International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-3, January 2020

# Performance Aspects of Multiband Microwave Planar Devices for Wireless Applications

**S. Sivasundarapandian, M. Shravan Kumar Reddy**

***Abstract*: The RF front end receiver plays a key role to fulfill the demands of the numerous applications in the wireless communication .This article of lettering portrays about the analysis of planar microstriplines based multiband passive microwave devices which are simulated in ADS (Advanced Design System) software. Also we have designed a multiband band pass filter, and multiband hybrid coupler which are essential in the front ends design of receivers such as software defined radio and cognitive radio. Here BPF covers the frequency range from 400 MHz-2GHz and hybrid coupler covers from 1-5GHz. With the use of these components the single band RF front end will become the multiband front end receiver architecture.***

***Keywords* : hybrid couple,; band pass filter, multiband devices, planar devices.***

## I. INTRODUCTION

Due to the fast advancements and tremendous growth in modern communication industry, the system needs to be a simple and more adaptable for several applications. As day by day the demands increases in the wireless communication field that amenable communication system requires multiband devices and multiband antennas in RF front end architectures. The architecture of Cognitive Radio is different from other architectures of digital communication receivers. The architecture of cognitive radio is same as software defined radio, and it is also should be capable of spectrum sensing. The general RF front end receivers consist of a broad-band LNA, a wide band BPF and a wide band BSF. The Cognitive Radio RF front ends consist of BPF, LNA, Frequency synthesizer, Mixers, baseband filters and ADCs for wide band RF to digital conversion for spectrum sensing. As of now in time in the best consistently maturing RF communication world, the spectrum range deficiency is a main alert which ought to be taken as a difficult issue and to comprehend the response for it. At present, the electromagnetic frequency range is inside and out fit into set and within reach no obviously open range for the upcoming ages. Pretty much ten % of the event the range is perceptively utilized and rest of the time the electromagnetic spectrum range allows the idea of being at time off.

**Revised Manuscript Received on January 30, 2020.**
***** Correspondence Author
**S. Sivasundarapandian ***, Department of ECE, Aurora's Technological and Research Institute, Hyderabad, India. Email: ssp_2020@rediffmail.com
**M. Shravan Kumar Reddy** , Department of ECE, Aurora's Technological and Research Institute, Hyderabad, India. Email: shravan4222@gmail.com



So by method for the intellectual radio the optional clients can exercise the range effectively and creatively without snooping with the essential clients. From the moment when the intellectual radio is to an ever increasing extent, and a day gives the impression of being for completely open range it wants a multiband receiving antenna for range insight. There are various sorts of intellectual radios. One of the sorts of subjective radio is utilizing TV frequency band and another is general intellectual radio that can get to any frequency band.

This paper is sorted out as pursues. Section two clarifies about band pass filter, segment three about hybrid coupler lastly about conclusion.

## II. BANDPASS FILTER

The structure and creation of a profoundly scaled down double band pass filter utilizing the free band stop resonators by installing all the passive lumped components into a low-temperature co-terminated artistic (LTCC) substrate for 2.4 GHz to 2.5 GHz and 5.15GHz to 5.85 GHz remote LAN framework applications[1]. To diminish the size or volume of the channel and to maintain a strategic distance from electromagnetic parasitic couplings between the installed uninvolved components the proposed channel was structured by utilizing third request Chebyshev circuit topology and J-inverter change innovation. [2] By installing all the lumped components into a LTCC substrate for 2.4-2.5 GHz and 5.15-5.85 GHz WLAN applications a significantly scaled down double band pass filter has been created. The J-inverter change innovation was best to limit electromagnetic parasitic coupling between the huge inductors. The quantity of passive components in the filter circuit is diminished with the assistance of band-stop resonator. Along these lines, the structured double band filter was joined with straightforward LC duplexer. [3]. The analysis of double-band double-mode filter with implementing a floating-plate cannot only accomplish a permission band bandwidth broader than the predictable structures but also the understanding of double pass bands. Though, the construction of the floating-plate intersection limits the input positions of two loop resonators cannot be applied to implement the two pass-bands. A lot of plan conditions are utilized to decide the double mode channel. So as to check the proposed plan, a test channel having two structured pass-groups at 2.4GHz and 3.6GHz, individually, were planned and created by utilizing single layer PCB innovation . [4] A double-mode double-band pass filter has two benefits. The first one is the dimensions of the double -mode micro strip filter obtained is reduced than the conservative double-mode filters.

The proposed filter can accomplish 60% dimension shrinkage. Another one is that there is a couple of transmission zeros near each and every pass band. [5] By inserting two unclosed coils between two coupled half wavelength resonators a novel double band semi elliptic filter with conservative measure and wide stop band has been proposed.

Two internal partially open coils are put far enough to keep away from common coupling. The two semi-lumped hostile to coupled structure is utilized to acquire an expansive upper stop band without including additional circuit size. A double band filter has been planned and manufactured utilizing single-layer printed circuit board (PCB) innovation. The filter resounds at three particular groups of operating frequencies. The first band of frequency is 640MHz, and the second band of frequency is 1200MHz and third band is 1780MHz.

In our proposed system for designing the dimensions used are l1=81mm, l2=53mm l3=23mm, l4=16mm and w=2mm. The proposed multiband Band Pass filter is simulated in ADS software using method of moments. It is fabricated in FR4 material with the thickness of 1.8mm and permittivity is 4.5.

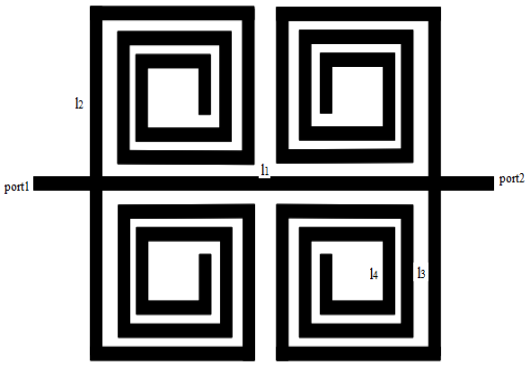


**Fig.1. The proposed multiband BPF dimensions**

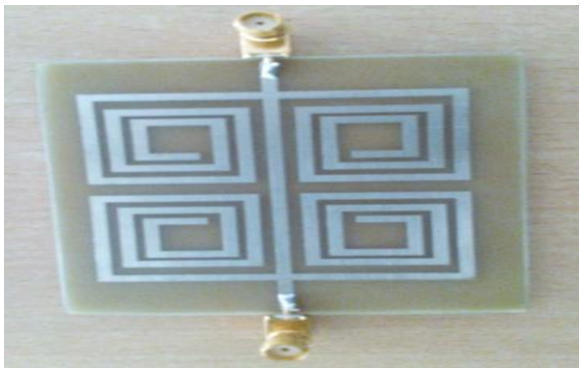

**Fig.2.Fabricated BPF**

**Table- I: Dimensions of Hybrid coupler**

| $l_{1(mm)}$ | $l_{2(mm)}$ | $l_{3(mm)}$ | $l_{4(mm)}$ | $l_{5(mm)}$ | $l_{6(mm)}$ |
|---|---|---|---|---|---|
| 4.8 | 5.8 | 3 | 6 | 3 | 6 |
| $W_{1(mm)}$ | $W_{2(mm)}$ | $W_{3(mm)}$ | $W_{4(mm)}$ | $W_{5(mm)}$ | $W_{6(mm)}$ |
| 2 | 3.6 | 8 | 8 | 7 | 8 |

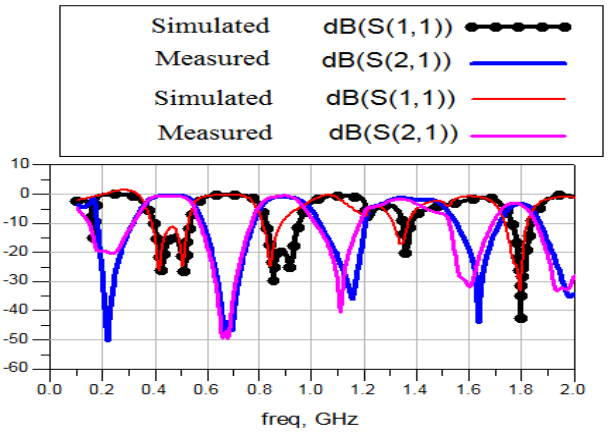


**Fig.3. The simulated and measured result of multiband BPF**

### A. Result Analysis

The simulated and measured graph shows that it resonates at 400GHz,500GHz ,900GHz,1.35GHz and 1.8GHz.The fabricated device was analysed with its simulated and measured results. This band pass filter resonates at five different frequencies 400GHz,500GHz ,900GHz,1.35GHz and 1.8GHz.The S11 shows the return loss of the Band pass filter.At 400GHz, 500 GHz and 900GHz the measured and simulated value of return loss(S11) is -25dB.Also at 1.35GHz and 1.8GHz the measured and simulated value of return loss(S11) is -35dB.

## III. DOUBLEBAND HYBRID COUPLER

A two-band hybrid coupler was structured by embracing improved composite right-left- transmission line stubs [6]. A stub is made out of two transmission line unit cells with uniform segments that can create indicated impedance and phase shift at two subjective frequencies. A planar double band hybrid coupler in small scale strip arrangement with stub was acknowledged, which uncover unrivaled act in double band activity. A patch hybrid coupler which can give wild power division proportions more than two self-assertive recurrence groups are actualized in [7]. To empower double band activity the Complementary split ring resonators are stacked onto every quadrant of a patch hybrid coupler which gives diverse power division proportions more than the two recurrence groups. A proportional circuit additionally integrated and used to portray the working standards.In [8] a dual band rat-race coupler with left-handed transmission lines is implemented, which has an advantage of that they are used to reduce a number of cells, which improves the performance. To reduce the dimensions of the coupler, the 3/4 composite right handed (CRLH) sending line is replaced with a D-CRLH sending line, and there was introduced a method to design the quarter wavelengths transmission lines with the minimum number of cells. The major thought of the hybrid rat-race coupler is to use the duality between the CRLH and D-CRLH transmission lines and to replace a transmission line that Produces a phase shift of 270° with a transmission line introducing a phase shift of -90°, and vice versa.

A reduced double band planar 3-dB hybrid coupler with winding open stub is executed [9]. To introduce stubs on the hybrid for double band application, four similarly round openings are fixed on the cross-slotted fix, to keep up the exhibition of the single-band hybrid coupler due to the impact on the present appropriation. The four winding open stubs are fixed into the roundabout openings without expanding the size of the coupler, and the double band activity is accomplished. A double band VCO for quadrate age with various hybrid coupler is actualized in 40nm CMOS transformer used double band VCO with unmistakable hybrid coupler for I and Q signals [10]. The following table shows the dimensions of the double band hybrid coupler which is simulated for FR4 material using method of moments. It is fabricated in FR4 material with the thickness of 1.8mm and the permittivity is 4.5. A shunt short circuited stub having interdigital capacitor in microstrip technology is used in our proposed modified ring coupler design. It resonates at two different frequencies 1.8GHz and 5.2GHz .By cascading different LH and RH cells a balanced cell is designed for the resonance frequency at

$$Wr = \frac{1}{\sqrt{LC}}$$

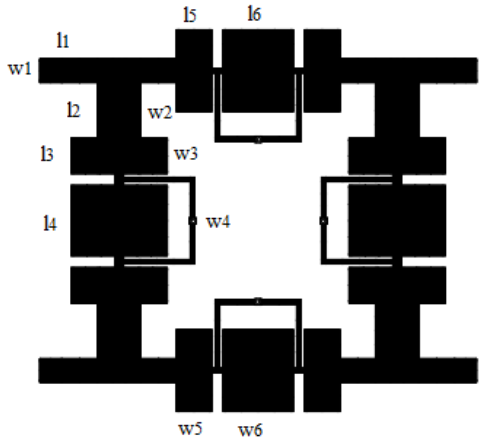


**Fig.4. The Double band Hybrid coupler Dimensions**

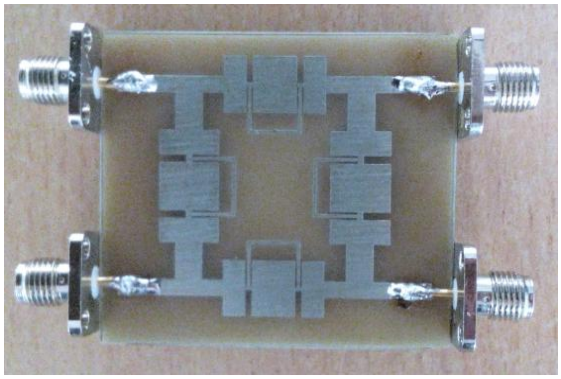

**Fig.4. The Double band Hybrid coupler Layout**

### A. Result Analysis

The simulated and measured graph shows that it resonates at 1.85GHz,5.25GHz .The fabricated device was analyzed with its simulated and measured results. This Hybrid coupler resonates at two different frequencies 1.85GHz and 5.25GHz.The S11 shows the return loss of the Band pass filter. At 1.85 GHz the measured and simulated value of return loss(S11) is -32 dB and -28dB respectively. Also at 5.25 GHz the measured and simulated value of return loss(S11) is -22 dB and -20dB respectively. Also the transmission coefficients (S12,S13) ,isolation between the ports(S14) also analyzed and all measured and simulated values are given in table 2.

**Table II. The simulated result of Dual Band Hybrid coupler**

| Resonant frequency | S-Parameters | Simulated(dB) | Measured(dB) |
|---|---|---|---|
| 1.85 | S11 | -32 | -28 |
| | S12 | -6 | -6 |
| | S13 | -3 | -4 |
| | S14 | -28 | -25 |
| 5.25 | S11 | -22 | -20 |
| | S12 | -5 | -5 |
| | S13 | -3 | -4 |
| | S14 | -20 | -28 |

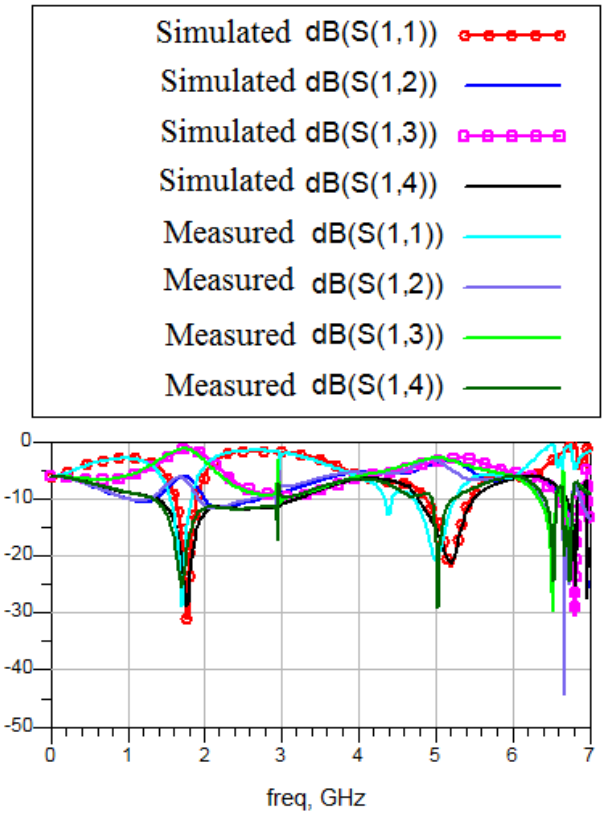


**Fig.5. The simulated and measured result of double band Hybrid coupler**

## IV. CONCLUSION

A novel front end design of multiband receiver architecture for software defined radio, and cognitive radio is reposed and reviewed the feasibility of implementation of the multiband receiver. In this proposed work, we have analyzed two multiband microwave passive devices such as band pass filter and hybrid coupler which they are used in the implementation of multiband six port junction,

multiband Butler matrix and multiband Nolen matrix and it tends to be easily incorporated inside the printed circuit sheets (PCBs) of RF devices resembling cognitive radio. According to the survey made by us, we came to the conclusion that, a multiband cognitive radio or multiband software defined radio can be designed with the integration of multiband smart antenna systems and multiband six port junction.

## REFERENCES


1. J.H.Park, S.J.Cheon, J.Y.Park, J.T.Lim, "Ultra-compact dual-band WLAN filter using independent band stop resonators" , IEEE 61st Electronic Components and Technology Conference (ECTC), 2011 ; PP:2096 – 2100 .June 3 2011.
2. .J.H. Park, S.J. Cheon ,J.Y.Park, J.T. Lim ," Compact WLAN dual-band filter using independent band stop resonators combined with diplexer ",IEEE MTT-S International Microwave Workshop on Intelligent Radio for Future Personal Terminals (IMWS-IRFPT), 2011, PP:1 – 2 , 24-25 Aug. 2011.
3. Yi-Chyun Chiang , Chin-Lung Yang , Yu-Han Pan , Jing-Peng Chen ," A dual-band dual-mode filter constructed by using floating-plate overlay structures ",Microwave Conference Proceedings (APMC), 2012 Asia-Pacific , PP:523 – 525 , 4-7 Dec. 2012.
4. Ying Shui ,Bo-Ran Guan , "Compact dual-mode dual-band microstrip bandpass filter ", Electronics, Communications and Control (ICECC), 2011 International Conference on , PP:2588 – 2590 , 9-11 Sept. 2011.
5. Wei Jiang , Wei Shen ,Liang Zhou , An-Ming Gao , Wen-Yan Yin ,Jun-Fa Mao,"Design of compact dual-band quasi-elliptic filter with high selectivity and wide stopband rejection ", Microwave Conference Proceedings (APMC), 2012 Asia-Pacific , PP:214 – 216 ,4-7 Dec. 2012 .
6. Jian-Qiang Gong , Chang-Hong Liang , "Novel dual-band hybrid coupler using improved simplified CRLH transmission line stubs" ,Microwave and Millimeter Wave Technology (ICMMT), 2010 International Conference on , PP:856 – 859 , 8-11 May 2010 .
7. Shao Yong Zheng , Yongle Wu , Yuanxin Li ,Yuanan Liu ,Yunliang Long ," Dual-Band Hybrid Coupler With Arbitrary Power Division Ratios Over the Two Bands , Components, Packaging and Manufacturing Technology", IEEE Transactions on (Vol:4 , Issue: 8 ) , PP:1347 – 1358 , Aug. 2014 .
8. I.A.Mocanu, T.Petrescu , "Novel dual band hybrid rat-race coupler with CRLH and D-CRLH transmission lines ", Microwave Conference Proceedings (APMC), 2011 Asia-Pacific , PP:888 – 891 , 5-8 Dec. 2011 .
9. Yan Li , Sheng Sun , Feng Yang ,"Dual-band hybrid patch coupler with embedded spiral open stubs" ,Microwave Conference Proceedings (APMC), 2012 Asia-Pacific , PP:169 – 171 , 4-7 Dec. 2012 .
10. Mangraviti, G. , WambacqQixian Shi , Vaesen, K. , Parvais, B., P. ," A 54–69.3 GHz dual-band VCO with differential hybrid coupler for quadrature generation", Solid-State Circuits Conference (A-SSCC), 2013 IEEE Asian , PP:325 – 328 , 11-13 Nov. 2013.


## AUTHORS PROFILE

**Sivasundarapandian.S** was born in Athipatti, Madurai,Tamilnadu, India.He received the B.E. degree in Electronics and Communication Engineering from Madurai Kamaraj University,India, and M.Tech in VLSI Design from Sathyabama University ,Chennai, India. He also received PhD award from Sathyabama Institute of Science and Technology(Deemed to be University),Chennai. .Since 2008, he had been working with Department of Electronics and Telecommunication Engineering, Sathyabama University, Chennai, India. Since 2018, he has been working working as Professor in Aurora's Technological and Research Institute,Hyderabad,Telangana,India. His research interests include Microwave Devices , multi-band Antennas and RF circuit design.

**M. Shravan Kumar Reddy** was born in Aler, Yadadri Bhongir, Telangana, India. He received the B.Tech. degree in Electronics and Communication Engineering from Jawaharlal Nehru Technological University Hyderabad, India, and M.Tech in Advanced Communication Systems from NIT Warangal, India. Since 2010, he had been with Department of Electronics and Communication Engineering, Aurora's Engineering College, India. His research interests include Microwave Devices, multi-band Antennas and RF circuit design.