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Review Paper of DGS based Band Pass Filter

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Abstrect

The modern wireless communication systems require dual bandpass filters that work at multiple frequency bands. This paper provides a review of the literature on DGS based microstrip Band Pass Filter. Band Pass Filter's features are low cost, compact dimensions, light weight and ground side a complete metallization structure. In recent years, a new concept has been applied to the ground plane structure. This concept is known as the Defected Ground Structure. Using DGS improved the electrical performance in the passband, sharp selectivity, unwanted frequency rejection, and circuit size reduction. The results in terms of insertion loss and return loss are analyzed in detail, which comparative study according to base on DGS and without DGS filters.

Keywords: ***Microstrip Bandpass filter, Microstrip Hairpin bandpass filter, Defected ground structure.***

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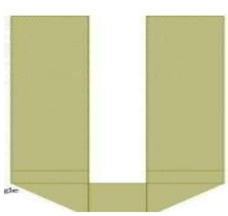
I. INTRODUCTION

The multi-service mobile wireless communication systems such as the wireless local area network (WLAN) or 5G communications have become more and more attractive for commercial products[1]. In RF and microwave applications such as communication, radar, navigation, medical instrumentation, which cover a frequency range of 300kHz up to 300GHz. Bandpass filter (BPF) is an important element in the RF front end, and it is required to provide two or more passbands for multi- communications under this progress. The existence of multi-band signals, especially in developed the wireless local area networks (WLANs) standards such as IEEE 802.11b (2.4 GHz), IEEE 802.11a (5.2 GHz) and also in WiMAX standard such as IEEE 802.16e (2.5 GHz) and in downlink of satellite communication system (7.4 GHz) has been growing with a fast speed [4].

The recent development in communication standards and applications promoted the design of dual- band wireless systems, which require filters with dual-band capability to extract signals. A single filter with dual-bandcharacteristics, known as a dual-band bandpass filter [9].

A defected ground structure is a very useful method for reducing the size of microwave components. The concept of defected ground structure (DGS) is coming from the Photonic bandgap structure. The defected ground structure (DGS) is realized by etching simple shape in the ground plane of the microstrip line. The etched pattern disturbs the current path in the ground plane changes the performance of the microstrip line [11].



Dual-band bandpass filters may also be featured in cognitive radio and application of communication channels. Miniaturization is very important for modern wireless communication systems, especially such as dual-and multi-band mobile communication systems, and satellite communications systems [9].

II. TYPES OF FILTER

A filter is an electronic device. A filter circuit passes some frequency signals without any attenuation with some amplification, & attenuates other frequency depending on the types of the filter[10].

A. Based On Their Construction

Passive filters are made up of passive components, such as resistors, capacitors & inductors. It does not require external sources and Active filter uses an active component such as an operational amplifier, transistors, etc. The downside is that it needs an external source of power [10].

B. Based On Their Frequency Response

Low Pass Filter is allows low-frequency signals without any attenuation but it rejects any high-frequency signals and High Pass Filter is allows the high-frequency signals to pass without any attenuation in its amplitude & blocks (rejects) any low-frequency signal is called a high pass filter. Any signal with a frequency lower than the cut off frequency of the filter gets blocked. while any signal with a frequency higher than the cut off frequency passes with full amplitude and Band Pass Filter is allows a specific band of frequencies & blocks any other frequencies lower or higher than its passband frequencies. Bandpass blocks low frequencies & high frequencies, while allows the frequencies in between known as the passband frequencies and Band Reject Filters that attenuates the signal whose frequencies lies on a fixed band of frequencies. It is also known as Band Stop filter or Notch Filter [10].

III. Hairpin Filter

Figure 1: Hairpin U section[6]

Conventional, microstrip coupled line bandpass filter, size is large because of the use of normal λ/2 resonators. The hairpin filter is the most popular and widely used configuration in microstrip Bandpass filters due to their compact design. They are conceptually obtained byfolding the arms of normal parallel-coupled λ/2 resonators into U shape

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to reduce the size of the filter [5]. Hence, the same design equations for parallel-coupled half-wavelength resonators can be used. However, to fold the resonators it is used for the reduction of the coupled-line lengths, which reduces the coupling between the resonators. The line between two bends tends to shorten the physical lengths of the coupling sections, and the coupled section is slightly less than a quarter wavelength. Two types of inputs coupled line or tapped lines can be used for hairpin filters. The coupled line input is not very popular since low spacing at the end resonators causes larger coupling which in turn, hampers the insertion and return loss.

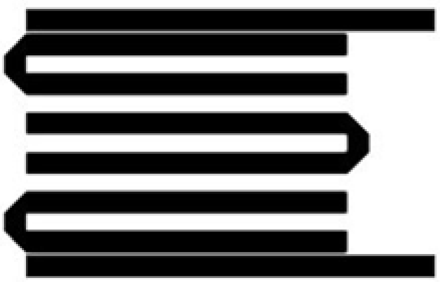

Figure 2: Microstrip Hairpin Structure[18]

The two types of input structures are used in the hairpin resonator. These are coupled with input and tapped input structures. In the couple line input, the input transmission line is directly connected to the coupling section first. This results in weak isolation which in turn affects the response characteristic Tapped line input resonator is introduced due to poor response characteristics of the coupled line input resonators [12].

IV. Defected Ground Structure

One of the new concepts that were applied to microwave, circuits are by the Defected Ground Structure (DGS) technique. This is done by modifying the ground plane metal of a microstrip circuit intentionally to enhance performance. There are different shapes of the DGS unit section [6].

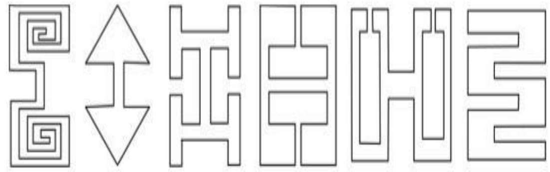

Figure 3: Structure of DGS[18]

The DGS geometries have been reported so far that includes simple shapes such as rectangular dumbbell , circular dumbbell ,spiral , U-shaped, V-shaped ,H-shaped ,cross-shaped ,concentric rings, etc. Some other geometries are DGS of cross-shaped, Hilbert curve rings, stepped hairpin-shaped, hexagon-shaped, C-shaped, multi-ring resonators, L-shaped, E-shaped, and T-stub-shaped [7].

DGS allows placing a notch almost anywhere. The inductor and capacitor in the transmission line has changed due to disturbing the current distribution. The need for a more complex design can be avoided if DGS elements are used to improve the stopband performance because simple microstrip filters have a symmetrical stopband. With the usage of DGS in the filter, it helps to reduce the size of the filter, and this indirectly can reduce the cost of designing it. This is because there will be no extra or complex design of filters needed [7].

The DGS with the microstrip line employs a defect on the ground and it provides band rejection characteristics from the resonance property. The cut off frequency of the DGS is mainly dependent on the etched square area in the ground plane. There is an attenuation pole location, though it is at the etched Gap distance. Attenuation poles may be generated due to induction and capacitance elements. The capacitance factor is required to explain the frequency characteristic of the DGS section. The added gap area, which is placed under the conductor line, provides capacitance parallel to effective line induction [7].

“A novel 1-d periodic defected ground structure for planar circuits” is published in 2000 by IEEE. The author says that the filter’s etched the DGS circuit, which is located on the ground metallic plane. The variations of the series inductance and gap capacitance etched square area was varied. The variation of inductance introduces the cut off characteristic at a certain frequency. As theunit of the area is increased by the series inductance and increasing the series inductance gives rise to a lower cut off frequency. In this paper, the dumbbell shape of DGS is provided the cut off frequency

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characteristic due to the effective inductance of the etched lattice. The easily control the effective inductance due to changing the physical dimensions of the etched lattice. It provides the easier to control the cut off and stopband characteristics by changing the dimensions [13].

"A Compact Bandpass Filter with Enhanced Stopband Characteristics by an Asymmetric Cross- Shape Defected Ground Structure" is published in 2006 by IEEE. This paper is used in the cross shape of DGS. The CSDGS slot controls the inductance, and connecting the rectangular slot controls the capacitance. The separating distance between the slot heads has an effect on both inductance and capacitance. The dimensions of both right and left-hand sides of the H-shape defect in CSDGS are adjusted to achieve two different rejection frequencies. The H-shape DGS is provided two stopbands that were not harmonic responses so that the high attenuation was obtained. And the I-shape DGS used to remove the attenuation poles were provided for wide-stopband performance due to the resonance characteristic of aperture. The result is obtained by First, the transmission zeros were mainly achieved by the asymmetric, H-shape DGS. Second, the ultra-wide stopband bandwidth was obtained from both the symmetric I-DGS and asymmetric H -DGS structures. This structure is widely applied in miniaturization for communication applications [14].

"Improving Frequency Response Of Microstrip Filters Using Defected Ground And Defected Microstrip Structures" is published in 2010 by PIR. This paper concludes that used dumbbell shape of DGS cells in the filter, attenuation in the stop-band can be made on the rejection band. This technique used for improving the selectivity without changing the insertion loss in the band-pass. It was observed that the implementations of low-pass filter with microstrip lines and a combination of Defected Ground cells show a frequency response that is not completely adequate at frequencies away from the cut off frequency when the use of Defected Ground Structures enhance the performance of suchfilters. By using the method in the high-impedance microstrip lines are substituted by Defected Ground cells, The size of the filter becomes more compact[15].

"A Design of Microstrip Bandpass Filter with Narrow Bandwidth using DGS/DMS for WLAN" is published in 2013 by IEEE. This paper is used in the circular dumbbell shape of DGS. A two slot in conducting line with the circular head defected ground structure is used for achieving the bandpass characteristics with low insertion loss in the passband and high attenuation in the stopband at center frequency
5.4 GHz. The DGS provides better coupling The gap discontinuity is introduced gap capacitor that used in bandpass characteristics. Using circular head-shaped DGS, a size reduction with reduced harmonics in the passband [16].

"DGS-based UWB Microstrip Bandpass Filter and Its Equivalent Circuit" is published in 2017 by IEEE. In this paper, DGS-based UWB microstrip BPF composed of microstrip coupled lines with 2 open stubs and 3 circular dumbbells of DGS. The microstrip line is represented by an inductor, whereas the open stub can be replaced by the series inductor and grounded capacitor. the presence of a gap in the microstrip line is represented by capacitors arranged in a Π shape. DGS circular dumbbell can be replaced by a Π shape arrangement of an inductor and grounded capacitors, while the ground plane is represented by adding another capacitor at the inductor of the microstrip line. Then, by integrating the left and right sections and the overall equivalent circuit of DGS-based UWB microstrip BPF can be obtained [17].

"A Compact Hairpin Filter With Stepped Hairpin Defected Ground Structure" is published in 2018 by IEEE. The design process starts from the parallel-coupled line design equations which are then modified to get the hairpin design by bending the λ/2 resonator into λ/4 arms to form a U-shape. DGS is a defect, usually in the ground plane, in order to change the current distribution on the ground plane of an antenna or filter. The structure is etched on the ground plane which causes a change in the capacitance and inductance. The DGS is used to suppress spurious passbands. This work can be used as a good reference for compact hairpin filters from
2.0−2.7 GHz. The insertion loss and return losses are 3db and 26db respectively [5]

V. CONCLUSION

From many DGS and without DGS paper, I have

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come to the conclusion that when we compare S parameter response between without DGS and with DGS filter. There is get better response in DGS filter then without DGS filter. With the use of DGS there is improvement of insertion loss and return loss in S parameter.

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