Compact narrow band-pass filter based on alternate Right– Left Handed Transmission Line Concept By Altered Design Parameters

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Abstract : This paper introduces an innovative design for a compact narrow band-pass filter (BPF) that Follow the principles of alternate right and left-handed transmission lines (RLHTL).

The size of filter is further reduced from what it is in previous researches and ease of fabrication is achieved. The defective ground structures are absent in the proposed structure, as a result the fabrication of filter is further simplified . The Centre frequency of passband is 8.218 GHz with fractional bandwidth of 10.84 % The proposed structure is designed and simulated using Keysight Advanced Design System (ADS). The proposed filter is designed on FR4 with dielectric constant 4.6 and thickness 1.6 mm .This design significantly reduces the size of the filter while ensuring high selectivity and minimal insertion loss within the passband. The narrow bandwidth is fine-tuned by modifying the length and coupling of the RH and LH sections.

Keywords - Alternate right–left handed Transmission Line (ARLH-TL)

INTRODUCTION – Bandpass filters (BPFs) are essential components in wireless communication systems, designed to transmit desired signals while filtering out unwanted ones [1][2] .

IN RECENT years, Rapid advancement of various modern wireless communication systems has led to increase the demands of the high performance and miniaturized size of the filter [5]. As the technologies Continue to Evolve , there is a growing need of microstrip Band-Pass Filter in wireless communication . Miniaturization has become a fundamental requirement in the design of BPFs for communication systems [6] . With develop the communication Devices , more than ever the need for bandpass filters (BPFs) with flexible passbands, and a Very simple Geometry . There are different methods to design BPFs, such as balance circuits, coupled structures and multi-layer circuits with the Coupled Stubs . By using a substrate integrated wave-guides (SIWs) , a dual-band BPF was reported in , That Narrow Band Pass Filter Was Designed For Various WLANs Applications [11] . This filter's passband frequencies can be changed, but its massive size and insertion loss in passbands are its disadvantages. Since these circuits are analyzed using an LC model, new structures made of the coupled stubs were examined. [9-11] .

Bandwidth selection is one of the important issues in modern communication systems and the BPFs has significant place in this case. Today, single-band and dual-band operators have been so frequent in wireless communication. The advantages of a BPF can be expressed as: compact circuit size, good isolation between passbands, high selectivity, and wide stopband [13] . A Compact Narrow Band Pass Filter (NBPF) is an advanced RF/microwave filter engineered to permit a precise narrow band of

frequencies to transmit , In the context of WLAN/WiMAX communication standards at 2.4 GHz, 2.5 GHz, 3.5 GHz, and 5.8 GHz.

- **Designing Of The Proposed Filter Structure –** Designing That Architecture Of That Filter Of That Compact Narrow Band Pass Filter (NBPF) is Shown in Fig 1 , Consists of these **3** Main Elements –

  (a) The Coupled Inter Digital Structure That especially Used in microwave frequency ranges Buit In The Comb Like Structure .

  (b) **Resonator** - Typically a metallic cavity shaped like a rectangle, where electromagnetic waves resonate at specific frequencies based on its dimensions. The Main Uses of Bandpass Filters are - Oscillators , Antenna Design , Microwave Integrated Circuits (MICs)
  .

  (c) **Stubs -** Uses of Stubs Are Basically Used in Impedance Matching , Bandpass and Band stop Filters , Tuning and Reconfigurability of the Filter , and Frequency Selection .

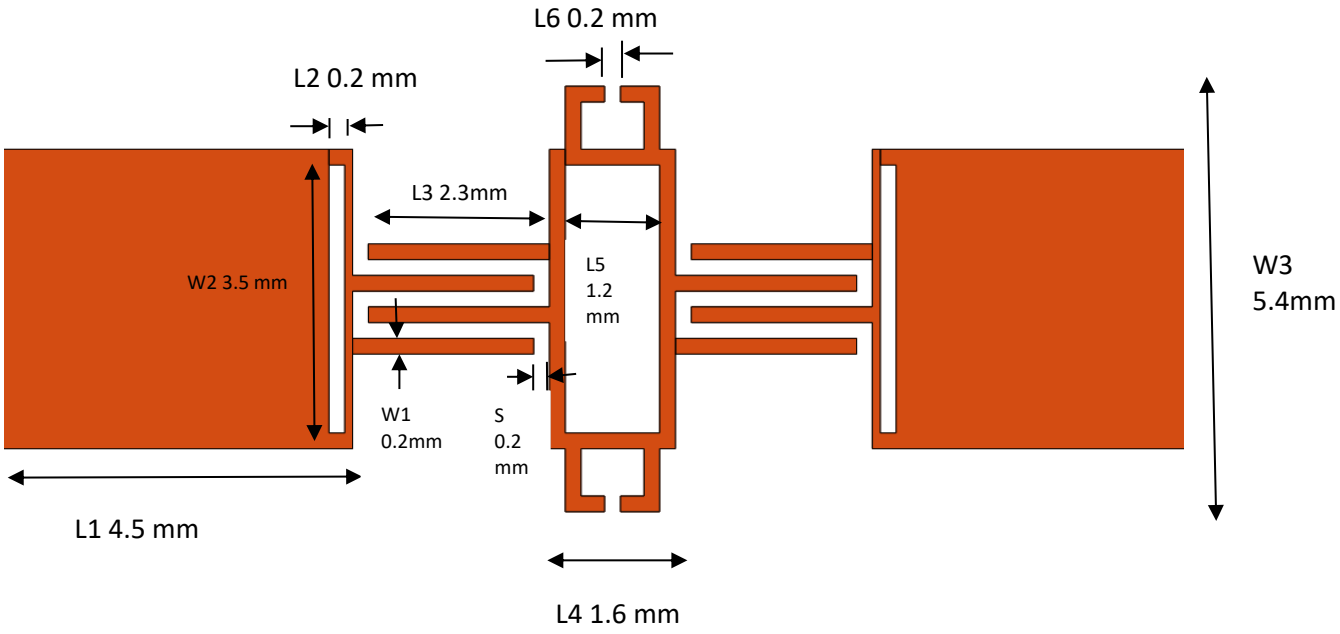


Figure – Proposed Model Design

Design and Analysis of Compact Narrow Band Pass Filter –

The Designing of The Compact Narrow Band Pass Filter Is designed by Cascading The Resonator with the Comb Shaped Inter-Digital Structure In Addition of the Stubs that are Required For The Impedance Matching As Well For Certain Frequency Selection. We Would Introduce the Innovative Structure That Has a Great Significance in the Frequency Selectivity In The Compact Narrow Band Pass Filter In the Model Designing , In the Structure The Comb Like Structure Generate the Effect Of

Inductor, L and the Gaps Between Then Generate the Effect of the Capacitance C. The Spaces Between the Inter-Digital Structure, Represent the Capacitive Effects.

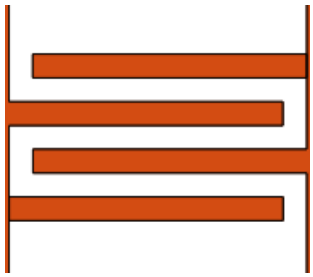


Fig 2 Inter-Digital Structure

This Fig 2 , Represents Inter-Digital Structure Which is A Comb Like Structure In Which the Comb like Structure Represents the Inductive Effect and the Spaces that is the Gap Between Then shows The
Capacitive effect C . The Inter-Digital Structure in filter design Describes
to a unique category of microwave filters that feature parallel coupled resonators configured to resemble interlocking fingers, which is the origin of the term "inter-digital." These filters are commonly utilized in RF and microwave circuits, particularly for compact bandpass filter designs , In the Special Type of the Frequency Selectivity .

This Designing of that Filter , is Done in The ADS Software , Where the Model that has Been Designend , with the Dimensions 7.2mm X 5.4 mm , We Have Done Adjustment in the Previous Proposed Structure By Reducing The Length of the Filter , In Addition of the Extra Lines in the Inter-Digital Structure , In Extra of addition of 2 resonators of different Length With the addition of the 2 Pair of Stubs Which Help in Filtering Out Some Specific Range Of Frequencies .

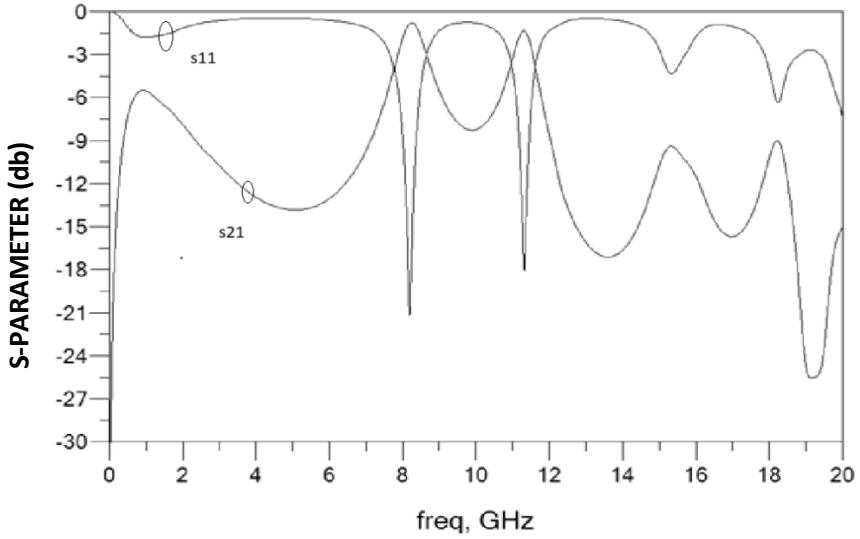
The 3db Fractional Bandwidth of the Filter is 10.84 % , Upper Cutt-off and Lower Cutt-of frequencies of the Pass Band are 8.663 GHz , 7.773 respectively . The Keysight Advanced Design System (ADS) is utilized to optimize the Band Pass Filter dimensions in the suggested filter , By altering the Gap of the Inter-Digital Structures , the suggested filter's pass band frequency range can be changed. Changes in S21 in the higher band and a greater cutoff frequency in the lower band are observed when the Inter- Digital Structures length and the Gap Changed between them

In the design of proposed filter Rectangular Resonator , Inter-Digital Structure (IDS) , open and closed rectangular loop structures and the Stubs are used to improve the overall performance of the filter. To achieve required band with good performance the dimensions of the proposed filter are given in table-1. Filter is designed on FR4 with dielectric constant of 4.6 and of thickness 1.6mm.

TABLE 1: DIMENSIONS OF PROPOSED FILTER

S.NO	PARAMETERS	VALUES (mm)
1.	L1	4.5
2.	L2	0.2
3.	L3	2.3
4.	L4	1.6
5.	L5	1.2
6.	L6	0.2
7.	S	0.2
8.	W1	0.2
9.	W2	3.5
10.	W3	5.4

The center frequency of passband is 8.210 GHz with fractional bandwidth of 10.84 %, the return loss of -21dB. The S-parameter performance characteristics also includes good rejection performance.



CONCLUSION

This paper presents Advanced design for bandpass filters (BPFs). This Depicts Narrow BPF that combining an interdigital structure (IDS) with a Rectangular Resonator configuration . It offers a compact form factor, simplified fabrication by avoiding vias and defected ground structures, a Center frequency of 8.218 GHz, a fractional bandwidth of 10.84 %, and a return loss of -21 dB. The design exhibits excellent rejection characteristics and shows strong alignment between simulation and measurement results on an FR4 substrate. The second design is a dual-band BPF tailored for Wi-Max and WLAN standards. Both designs offer simplified fabrication, cost-effectiveness, and superior performance compared to previous designs.

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