software. The dimensions of the filter are given in the following tables the stimulated filter response are depicted below

TABLE 1
DIMENSIONS OF THE FILTERS FOR $n=3$ (in mm)

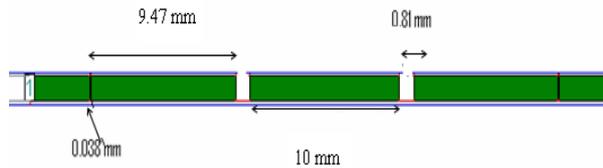
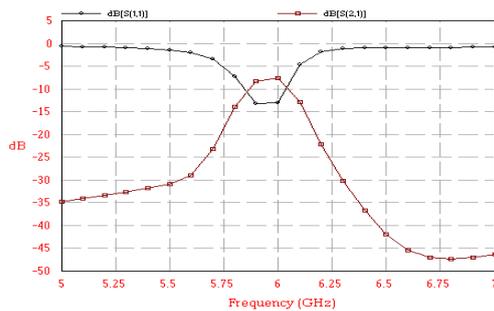


Fig.1. Layout of equal-ripple BPF on a substrate with a relative dielectric constant of 3.02 and a thickness of 0.672mm



The physical length of resonator is given by

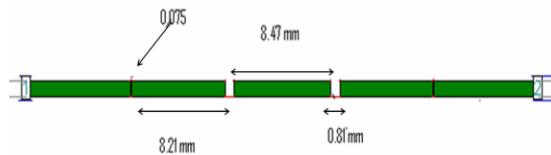


Fig 3. Layout of end couple BPF on a substrate with a relative dielectric constant of 3.02 and thickness of 0.672mm

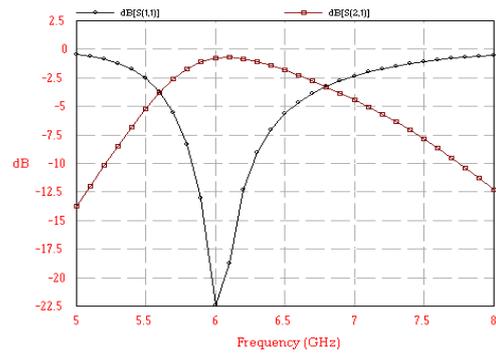


Fig 4 full wave EM Simulated frequency response of the filter for $\epsilon_r = 3.02$ and $h = 0.672$ mm.

IV. RESULT & ANALYSIS

The conventional geometry of the band pass filter, shown in fig1, the stimulated response of the conventional geometry in fig.2. The attenuation decreases at 6GHz frequency shows in fig2, for the band edge frequency of 5.58GHz and 6.15GHz. The conventional geometry of band pass filter shown in fig3. The stimulated response of the conventional geometry in fig4., the attenuation decreases at 6GHz frequency shown in figure for the band edge frequency of 5.75 and 6.75GHz, we getting a sharp curve off at 6GHz & maximum flat response without any ripple in the pass band with no attenuated frequency in the desired band. Considerable improvements in the frequency response can be seen.

V. CONCLUSION

The filters are the very important part of the microwave system, not only in microwave but they are also important in communication field. Any communication system cannot be designed without filters. The stimulated end couple band pass filter achieved an insertion loss is less than 1.0dB and both filters are designed on 0.672mm thick substrate for $\epsilon_r = 3.02$ with loss tangent 0.0016. Considerable improvements in the frequency response can be seen.

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