Single Ring Dual-Band Bandpass Filter with Meander For WLAN Application.

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Abstract— **A single ring resonator dual-band bandpass filter using quarter-wavelength resonators suitable for WLAN applications is presented in this paper. Both side of ring resonator consist of quarter-wavelength parallel coupled lines. In further reducing the size of the filter, meander structure is applied to an existing design. Using different number of meander slots, a microstrip dual-band single ring resonator are applied and realized on FR4 substrate to suite filter operating at 2.5GHz and 5.2GHz. Simulation is carried out in analyzing the performance of the design using Advance Design System (ADS) and fabrication is done to validate the topology.**

Keywords: Dual-band Single Ring Resonator (DBSRR), filter, microstrip.

I. INTRODUCTION

Filter becomes an important role in modern wireless communication applications and in many microwave systems. The behavior of the design filter can gave a huge effect on the total design output and quality. Furthermore, filter is a compulsory component in obtaining the selected frequency response of any application [1-4]. Bandpass microwave filters, has an essential role to suits the broadband wireless access problem in the latest communication technologies deployment. Filter is one of significant component in the RF front ends (receivers and transmissions module) in communication design. Therefore, bandpass filters with good performance are highly demand in wireless communication environment. It plays an important role in processing only the wanted signal through the system and rejects unnecessary signals at both higher and lower frequencies. Therefore, characteristics such as of bandwidth, center frequency, insertion loss, selectivity or rejection, ripple and return loss are normally used to measure their performances [5-9].

Today the growing interest for dual-band bandpass filters is increasing drastically in modern communication applications with the demands in multiple functions and multiple bands. The advantages of dual-band bandpass filter is that it can select more than one band at a time or simultaneously to support multifunctional communication systems [1-9].

Dual-band filters being one of most important elements in communication systems. Therefore various design structure were presented on dual-band bandpass filter involves three main design structures which are single layer, cascaded and multilayer structure/topology. All design simulate and fabricate to achieve transmission zeroes at desire frequency and support dual frequencies resonance. Their consideration focuses on small size and compact which can be implemented in various applications.

Single layer filters play key component in wireless communication systems especially in the new developed wireless local area networks (WLANs) standards such as IEEE 802.11b/g (2.4 GHz) and IEEE 802.11a (5.2/5.7 GHz) specifications [1]. Taking advantages of compact size, high performance, low cost, simply design and easy fabrication [1] various microstrip structures are widely applied for realizing dual-band filters on single layer topology.

This paper demonstrates a topology for a dual-band bandpass filter using a single ring resonator. The topology is consisting of quarter wavelength line impedances, Z_{r1} as shown in Figure 1. Two quarter-wavelength line impedances taking part at the upper and bottom part of ring topology, with both side of ring resonator consist of quarter-wavelength parallel coupled-lines. All DBSRR topologies were simulated and tested using FR4 substrate with thickness of 1.6mm and dielectric constant of 5.4.

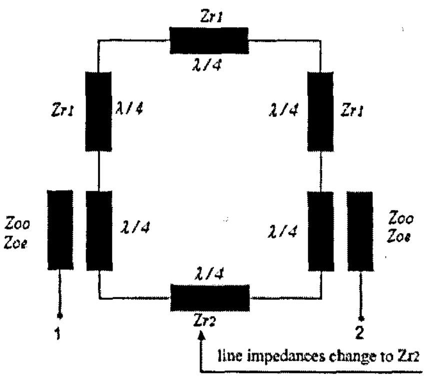

Figure 1: Circuit diagram of DBSRR topology.

TABLE 1: Parameters Value for Ideal DBSRR Topology.

Parameter	Values(μm)
W_{io}	1750.65
W_r	1000.90
W_c	600.40
L_c	7300.27
L_r	12000.88
G	290.71
L_{io}	7950.47

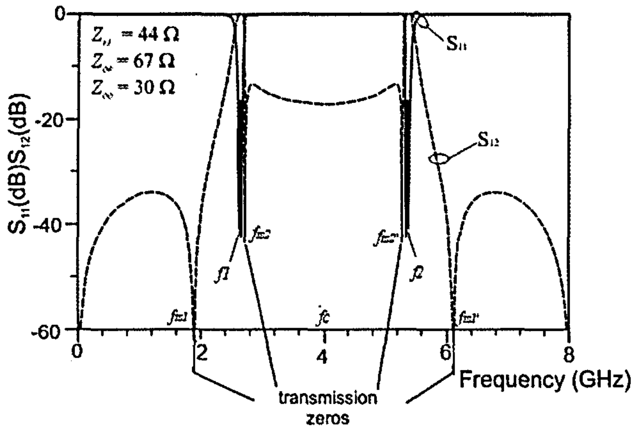

Figure 2: Ideal circuit microstrip simulation result

Based on Figure 1, a meander structure was applied to the original design in order to miniaturize the filter. 'U' shape meander is applied on top of design and replacing straight line structure of original design. The number 'U' shape of meander applied will effect on filter characteristics. By tuning the dimension parameters of DBSRR with meander structures, the characteristics of filter is defined, analyzed and compared with ideal design.

II. DBSRR WITH MEANDER IMPLEMENTED DESIGN AND MICROSTRIP SIMULATION

A. DBSRR circuit with ONE meander structure:

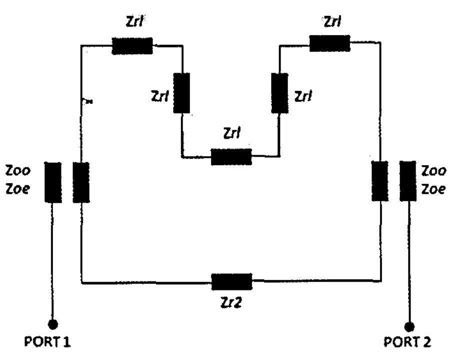

Figure 3: DBSRR circuit with **ONE** meander structure.

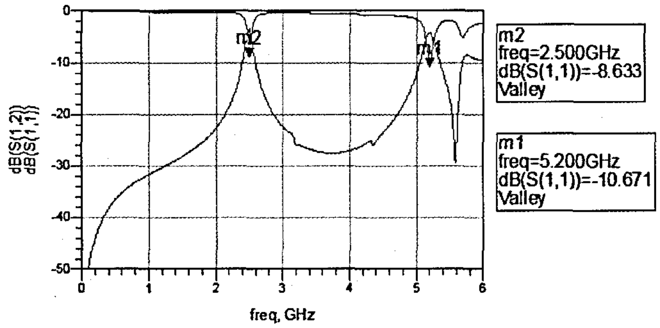

Figure 4: DBSRR circuit with **ONE** meander microstrip simulation.

B. DBSRR circuit with TWO meanders structure:

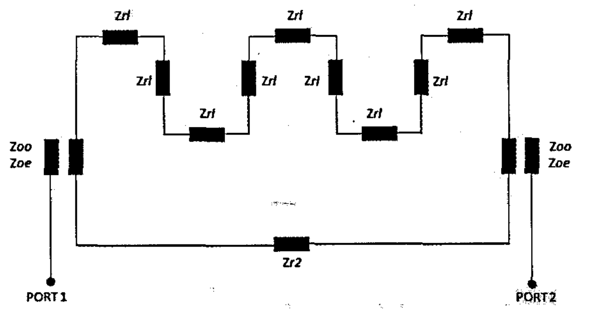

Figure 5: DBSRR circuit with **TWO** meanders structure.

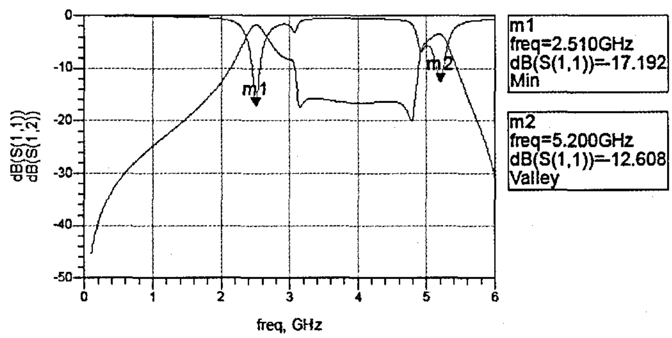

Figure 6: DBSRR circuit with **TWO** meanders microstrip simulation.

C. DBSRR circuit with THREE meanders structure:

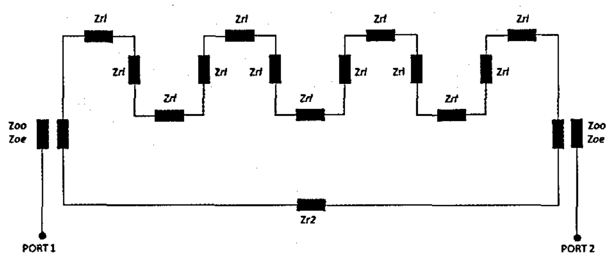

Figure 7: DBSRR circuit with **THREE** meanders structure.

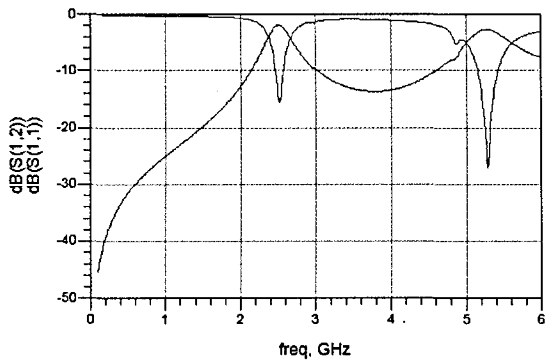

Figure 8: DBSRR circuit with **THREE** meanders microstrip simulation.

D. DBSRR circuit with FOUR meanders structure:

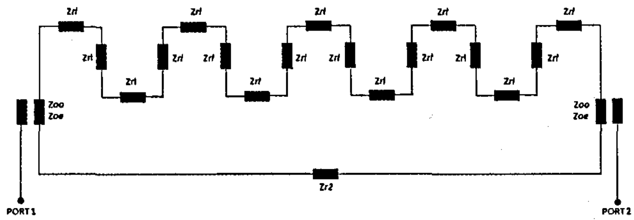

Figure 9: DBSRR circuit with **FOUR** meanders structure.

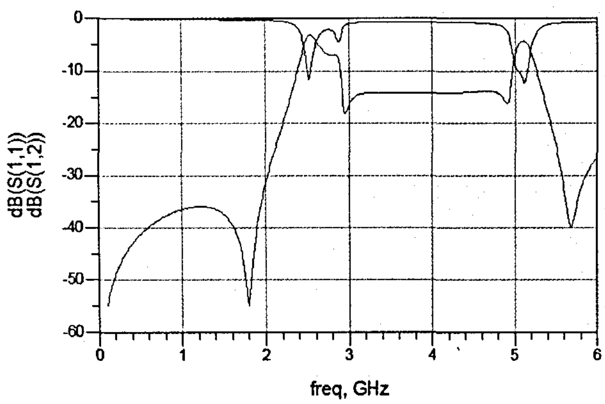

Figure 10: DBSRR circuit with **FOUR** meanders microstrip simulation.

E. DBSRR circuit with SIX meanders structure:

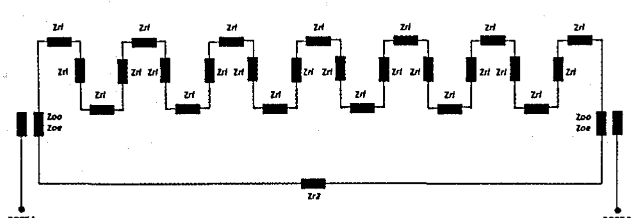

Figure 11: DBSRR circuit with **SIX** meanders structure.

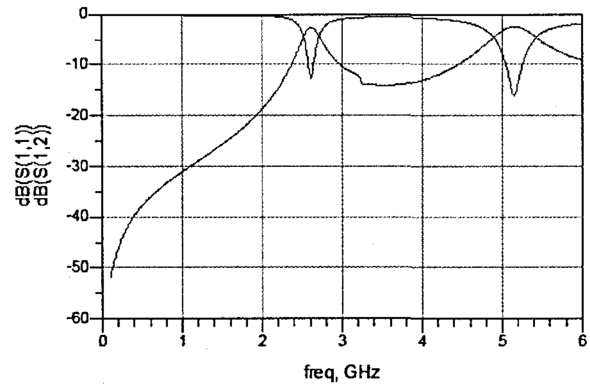

Figure 12: DBSRR circuit with **SIX** meanders microstrip simulation.

Modifications on ideal circuit of DBRSS were done by implementing meander structure in the design. The number meander structure was increased to identify the contribution of coupling effect phenomenon to microstrip simulation result. Figure 3 - figure 12 shown the modification circuits and microstrip simulation results are done in this paper accordingly.

Figure 4, and figure 8 which are implemented one and three meanders structure accordingly haven't had isolation between lower and upper passbands. Coupling effect phenomenon which is increase capability to store charge in these topologies filter erased isolation behavior of filters. Therefore lower and upper passbands is not separate properly and it characteristics differ compare to original characteristics of design filter.

However, figure 6 and figure 10 which are implemented two and four meanders structure respectively, created isolation at 15dB between 3 GHz and 4.8 GHz. Even number of 'U' shape meander structure cause of elimination coupling effect phenomenon in the circuit and giving results similar to original filter design. Unfortunately, DBSRR with six meanders structure as shown in figure 12, fail to have an ideal characteristic due to components are so close to each other's give huge impact on increase coupling effect phenomenon.

III. Microstrip Simulation Results and Observations

Microstrip simulation results show that DBSRR circuit with **TWO** and **FOUR** meanders structure having same characteristic to ideal DBSRR circuit which is **WITHOUT** meander structure. However, DBSRR circuit with **ONE, THREE** and **SIX** meanders structure given difference behavior compare to ideal DBSRR circuit.

Therefore, DBSRR circuit with **TWO** and **FOUR** meanders structure filter can be used to replace ideal circuit due to their simulation characteristics similar to ideal filter. By implementing meander structure the size of the filter is reduced to 17.6% for DBSRR circuit with **TWO** meanders structure filter and will reduce to 58.8% for DBSRR circuit with **FOUR** meanders structure filter.

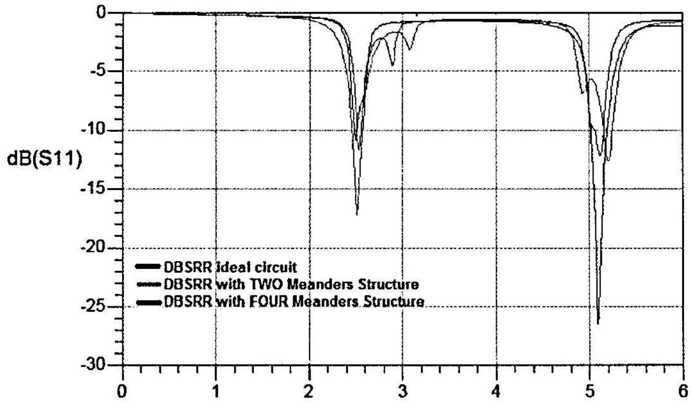

Figure 13: Comparison microstrip simulation results for ideal DBSRR, DBSRR circuit with **TWO** and **FOUR** meanders structure (S11).

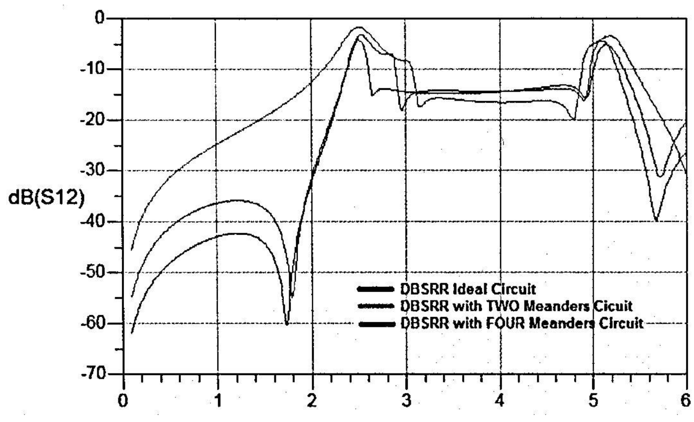

Figure 14: Comparison microstrip simulation results for ideal DBSRR, DBSRR circuit with **TWO** and **FOUR** meanders structure (S12).

IV. FABRICATION AND MEASUREMENT

Base on simulation results, DBSRR circuit with **TWO** meanders structure filter is chosen due to better performance and less coupling effect. Even though, **FOUR** meanders structure contribute to reduce the filter size more, it also introduces higher coupling effect and reduces performances of the filter. Therefore, increase the meander structure in filter circuit design will give impact to overall performance of filter. This was proved by applied DBSRR circuit with **SIX** meanders structure, the performance of filter totally drop and difference from ideal filter.

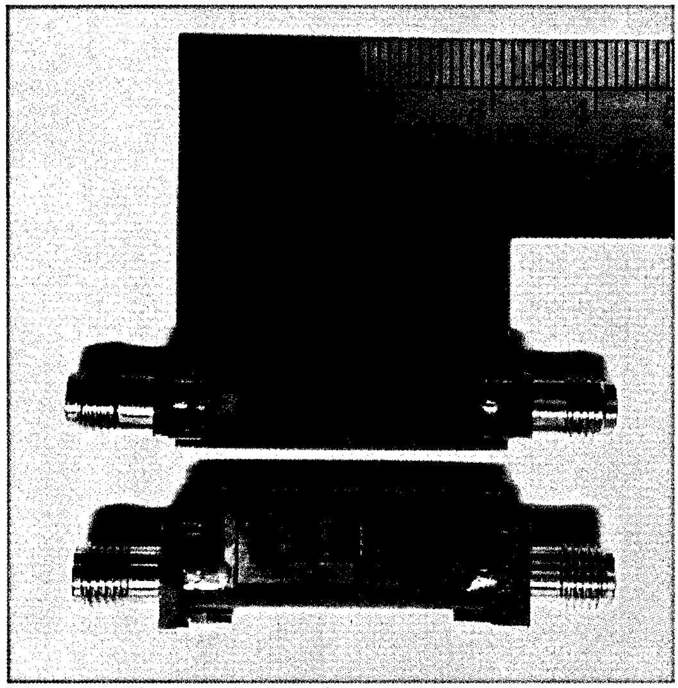

Figure 15: Photograph of the fabricated DBSRR filter.

The DBSRR circuit with **TWO** meander structure filter is designed and fabricated. Figure 15 show comparisons between ideal filter and DBSRR with **TWO** meanders structure filter after fabricate. DBSRR with **TWO** meanders structure filter reduce half size of ideal DBSRR filter.

Then, fabricate filter was measured carefully using Rohde & Schwarz vector network analyzer model ZVB20. As results shown in figure 16, the DBSRR with **TWO** meanders fabricate circuit exhibits similar characteristics as simulation results (refer to figure 6). The passbands are centered at 2.8 and 5.6 GHz, the lower and upper passbands have fractional bandwidths of 7.14% and 3.57% respectively. The insertion loss is approximately 8 dB and 11 dB for both passbands. However, return loss is measured as 18 dB at lower passband and 11 dB at upper passband. The isolation between these two passbands is approximately 16 dB from 3 GHz to 5.2 GHz.

Figure 16: Measurement results using vector network analyzer

Unfortunately, measurement results also shown the central frequency of DBSRR with TWO meander structure filter was shifted almost 300 MHz from simulation results due to simulation circuit must transfer to DXF file before fabricate process. Cable and connecter loss is believed contribute to make graph having ripple in measurement results. High insertion loss occurred mainly because of the high loss tangent of the FR4 substrate used.

V. CONCLUSIONS

In this paper, a single resonator ring dual-band bandpass filter using quarter-wavelength resonators was designed, analyzed and fabricated. DBSRR with several numbers of meander was investigated and a ring with two meanders was found having similar characteristics as the original DBSRR topology. By implementing meander structure to the ideal circuit, the size of filter becomes reduces more than 40% which makes its more compact and suitable for today WLAN applications.

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