PARAMETRIC STUDIES ON EFFECTS OF DEFECTED GROUND STRUCTURE (DGS) FOR 6 GHz BANDPASS FILTER

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Abstract- **Parallel coupled bandpass filter is proposed and designed by placing defected ground structure (DGS) in the ground plane. The proposed open loop dumbbell shaped DGS is used to tuned the bandpass filter to 6 GHz with a dimension of 50mm x 25mm. The bandpass filter is designed by using FR-4 printed circuit board and a tuning range of 0.994 GHz is achieved. This filter gives an insertion loss of -5.784 dB and a return loss of -11.051 dB. A comparison of the design of bandpass filter with open loop dumbbell shaped DGS is analyzed to identify the better performance of the bandpass filter. The results of simulated and measured filter is analyzed and discussed.**

Keywords: Bandpass filter, Defected Ground Structure (DGS), lumped element, FR-4 printed circuit board.

I. INTRODUCTION

Nowadays, the modern of telecommunication technology developed more frequently rise and increases the biggest market demand. The governmental effort was supported toward the invention and innovation of new application in wireless communication. The examples of wireless communication include in microwave application, satellite application and WiMAX. These new application offer the good advantage and improvement in the telecommunication services and it offer the three important items to the customer which are coverage, capacity and Quality of Service (QoS). In term of coverage, the customers get the minimal signal level of electromagnetic waves. In term of the capacity, the rate of uploading and downloading more satisfactory and adequate to the customer. Then, the good quality of service (QoS) provide with no error of transmission of data as well so that no problem occurred to the service. [1]

The microwave application such as filter is chosen to achieve the frequency selectivity in the various wireless systems operating. Bandpass Filter acts as the backbone components that provide overall performance of various communication systems. [2] Bandpass Filter will allow the selected frequency to pass through and reject the frequency outside the range. Normally, there are two different types of structure to produce the compact design and high performance of microwave components. It named as the Defected Ground Structure (DGS) and the Electromagnetic Band gap (EBG). DGS mostly used in many microwave design technique due to simple in it model rather than EBG.

In this project, the parallel coupledbandpass Filter with open loop dumbbell shaped DGS for 6GHz was designed. The DGS was put in the metallic ground plane of planar transmission line. This DGS will disturb the shield current distribution in the ground plane cause of the defect in the ground [3]. Then, this disturbance will modify characteristic of transmission line and it will ensure the effective capacitance and inductance were produced.

II. OPEN LOOP DUMBBELL SHAPED UNIT AND IT CHARACTERISTIC

An open loop dumbbell shaped DGS unit is implemented in the design due to it has the good stopband effect for 6GHz of the bandpass filter. It has pair of end coupled in the above and below side with equal length. A dumbbell shaped outline symmetrically etched in the ground plane. The etched pattern consists of two identical square-loops having open-loop edge. The design of configuration made on the FR-4 printed circuit board substrate with a dielectric constant 4.6 and a thickness of 1.6mm. Table 1 shows the specifications that have consider the bandpass filter with the open loop dumbbell shaped DGS.

Table 1: Bandpass filter specification

Parameter	***Values***
Center Frequency, Fc	6 GHz
Lower cut-off frequency,f1	5.65 GHz
Upper cut-off frequency,f2	6.35 GHz
Bandwidth	700 MHz
Type of Response	0.5 ripple of Chebyshev response
Return Loss (min)	10 dB
Impedance, Z_0	50 Ω

The desired center frequency is 6 GHz with the bandwidth minimum 700MHz. The characteristic impedance that is considered here is 50 ohm. The figure 1 shows the dimension of open loop dumbbell shaped DGS.

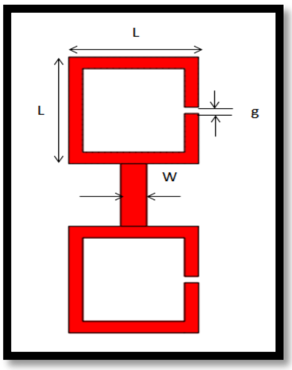


Figure 1 : The defected ground structure (DGS)

There are bandpass filter with single design of DGS and double design of DGS . The parameter of DGS is varied into some values. Parameter "L" is varied into 2mm, 3mm, 4mm and 5mm. Parameter "W" is varied into 1mm and 1.3mm. The value of gap "g" is set to 0.3mm. The figure 2(a) and figure 2(b) shows the both design.

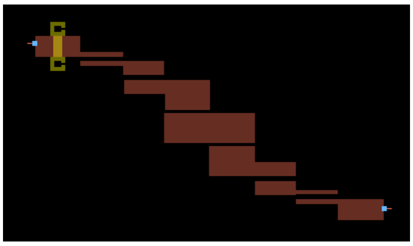


Figure 2(a) : Single design of open loop dumbbell shaped DGS

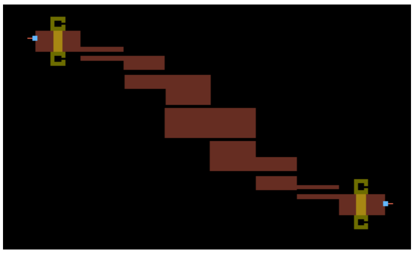


Figure 2(b): Doubled design of open loop dumbbell shaped DGS

III. RESULT AND DISCUSSION

Below are the results for both design single and double DGS. From the both single design and double design of DGS shown in Figure 3,4,5 and 6 the best result of return loss and insertion loss were analyzed. It shows that the best value of “L”is equal to 5mm and the “W” is equal to 1.3mm and the gap (g) is equal to 0.3mm.

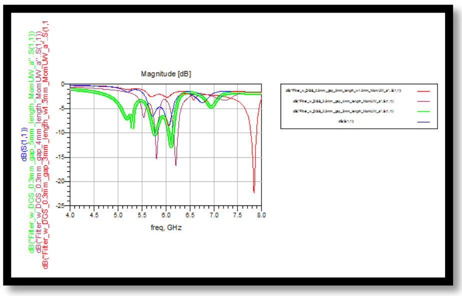


Figure 3: Simulation result for return loss for Single DGS with W= 1.3mm

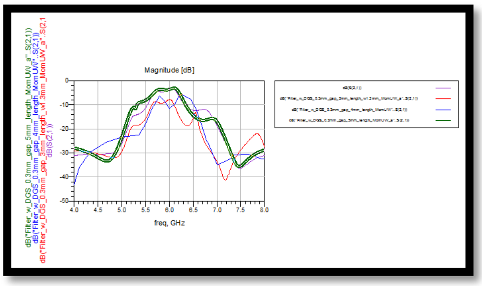


Figure 4: Simulation result for Single DGS insertion loss with W= 1.3mm

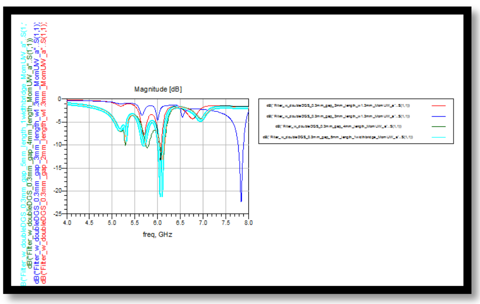


Figure 5 : Simulation result for Double DGS return loss with W= 1.3mm

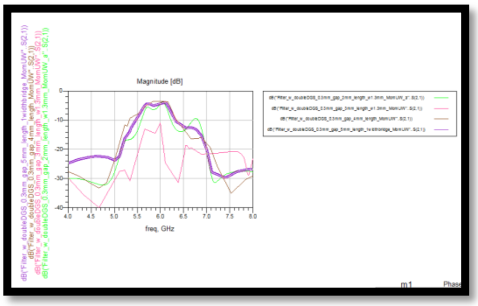


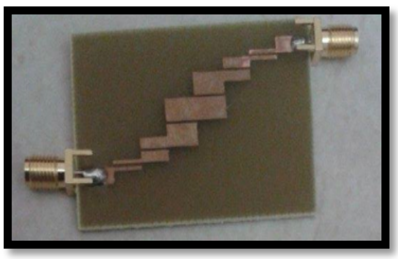
Figure 6 : Simulation result for Double DGS insertion loss with W= 1.3mm

Then, the value of insertion loss and return loss are compared between the conventional bandpass filter, bandpass filter with single design of DGS and bandpass filter with double design of DGS. Table 2 shows the comparison among of them. It includes comparison between the measured and simulation result.

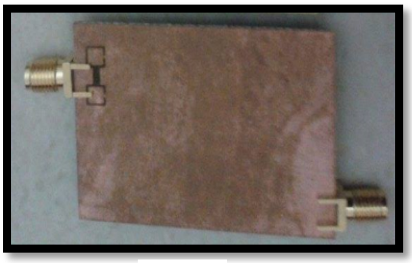
Table 2: Measured and simulated results

Filter	**Response**	**Bandwidth**	**S_{21} (dB)**	**S_{11} (dB)**
Conventional	**simulated**	579MHz	-2.670	-20.181
	measured	436 MHz	-5.044	-11.374
Single design of DGS	**simulated**	611 MHz	-8.123	-21.774
	measured	994 MHz	-5.784	-11.051
Double design of DGS	**simulated**	574 MHz	-6.395	-21.260
	measured	840 MHz	-7.246	-13.961

The figure 7(a) and 7(b) below shows the fabricated parallel coupled bandpass filter with single design of DGS.



(a)



(b)

Figure 7 : Fabricated parallel coupled bandpass filter with single design of open loop dumbbell shaped DGS (a) front (b) back

The parallel coupled bandpass filter with single DGS shows a good response as expected as in desired specification. The bandwidth achieved is 994MHz. The desired value should be achieved 700MHz. Besides, the stopband effect cannot produce the bandwidth similar to the desired one. This unwanted frequencies do not attenuate may be due to some experimental error during measurement.

IV. CONCLUSION

In this paper, the filter designing by using chebyshev response, the designing of bandpass filter with the combination of concentrated components such as inductors and capacitor produce the good response. ristic at the centre frequency 6 GHz. Type of DGS chosen is open loop dumbbell shaped DGS due to the compatibility with bandpass filter with 6GHz. There are 3 type of parameter of DGS that be analyzed in term of length (L), width (W) and gap (g). From all the parameter which had testing, it produced the different insertion loss, return loss and bandwidth of filter. Moreover, by changing the parameter this filter has the capability to give wide range of tuning.

V. REFERENCES

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