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Design and Analysis of Tri-band Bandpass Filter Using Resonator

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ABSTRACT: A lightweight tri-band band pass filter with three pass bands at 0.92, 2.08, and 3.59 GHz has been designed in this article. To achieve the triple passband band pass filter, the stub-loaded technique was used, and the open stubs were coupled together to reduce the circuit size. The engineered filter has passband entry losses of 0.41, 1.39, and 1.97 dB, with return losses of above 27.7 and 16.2 dB, respectively. A TMR, which is the basic component for designing this TAB BPF, can be obtained by linking stepped impedance and radial stubs in a categorical manner. Microstrip lines are tapped over the resonator to serve as both feed lines and transmission zero generators. TMRs are MEMC (Mixed Electric and Magnetic Coupled) devices that aid in the generation of extra Transmission zeros (TZs) across passbands. A TB BPF is planned, manufactured, and calculated as proof. First, a Dual Band (DB) BPF is developed and thoroughly evaluated using even-odd mode analysis throughout the design phase. In order to analyze the circuit model of the filter, the lumped component model for the DB BPF is extracted. The work is then expanded to include the development of a Triple Band-Band Pass Filter. Compact scale, low entry loss, decent interband separation, and harmonic suppression are all advantages of the fabricated filters.

KEYWORDS:- Triple Band pass filter, Insertion Loss, SLR and Reflection Coefficient

I. INTRODUCTION

Using coupled lines with arrow form and U-slot defected ground structures, a lightweight Ultra-wide band pass filter (UWB-BPF) is suggested (DGS). On one hand of the substrate, below the coupled lines, the input and output feeding lines are attached to the coupled lines. To achieve the optimized proportions, a parametric study of the design's various variables was performed. The filter was simulated using two separate simulators, IE3D and HFSS, with strong agreement between the simulation effects. The photolithographic technique was used to create the modeled filter, and the calculated findings are in close alignment with the simulated ones. The working pass band calculated covered the UWB frequency band (3.0-9.5GHz), with a community latency difference in the pass band of 0.5. Style topologies for higher order coupled line hairpin dependent band pass filters are presented in this article. The engineered filter has improved filter characteristics and efficiency, with an insertion loss of less than -2dB and a return loss of less than -10dB. By adjusting the distance and spacing between the coupling lines, the insertion loss and return loss can be improved [1]-[5].

The folded coupled lines filter stub introduced in the middle point of the straight transmission line resonator and for the increase in insertion failure. In recent years, ultra deep band localization innovations have gotten a lot of coverage. The majority of current research focuses on two-way ranging-based machine topologies with minimal multi-user scalability. The aim of this research is to improve the accuracy and robustness of a control-grade time-difference of arrival dependent localization method. The aim of this research is to enhance the precision and robustness of highly scalable control grade time-difference-of-arrival based on non-line-of-sight conditions utilizing ultra wideband sensitive signal quality evaluation and internal sensor fusion. The suggested method's precision is checked in the lab. As opposed to the results in order to relate results, an experimental reference to a commonly used of the art the state in the strong scenario, an accuracy increase of over 60% may be obtained. Based on a signal interference strategy, a lightweight dual-wideband band transfer filter with two reflection zeros in the pass band and two transmitting zeros in the stop band is presented [6]-[10]. A transmission line is linked in conjunction with a series link of transmission lines and a short circuited edge coupled line to form the proposed filter. The situation for transmission zeros is derived using a basic lossless transmission line model. To run the GPS and INSAT satellite bonds, a compact dual-wideband band pass filter

was developed. 82.16 percent and 41.52 percent, respectively, are the fractional bandwidths. A UWB-BPF with notched band at 5.8GHz is now available. Indeed, a hybrid UWB filter with coplanar waveguide structure has been created, with CRR of full-guided waveguide duration coupled to generate pass band notch. CST microwave studio was used to build and simulate this filter. The configuration is small and has a pleasing frequency signature, making it a strong candidate for current communication systems. Furthermore, we observe the presence of a notched band by using closed ring resonators (CRRs) on the bottom plane [11]-[13]. It is a potential wireless networking device of low strain.

II. RELATED WORK

The proposed filter's complete design and study, as well as the dual mode resonator, have been identified. The insertion failure that was calculated, the S parameter, the transmission zero, and the FBW. The influence of modes in a triple mode resonator for various measurements of the radial stub and high impedance cable, such as arc angle and line duration. To design a triple band filter, a radial stub loaded high impedance meander line is added to the proposed DMR to obtain an additional mode. The triple band bandpass filter's lumped counterpart. The paper shows how to create lightweight DB and TB BPFs for TETRA, GSM, and GPS applications utilizing multimode resonators. For obtaining resonant modes of resonators, mathematical equations are derived. The circuit was rendered compact by using stepped impedance and radial stubs in the resonators. The presence of EM coupling between the resonators aids in the achievement of additional propagation zeros, resulting in strong band isolation. To get a better understanding of the filters, the lumped element models are removed. With fabricated and circuit models, the suggested filter is experimentally tested. To the best of our experience, such a filter has never been suggested before.

For the first time, a micro strip triple band tri-section band pass filter was engineered and simulated using stepped impedance resonators (SIRs). The effect of coupling between each SIR investigated and its effect on filter design is compared, and the findings are found to be quite similar. In wireless communication systems, a tri-band filter is an essential feature. When the contact mechanism becomes more complicated. The spurious harmonics wreak havoc on standard parallel coupled band pass filters. To address this issue, stepped impedance resonator filters (SIRs) may be used to create high-performance band pass filters by suppressing and spurious harmonics. Using the coupling segments seen, the wideband characteristic in the pass band can be obtained. The middle frequencies of the filter are 1GHz, 2.4GHz, and 3.6GHz, respectively. The simulation calculation results for insertion failure, return loss, and tri-section triple band pass filter for tri-section triple band pass filter are shown.

III. PROPOSED WORK

A Tri-band BPF is constructed using a stub loaded resonator (SLR), with a relative dielectric constant of 3.66 and a failure tangent of 0.004 on a 0.762mm thick Rogers RO4350 substrate. A tri-band BPF is constructed using a stub-loaded resonator that shares a typical through hole and is tapped with 50 ohm micro strip transmission lines, according to the study. Specific stub lengths and stub widths were regulated to place the pass bands. To reduce circuit size and produce transmission zeros in the stop band, the open stubs are coupled together. Simulations utilizing the 3D full-wave program ANSYS HFSS V15 are used to refine the tri-band filter response. $L_1=31.38$, $W_1=2$, $L_2=16.05$, $W_2=1.75$, $L_3=3.25$, $L_4=10.4$, $W_4=0.6$, $L_5=3.9$, $L_s=2.5$, $W_s=0.5$, $g_1=g_2=g_3=0.5$, and grounding from diameter=0.5 are the optimized geometrical measurements suggested tri-band BPF (all in mm)

$$Y_{in,odd1} = \frac{Y_1}{j \tan(\theta_1 + \theta_3 + \theta_5)}$$

$$f_{odd1} = \frac{(2n-1)c}{4(L_1 + L_3 + L_5)\sqrt{\epsilon_e}}$$

$$Y_{in,even1} = -jY_1 \frac{Y_s - 2Y_1 \tan(\theta_1 + \theta_3 + \theta_5) \tan \theta_s}{2Y_1 \tan(\theta_s) + Y_s \tan(\theta_1 + \theta_3 + \theta_5)}$$

$$f_{even1} = \frac{(2n-1)c}{4(L_1 + L_3 + L_5 + L_s)\sqrt{\epsilon_e}}$$

$$Y_{in,odd2} = -jY_2 \frac{Y_1 - Y_2 \tan \theta_2 \tan(\theta_3 + \theta_5)}{Y_2 \tan(\theta_3 + \theta_5) + Y_1 \tan \theta_2}$$

$$f_{odd2} = \frac{(2n-1)c}{4(L_2 + L_3 + L_5)\sqrt{\epsilon_e}}$$

$$Y_{in,even2} = -jY_2 \frac{Y_1 - Y_2 \tan \theta_2 \tan(\theta_3 + \theta_5 + \theta_s)}{Y_2 \tan(\theta_3 + \theta_5 + \theta_s) + Y_1 \tan \theta_2}$$

$$f_{even2} = \frac{(2n-1)c}{4(L_2 + L_3 + L_5 + L_s)\sqrt{\epsilon_e}}$$

$$Y_{in,odd3} = -jY_4 \frac{Y_1 - Y_4 \tan \theta_4 \tan \theta_5}{Y_4 \tan \theta_5 + Y_1 \tan \theta_4}$$

The symmetrical arrangement of the even-odd mode can be used in the resonator. There is a voltage null in the center of the odd mode excitation. We used formulas with the parameters mentioned below.

Y=Input admittance

F= Resonance frequency

ϵ_e =Dielectric constant and substrate

C=Speed of light in free space

L1, L2, L3, L4, L5=Lengths of respective lines

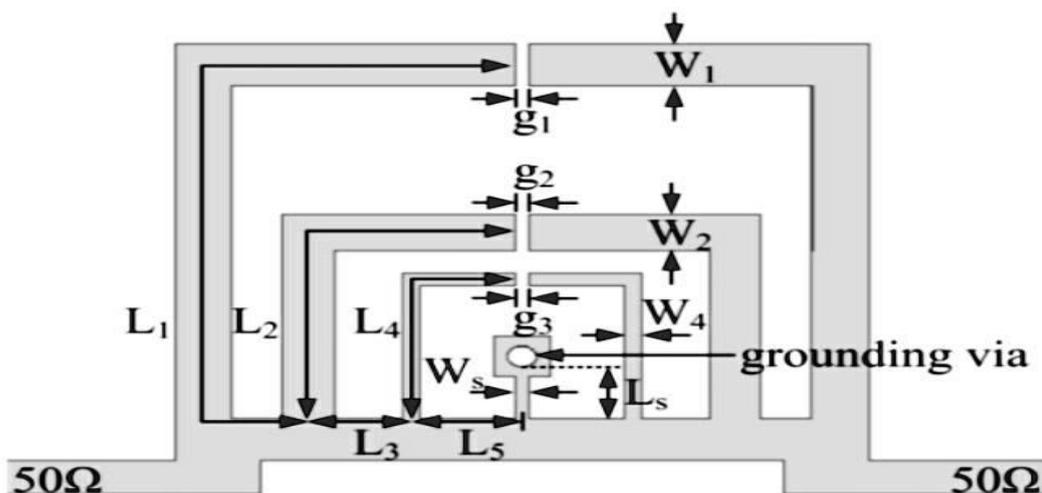


Figure.1. Design layout

The initial SLR is made up of two parts: an open stub and a shorted stub. Since the resonator's configuration is symmetrical, the even-odd mode approaches may be used to study it. Since there is no current flow through the symmetrical plane for even-odd mode excitation, we will bisect the circuit in the center to achieve the corresponding circuit. It has three resonant loops, each with a quarter-wavelength resonator grounded on one end. There is a voltage null in the centre for odd-mode excitation. This produces an approximate identical circuit with three resonators and one grounded end. Y1, Y2, Y3, Y4, Y5, and Ys are the characteristic admittances of the respective rows, L1, L2, L3, L4, L5, and Ls are the respective line lengths, and $n=1,2,3,\dots$. The speed of light in free space is denoted by the letter C. The even and odd mode resonance frequencies, which can be set by correctly selecting the stub distances, can be used to set the pass band frequencies of a tri-band filter. Other even and unusual mode resonance frequencies are often affected by L3, L5, and Ls. The equations do not strictly hold in the presence of tight coupling, necessitating fine parameter optimizations. The influence of various parameters on even/odd-mode resonance frequencies.

IV. RESULT AND DISCUSSION

The voltage reflection coefficient of the input port is S11. S11 is the most often used parameter when it comes to antennas. S11 is the reflection coefficient, and it reflects how much electricity is transmitted from the antenna. If S11=0 dB, the antenna will display all of the power and will not radiate anything..

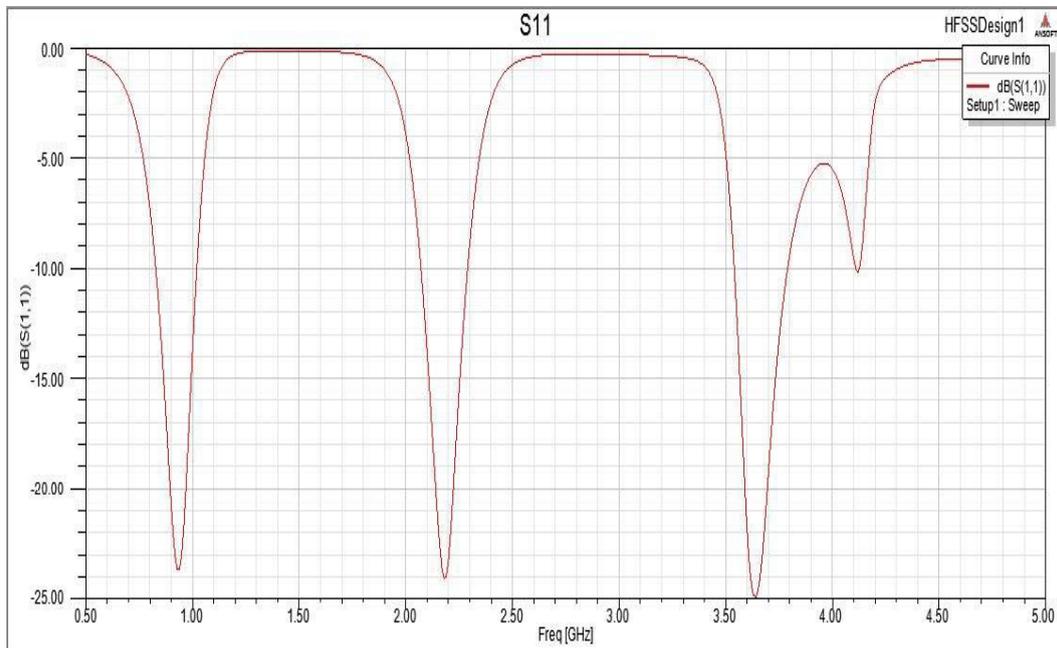


Figure.2. S₁₁ plot

The power transferred from port 2 to port 1 is represented by S₁₂. The reverse voltage gain is S₁₂. It's a coefficient of reversal of propagation. Isolation in the same direction. S₁₂ may apply to a number of things, including a military SABCA S12, a Belgian aircraft SIAI S12, and an Italian observation flying boat from the 1910s called SPAD.

The power transferred from port 1 to port 2 is represented by S₂₁. S₂₁ is a significant efficiency metric for a two-port network. An S parameter represents the sum of power exiting one network port in relation to the amount of power entering another network port. The suffix "21" in the case of S₂₁ signifies the power leaving port 2 and being delivered to port 1.

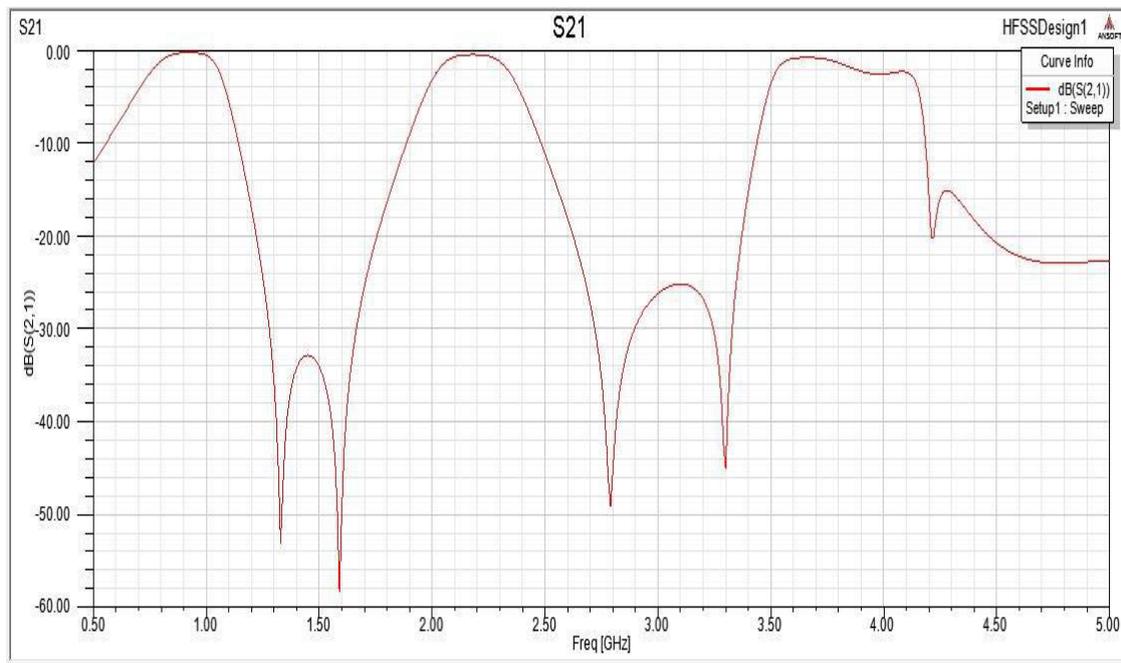


Figure.3. S₂₁ plot



S_{21} is a reflection measurement parameter.
 S_{21} provides useful information such as insertion loss, delay time.

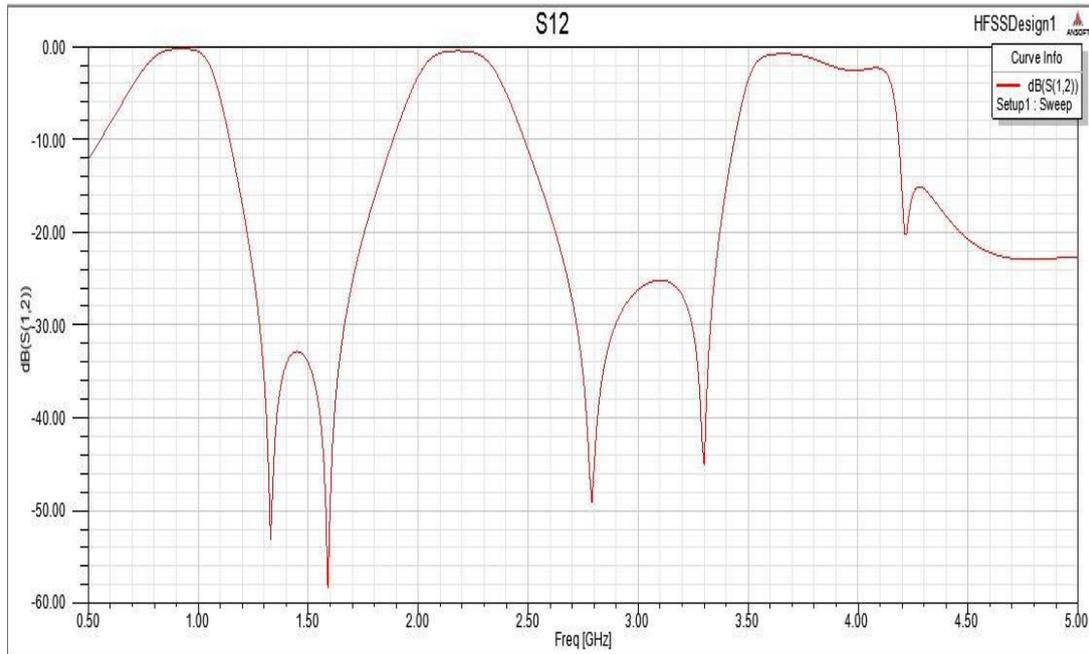


Figure.4. S_{12} plot

S_{12} is a reflection estimation parameter that can be used to calculate gain failure, route delays, and party delays. The voltage reflection coefficient of the output port is S_{22} . In a two-port network, the S-parameter matrix can be used to calculate the reflection coefficient and propagation gains on both sides. This idea may also be applied to determining the S-parameters of a multi-port network.

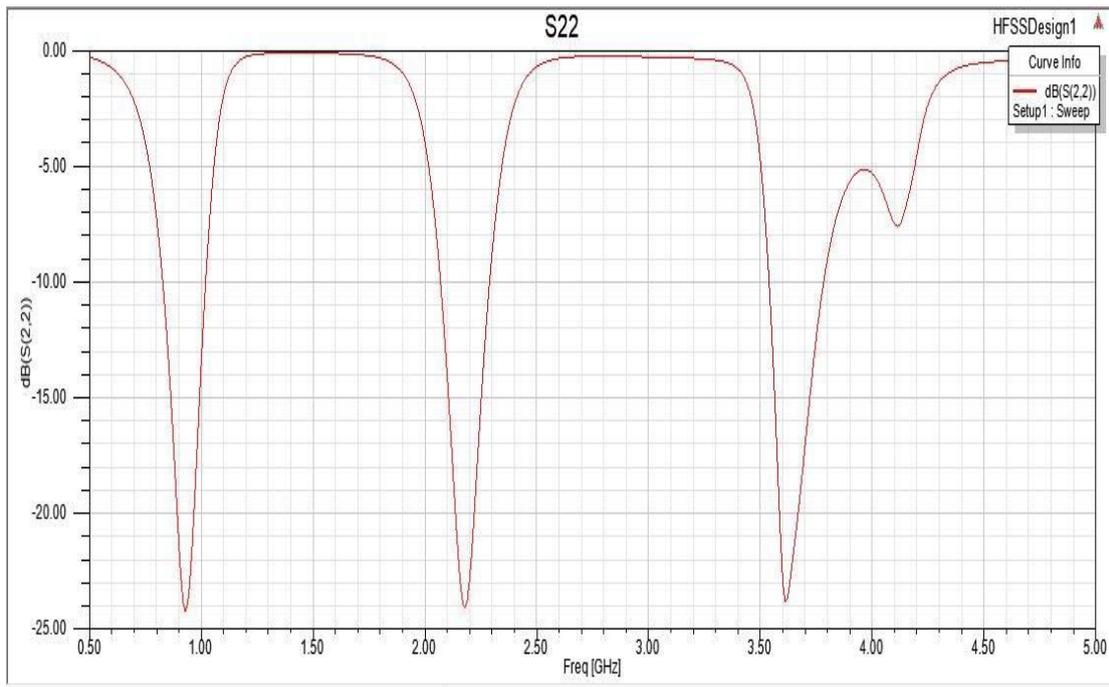


Figure.5. S_{22} plot

S22 is a parameter for measuring propagation.

It gives details including return failure, impedance, and admittance.

Transmission Zeros is the frequency at which a linear two-port network's transport mechanism has nil transmission.

Transmission of knowledge High-pass and low-pass filters, respectively, include zeroes at zero frequency and infinite frequency. At the same time, a transfer function may have many zeroes.

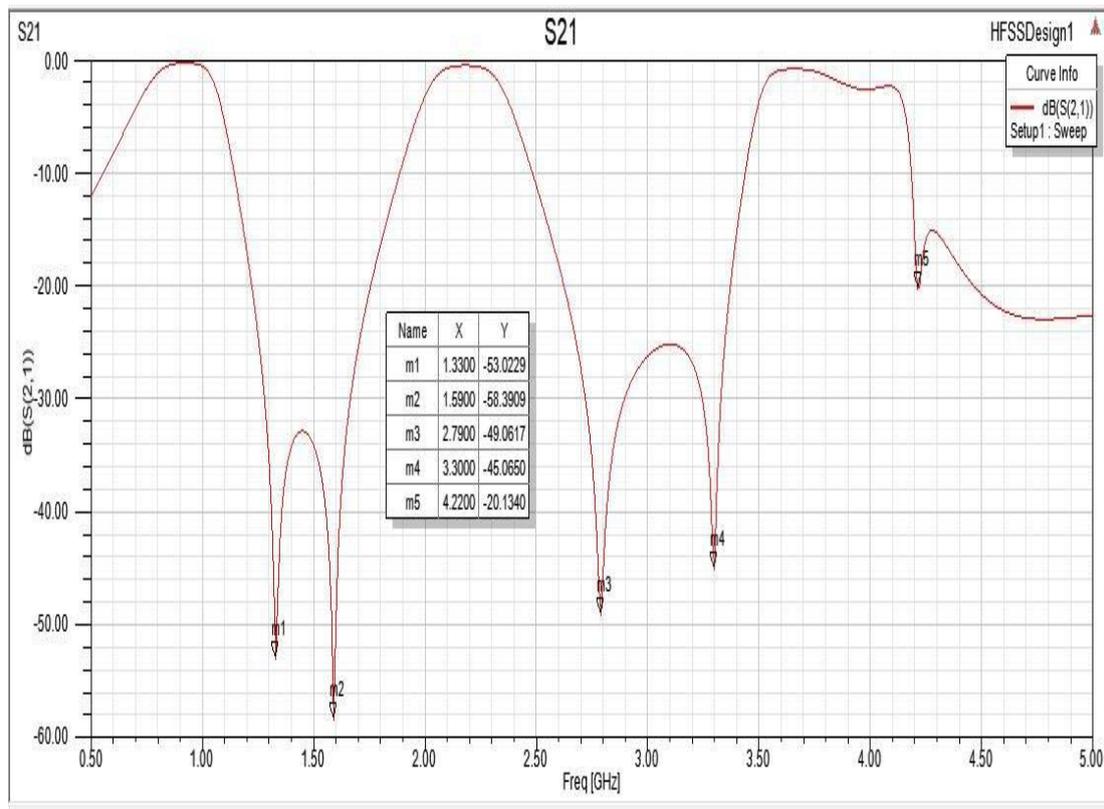


Figure.6. Transmission zeros

The resonators of TZRPs, which specify the position of the transmission zeroes and poles, will flexibly regulate the pass band of these filters. Insertion Loss (IL) is the signal loss that occurs as a signal travels in and out of a circuit or into and out of a component. Whether our signal is 100 percent heading into a component and there is a loss coming out, it is defined as insertion loss and is calculated in decibels (db). $|v_2|$ would be smaller than $|v_1|$ for passive filters.

$$Insertion\ loss = -10\log \frac{P_{Lb}}{P_{La}}$$

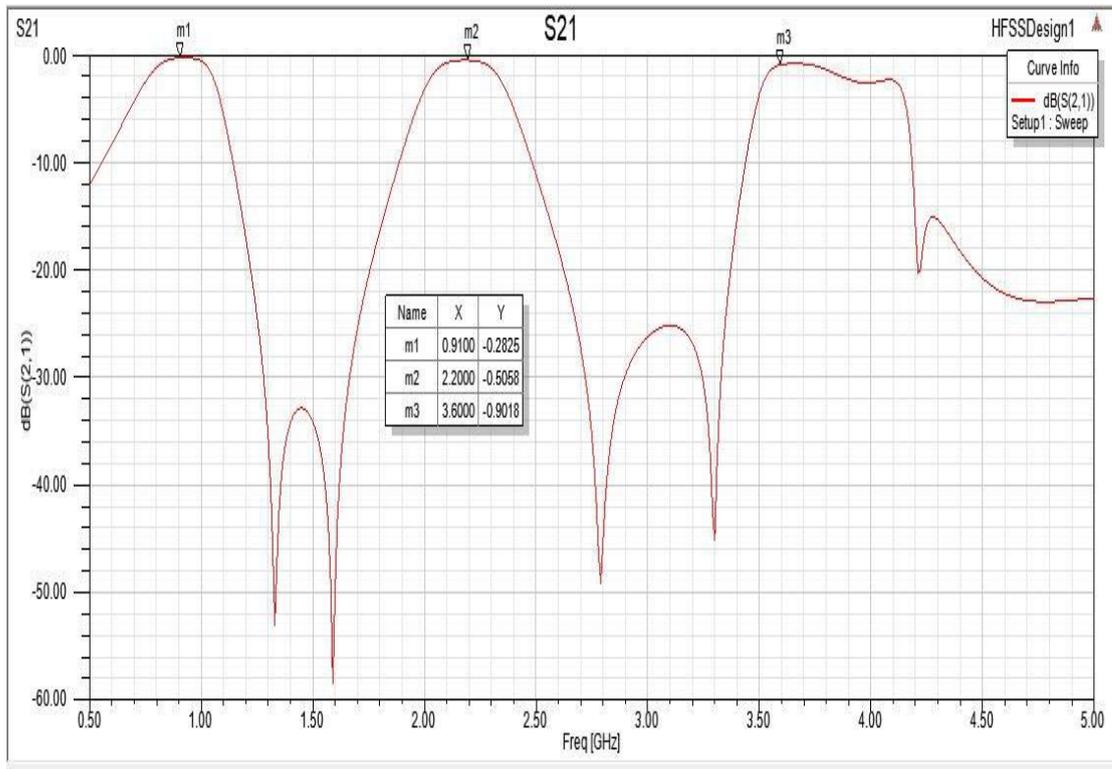


Figure.7. Insertion loss

Percentage The center frequency is commonly specified as the arithmetic mean of the upper and lower frequencies. Bandwidth is defined as the absolute bandwidth separated by the center frequency(). The harmonic mean of the upper and lower frequencies is often used to describe the middle frequency.

The fractional bandwidth is

$$\frac{\Delta f}{f_0} = \frac{2(f_0 - f_m)}{f_0} = 2 - 2 \frac{f_m}{f_0} = 2 - \frac{4\theta_m}{\pi}$$

$$= 2 - \frac{4}{\pi} \cos^{-1} \left[\frac{\Gamma_m}{\sqrt{1 - \Gamma_m^2}} \frac{2\sqrt{Z_0 Z_L}}{|Z_L - Z_0|} \right]$$

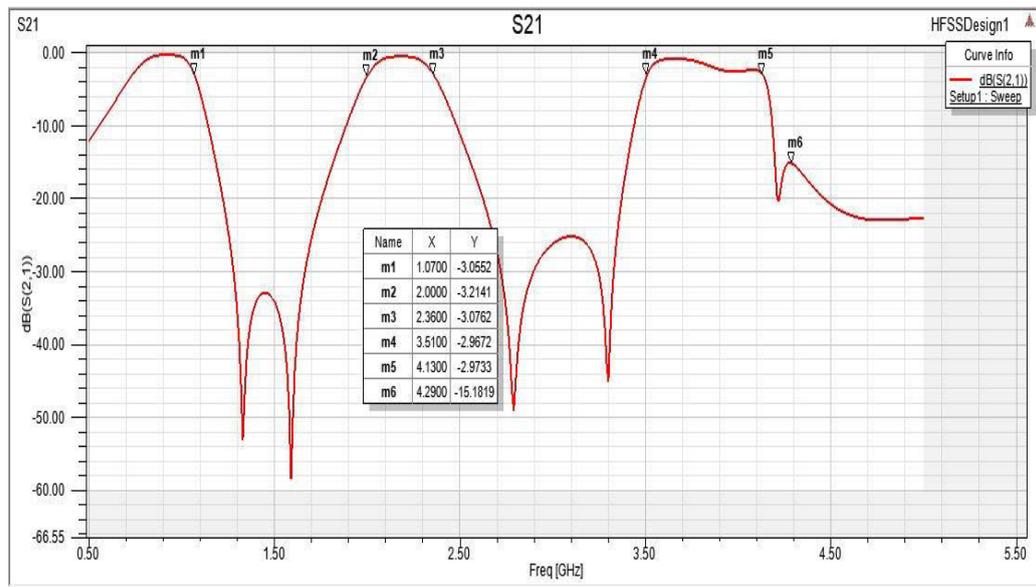


Figure.8. Fractional bandwidth

V. CONCLUSION

SLR is used to propose a lightweight triple-band band pass filter in this paper. By implementing four loaded open stubs and coupling between them, an additional pass band has been added. 3037 mm² is the compact dimension of the fabricated filter. The observed outcomes match the simulated results quite well. The frequency response of the proposed filter shows that it has a low entry loss, a moderate return loss, and a sharp skirt, making it suitable for 0.9 GHz GSM900, 2.1 GHz 3G, and 3.5 GHz WiMAX3.5 applications. ANSOFT HFSS version 15.0 is being used for this project's process and simulation.

REFERENCES

- [1] X. Y, Zhang, J, -X, Chen, Q. Xue, and S, -M, Li, "Dual-band band pass filters using stub-loaded resonators," IEEE Microw. Wireless Compon. Lett., vol. 17, no.8, pp. 583-585, Aug.2007.
- [2] X.Lai, C.-H. Liang, H. Di, and B. Wu, "Design of tri-band filter based on stub loaded resonator DGS resonator," IEEE Microw, Wireless compon, Lett., vol.20, no.5, pp. 265-267, May 2010.
- [3] S.Luo, L.Zhu, and S.Sun, "Compact dual mode triple band band pass filters using three pairs of degenerate modes in a ring resonator," IEEE Trans. Microw. Theory Tech., vol. 59, no.5, pp. 1222-1229, May 2011.
- [4] H.Liu, Y. Wang, X. Xiao, "Compact tri-band band pass filter using quintuple-mode stub-loaded resonator, Electromagnetic, vol.34, no.7, pp.545-542, Sep.2014.
- [5] S.W.Lan, M.H.Wen, S.J.Chang, C.Y.Hung, and S.K.Liu, "A tri-band band pass filter with wide stop band using asymmetric stub-loaded resonators," IEEE Microw. Wireless Compon., Lett., vol.25, pp.1950-1952, Dec. 2014.
- [6] N.Kumar, and Y.K. Singh, "Compact tri-band band pass filter using three stub-loaded open-loop resonator with wide stop band and improved and bandwidth response," Electron. Lett., vol.50, no.25, pp. 1950-1952, DEC 2014.
- [7] Y.Mo, K. Song, and Y. Fan, "Miniaturized triple-band band pass filter using stub-loaded SIRs with controllable bandwidths," microw. Opt.technol.lett., vol.56, no. 12, pp.2907-2910, Dec 2014.
- [8] Y.H.Cho, S.W.Yun. " A tri-band band pass filters using coupled lines and grounded stepped impedance resonators," IEEE Microw, wireless compon. Let., vol.24, no.5, pp.333-335, May 2014.
- [9] N.Jankovic, R.Geschke, and V.C.Bengin, "Compact tri-band band pass and band stop filters based on Hilbert-fork resonators," IEEE Microw. wireless compon. Lett., vol.26, no.6, pp.282-284, Jun 2013.
- [10] C.H.Lee, C.I.G.Hsu, and C.C.Hsu, "Balanced dual-band BPF with stub-loaded SIRs fo common mode suppression, "IEEE microw wireless compon. Lett., vol.20, no.2, pp.70-72, Feb 2010.
- [11] F.We, Y.J.Guo, P.Y.Qin, and X.W.SHI, "Compact balanced dual and tri-band band pass filters based on stub loaded resonators," IEEE Microw, wireless compon.Lett., vol.25, no.2, pp 76-78, Feb 2015.
- [12] J.Shi, and Q.Xue, "Novel balanced dual band band pass filter using coupled stepped-impedance resonators," IEEE microw. Wireless compon let., vol.20, no.1, pp.19-21, Jan 2010.
- [13] T.H.Cho and S.W.Yun, "Design of balanced dual-band band pass filters using asymmetrical coupled lines," IEEE Trans. Microw. Theory Tech., vol.61, no.8, pp.2814-2820, Aug.2013.



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