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Design and Implementation of Lowpass Bandpass Diplexer

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ABSTRACT: A novel approach for miniaturised microstrip SIR lowpass filter and copled line banspass filter has been proposed. The matching circuit involved is a simple L shaped microstrip line.This has replaced the simple H- plane Tee involved in the previous papers. The microwave tees although simple introduces signicant loading of the lowpass circuit. The lowpass filter is an open circuited fifth order lowpass filter while the bandpass filter is a hybrid staircase shaped coupled resonator filter The measured results are in good agreement with the simulated responses.Different components proposed in this diplexer have been designed on the HFSS software.

KEYWORDS*:* SIR;coupled resonator; lowpass; microstrip; even and odd capacitance

I. INTRODUCTION

In modern wireless and mobile communication systems, RF/microwave filters are always important and essential components. Planar filters are usually the best choice as they are fabricated using the printed circuit technology and are also suitable for commercial purposes due to their compact size and low cost. Microwave filters are two port ,reciprocal, passive, linear device which attenuate heavily the undesired signals and allowing the transmission of unwanted frequencies. The type of construction of low pass filter consists of inductors and capacitors elements producing ideally zero reflection loss in the passband and high attenuation in the stopband region. The practical filters have small non-zero attenuation in passband, a small signal output in the attenuation or stopband due to the presence of resistive losses in reactive elements of propagating medium. Diplexers are key devices in wireless communication systems. Diplexer is a passive device that implements frequency domain multiplexing. Two ports (for example L and H) are multiplexed on to a third port(for example S)The signals on ports L and H occupy disjoint frequency bands. Consequently, the signals on ports L and H can co-exist port S without interfering with each other. In most diplexers, bandpass response with favorable selectivity has been the key area of emphasis. However, some mixer applications for dividing IF and LO frequency require managing low pass and band bandpass signals for example. Diplexers are usually desired to be planar, compact and low cost and thus numerous designs have been proposed. The more common approach is to combine two different filters with a micro strip tee junction or a microwave Tee junction. The key point is to design a well-behaved low pass filter and a couples line bandpass filter utilizes proper impedance matching.Bandpass filters are essential components in microwave communication systems. Besides, a microwave switch is also important in a radio frequency front end system.

II. DESIGN OF LOWPASS BANDPASS DIPLEXER

Fig 1 show the circuit schematic and coupling structure of the proposed diplexer, respectively in low pass and bandpass filter . To obtain a dual band response, the proposed double diplexing structures shown in structure wherein the low pass filter is realized using the open circuited stub configuration and bandpass filter is realized using coupled resonator configuration.one micro strip line is used for micro strip coupled matching. The two filter performance such as isolation will be degraded when the two passbands become closer. The proposed structure consists of 5th order open circuited stub low pass filter.

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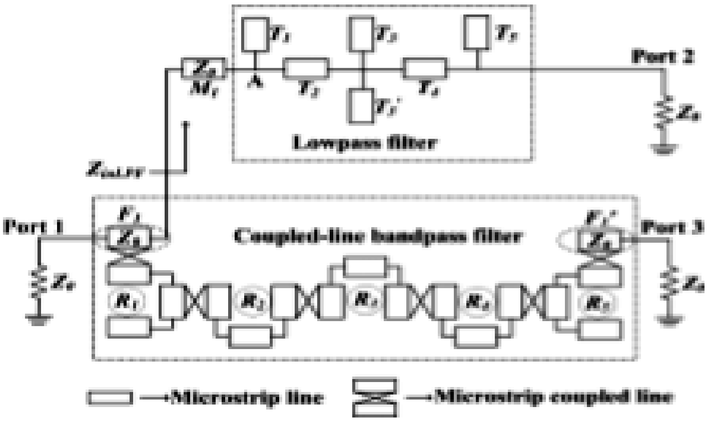

Figure 1 Circuit equivalent of the proposed structure

As well as it consists of hybrid staircase bandpass filter. The basic design is given in fig 1.where the low pass filter suffers from the loading effect. But the loading effect is reduced in fig 2. due to the hybrid bandpass filter. This paper presents a simple design for the matching requirement of a low pass bandpass diplexer. Hence, the low pass, band pass diplexer can be designed.

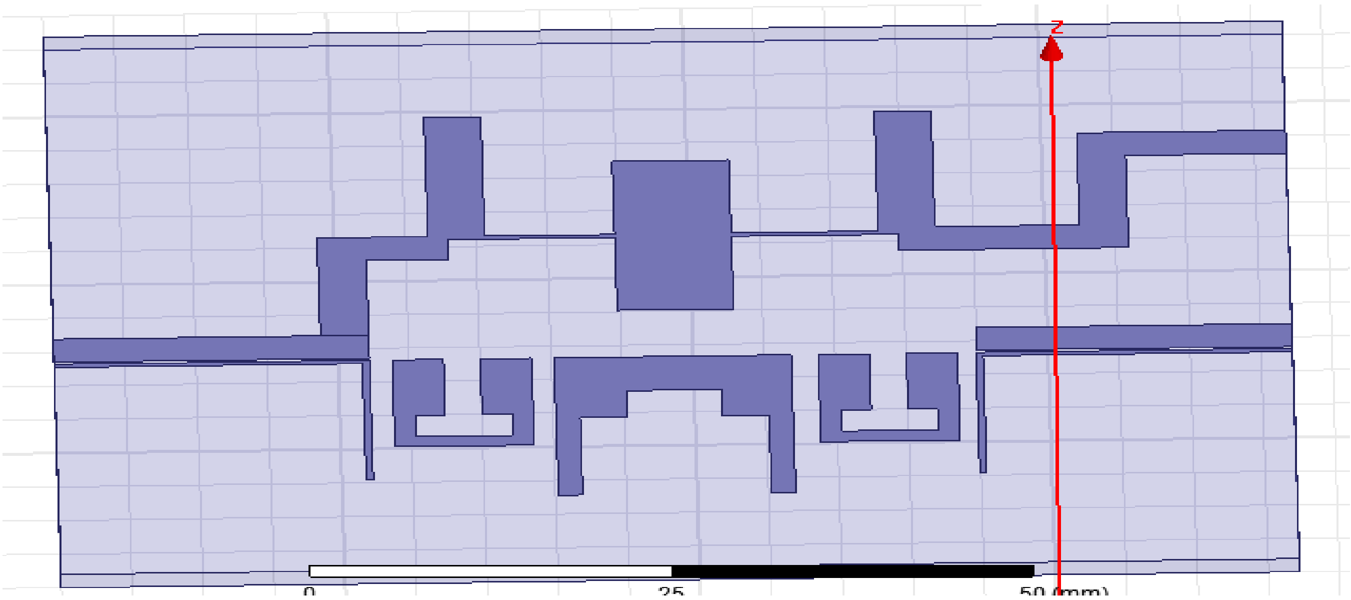

Figure 2 Base paper design

For the bandpass channel design, the characteristic impedance of the transmission line of the matching section should be set at Zo(the system impedance).The loading on the low pass filter can be ignored because the coupling between the resonators of the bandpass filter and input coupled feedline approaches zero. Hence the low pass filter and bandpass filter can be separately designed.

The proposed diplexer was fabricated on a Rogers RO 4003C substrate with a thickness of 1.524mm, relative dielectric constant of 3.55 and a loss tangent of 0.006. The low pass and bandpass filter can be designed separately. The low pass filter is designed for a fifth order Chebyshev response and a 0.5 dB equal ripple. For the bandpass channel design, the characteristic impedance of the transmission line (Fig. 2) should be set at (the system impedance);

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otherwise, it may cause an unwanted return loss at Port 1 when the signal is operated in the low pass band. Because the input impedance is designed to approach an open circuit around the bandpass band, the transmission line behaves in the manner of the coupled feed line of the BPF. Therefore, the coupled resonator BPF with coupled feedlines, as suggested in Chapter 8of [6], can be designed in the proposed low pass-bandpass diplexer, as shown paper presents a simple design for the matching requirement of a low pass bandpass diplexer. Hence, the low pass, band pass diplexer can be designed. For the low pass filter, the open stubs can be transformed into shunt capacitors and the series transmission lines with high characteristic impedance (T2 and T4) are close to the series inductors. The design equations of a 5th order low pass filter are given as:

$$\theta_{i=} \tan^{-1}\left(2\pi f_c C_i Z_i\right) \quad (1)$$

$$\theta_{k=} \sin^{-1}\left(\frac{2\pi f_c L_k}{Z_k}\right) \quad (2)$$

where fc is the cutoff frequency

$C_{i\,;}$,i=1,3 or 5

L_k; k = 2 or 4

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In the proposed low pass-bandpass diplexer, as shown inFig.3. The loading effect on the low pass channel circuit can be ignored because the coupling between the resonators of the BPF and input coupled feed line approaches zero when the signal is operated in the low pass band, that is, the mutual coupling interference can be neglected when the BPF is not operated around the resonance frequency and a similar concept was described in [5]. In other words, the low pass channel circuit can be independently designed under this feed line arrangement of the coupled resonator BPF with coupled feed lines. Based on the proposed design, the low pass filter and BPF can be separately designed, and the design procedure can be easily followed.

Figure3 and 5 shows the simulated scattering parameters of the proposed design. The simulation is made on HFSS 14 software.

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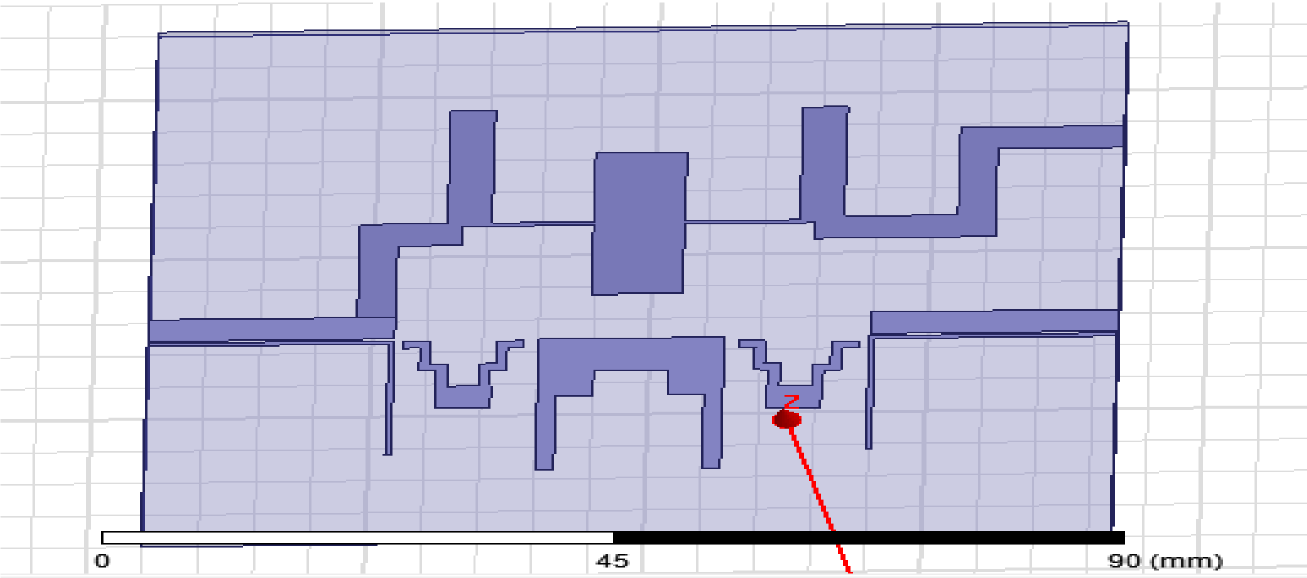

Figure 3 Modified structure

For the low pass channel, the measured in-band insertion loss -20log$|S_{21}|$ is less than 15dB.For the bandpass channel, the measured minimal insertion loss -20log$|S_{31}|$ is approximately 1.7 dB The measured isolation -20log$|S_{32}|$ between the passbands if greater than 43 dB.

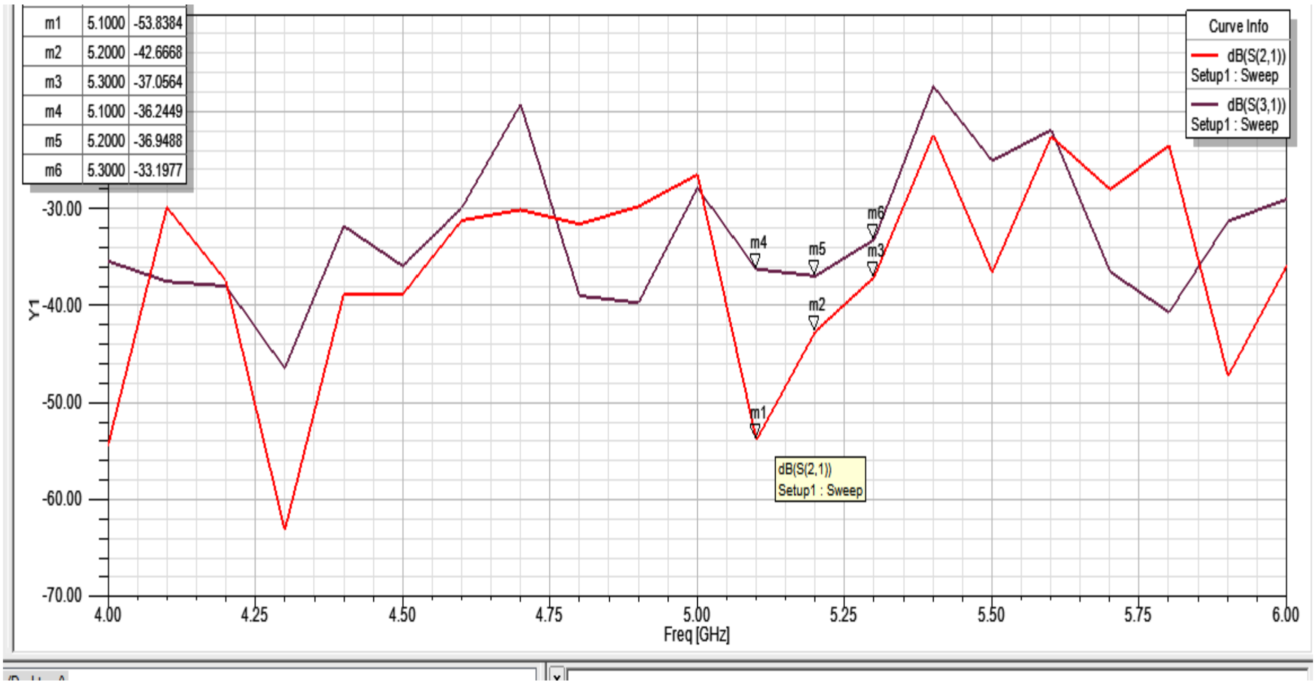

Figure 4 Insertion loss plots of lowpass filter and bandpass filter

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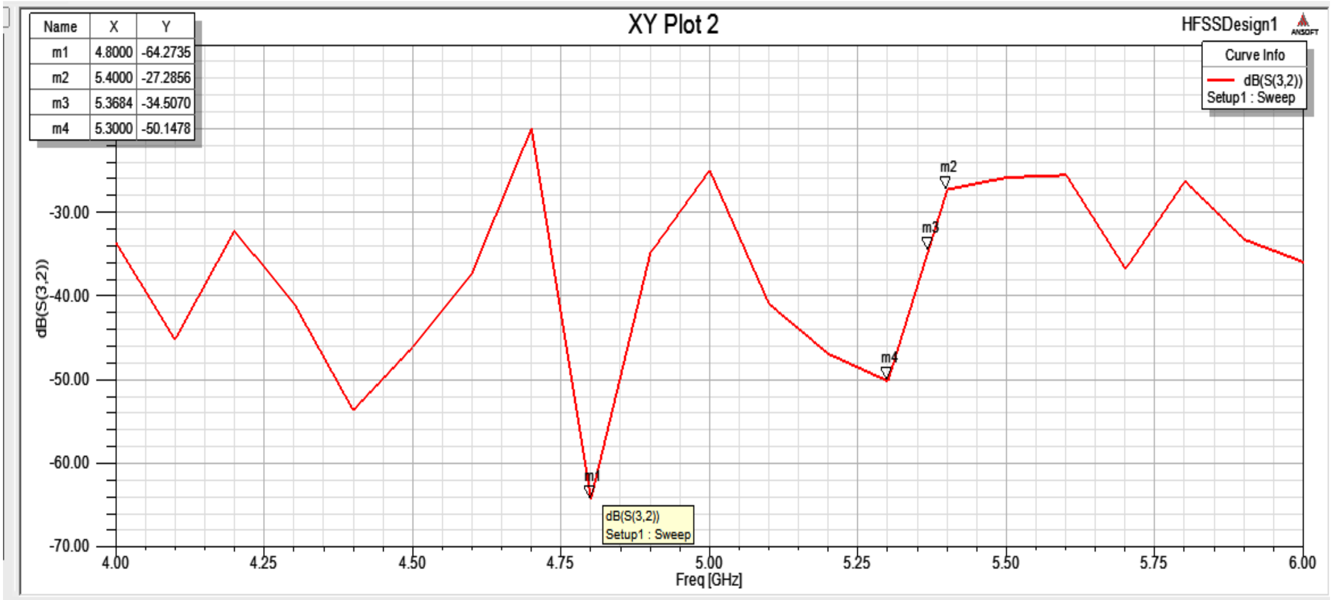

Figure 5 Isolation plot

TABLE 1 Comparison between basepaper and modified structure

Reference and this work	**Frequency of operation**	**In band insertion loss of low pass filter**	**Minimal insertion loss of bandpass filter**	**Isolation between two operating bands**
Basepaper	2.4GHz	Less than 0.25 dB	2.42 dB	Better than 35 dB
Modified structure	5.35 GHz	Less than 15dB	1.7 dB	Bette than 43 dB

III. CONCLUSION

The paper presents a new low pass, bandpass diplexer for low loss transmission with suppression of harmonics and favourable selectivity in different operating bands, respectively. Based on the proposed matching design, the low pass bandpass diplexer an independently design low pass and bandpass band circuit, which may make convenient the design process. The proposed circuit was carefully implemented, and the measured and simulated results are in good agreement.

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