Microstrip Coupled Band Pass Filter using Parallel Coupled Lines used for EMI Reduction

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Abstract**—***The use of BPF is in telecommunications wireless systems. The signal to be transmitted and which they are received are filtered at a center frequency having some significant bandwidth. This paper comprises a brief knowledge related to designing of a band pass filter (BPF) using microstrip parallel coupled line structure for reduction of noise and EMI. The band pass filter has a center frequency of 2.45GHz having less insertion loss and more than 20dB return loss in its pass band having more than 5% moderate bandwidth is successfully designed.The center frequency is selected such that it is mainly used in WLAN network or high speed wireless broadband is configured to transmit data voice and video IP because system requires more bandwidth. The layout is designed such that centre frequency is 2.45GHz with a fractional bandwidth of 200MHz and impedance resonator length of each coupled line is seperated such that impedance is adjusted to 50Ω exactly.Two sections are mainly given in design: two coupled lines distinguished by a non-uniform line resonator.The impedance resonators gives a separate resonance to obtain the passband region or response.The simulation is perform out on a HFSS software..*

Keywords**— WLAN, FBW, Microstrip, Insertion los, Resonators, Dielectric substrate and parallel coupled line, EMI, Coupling Factor.**

I. INTRODUCTION

With the growth in technology in the field of telecommunication, the market demands and governmental regulations push the invention and development of new applications in wireless communication which not only provide services but also deal with the coverage, capacity and the quality of services (QoS) which guarantee the quality of the transmission of data from the transmitter to the receiver with no error. But a strategy would be to open certain frequency regions for new applications or systems, in order to provide additional transmission capacity. Today Wi4 (Worldwide interoperability version-4) is trusted as a main application for solving telecomm related actual problems. A microstrip patch antenna consists of a conducting patch of any planar or non-planar geometry on one side of a dielectric substrate with a ground plane on other side. It is a printed resonant antenna that is very popularly required for wireless links of narrowband microwave because of its semi-hemispherical coverage [1]. Microstrip Patch antennas are low cost, low profile, light weight, mechanically robust, easy to fabricate and analyses. The size of microstrip antenna is compact and the major parameters are radiation pattern and selective range in microstrip antenna. The microstrip antenna radiates a relatively broad beam broadside to the plane of the substrate. Thus the microstrip antenna has a very low profile, and can be fabricated using printed circuit (photolithographic) techniques. This implies that the antenna can be made conformable, and potentially at low cost [2].

Realization of system like Wi4 needs a complete new transmitter and receiver. Bandpass filter is a passive component found in the transmitter or receiver has the function of selecting a specific band frequency with a certain centre frequency,it avoids signal from another frequency region ie. It potentially restricts the frequency which interfare with the information signal. Designing a Bandpass filter requires knowledge related to the maximal loss inside the pass region, and the minimal attenuation in the reject/stop regions, and characteristics of the filter in transition regions [2].

So must require some consideration while designing in order to fulfill above requirements, for example, the choice of waveguide technology for the filter is preferred in respect to the minimal transmission loss (insertion loss) [3]. In this work we would like to give a way to conceive, design and fabricate Bandpass filter for the Wi4 application at the frequency 5.84GHz, (C-band) with parallel-coupled microstrip as opposed to the one which designed filter for WLAN 5.75GHz and designed with composite resonators and stepped impedance resonators for filter realization [4].

II. DESIGNING *BANDPASS FILTER*

In our Parallel-coupled microstrip filter designed the strips lines are arranged parallelly,which are close to each other, so that they are coupled with certain coupling factors.Designing equations are as:

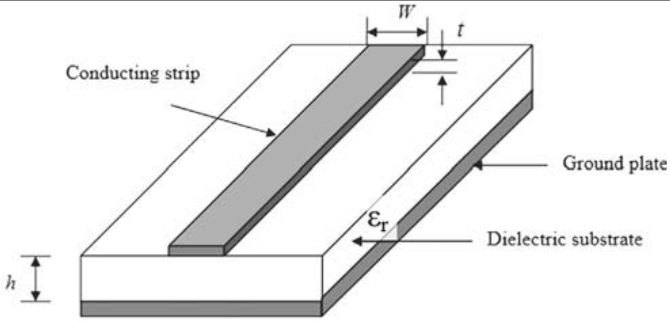

Fig. 1: Microstrip transmission line.

Step 1: Calculation of the Resonator length (RL1)
First we have to calculate lambda,
Lam=c/f=3x10^8/2.4x10^9=125mm
Resonator length (RL1) =lam/2*sqrt (4.4) =31mm
RL1=31mm
Similarly we have calculate for RL2 and RL3.
RL2=31mm and RL3=31mm
Step 2: Calculation of the feed length (Fl)
Feed length (FL) =lam/4*sqrt (4.4) =14.5mm
FL=14.5mm
Step 3: Calculation of the feed width (wf)-
A simple but accurate equation for Microstrip *Charateristic Impedance* is:

$$Z_0 = \frac{60}{\sqrt{\epsilon}} \ln\left(\frac{8h}{W} + \frac{W}{4h}\right) \quad \text{for } \frac{W}{h} \leq 1$$

$$Z_0 = \frac{120\pi}{\sqrt{\epsilon}\left[\frac{W}{h}\right] + 1.393 + 0.667 + ln\left(\frac{W}{h} + 1.444\right)} \quad \text{for } \frac{W}{h}$$

Where Z0=impedance
H=height of substrate
W=width of strip=?
Generally, feed width=2.7mm for 50ohm impedance
Feed width=1.4mm for 70 ohm impedance.
Feed width=0.7mm for 100 ohm impedance
Step 4: Calculation of the substrate length (Ls)-
Substrate length (Ls) =lam/4 =31mm
Ls=31mm
Step 5: Calculation of the gap between resonators (Rg)-
Gap (Rg) =0.02*lam to 0.05*lam
Rg=0.02*lam=2.5mm
In the above fig.2, the three parallel-coupled microstrip resonators formed in the design and so we can have more two resonators for other successive microstrips.
The width of the parallel couple microstrip lines 'wf' and separation between them 'g' can be calculated according to the rule describe in step [3, 5,].

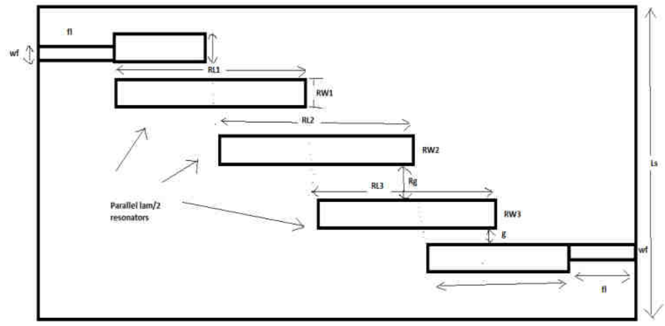

Fig.2: Top view of parallel coupled band pass filter (BPF)

III. RESULT AND ANALYSIS

We have designed the filter keeping in mind the parametric dimension of FR4 dilectric material with thickness 1.6 mm such that we could have the same during PCB fabrication. The dielectric substrate used in our design has a relative permittivity of 4.4 and tangent loss of 0.027. In order to obtain the wave impedance of 50 ohms in PCB fabrication, we designed the microstrip line whose strip width is 0.7 mm.

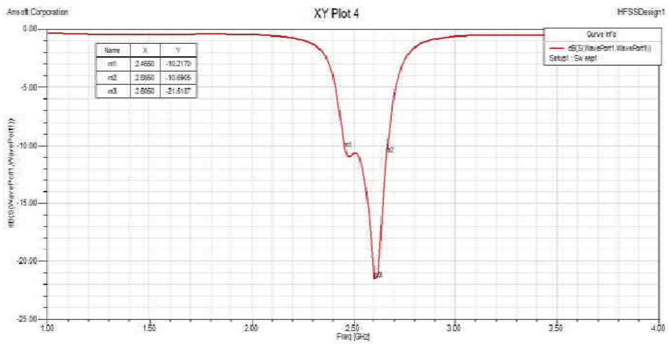

Fig.3:Return Loss (S11)

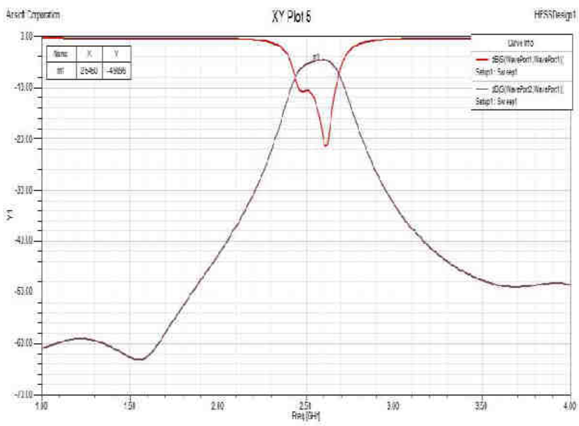

Fig.4: Insertion loss (S21) & return loss (S11)

Table1- Comparision table of coupling gap

Sr .No.	Gap of resonators	Freq range (GHZ)	S11 (dB)	S22 (dB)	S21 & S12 (dB)	BW (MHZ)
1.	Gap 2.3mm	2.54-2.65	-14.00	-22.39	-5.0	110
2.	Gap 2.7mm	2.45-2.65	-21.51	-22.98	-4.9	200

The fig.3 and 4 above is a simulated result showing the red is return loss (S11) and blue is insertion loss (S21) obtained for model. Figure 4 gives the reflection and transmission factor measured for the range 1 GHz to 4GHz. This result gives that the bandpass characteristics are indeed valid for a wide range of EM spectrum. In order to get detailed characteristics in the neighborhood .of 2.45 GHz, Figure 4 gives more information needed to quantify the measurement results. With the 3 dB boundary, we get about 200 MHz bandwidth, and insertion loss of -4.9 dB. with parametric dimension as given in Table.1.

As depicted from table.1, if the coupling gap between two parallel couple microstrips transmission lines is small then the impedance BW becomes low, it was found that coupling gap(g) 2.7mm provides a better result related to Bandwidth and also Relative frequency bandwidth. So, to designed parallel couple microstrip band pass filter we have taken the center frequency of 2.45Ghz.The order of filter used is n =3.

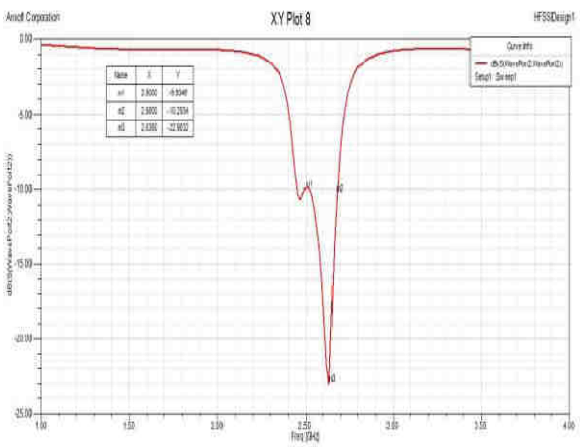

Fig.5: Return Loss(S22)

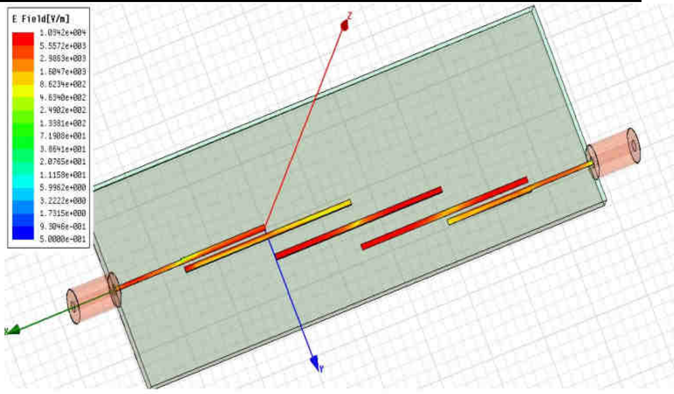

Fig.6: Current distribution of BPF filter

As shown in Fig.5 the current distribution of BPF. It shows that where the current is minimum & maximum. The red colours indicates current is maximum along the all resonators.

IV. CONCLUSION

The wideband band pass filter using microstrip coupled line impedance resonator structure used for 2.4GHz WLAN applications is presented here.The moderately wide band gives 200 MHz of relative frequency bandwidth. We also achieve a small size and relatively compact design of filter.

The designed filter is an efficient, high-performance and flexible filter. Because of frequency selective nature of BPF,it is used mainly in reception device for electromagnetic interference reduction. Also the nearer frequency channels are separate out by proper filtering at particular frequency band,

The results are better in insertion loss as well as return loss scenario which used at operating frequency of 2.45GHz frequency. The pass-band of the filter is accurate and free from any disturbances

By using filter the noise disturbances such as higher order harmonics, ripples, EMI etc. are reduced at very low level, so used in many of the transreceiver, satelliate links, mobile stations etc.

By optimization on resonator length and width with a specific gap (2.7 mm) between themselves we get a moderate wideband response.

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