Experimental Design and Illustration of Narrow Band Compact Microwave Notch Filter using EBG Structure

M. Naga Venkatesh, Manish Mandhe, B Naresh Kumar, k ch Sri Kavya

ABSTRACT: An exhaustive paper on Inverted U-shaped Electromagnetic-Band-Gap-(E/B/G) structure has remained investigated. The design has proved in an extremely compact size and volume. This compact ultra-wideband (UWB) Dual Notch Strainer through enhanced out-of-band presentation via quasi TEM EBG construction has been proposed. An analytical assessment consumes stayed approved out amongst the innovative building then the conservative mushroom-like EBG erection. The design is evaluated, modeled and simulated using Advanced Design System (ADS) by using Method of Momentum 2.5 D solver. The Dual Band Notch filter has been realized in a metal channel of 19mm x 53 mm in dimension. The Dual Notch Filter (DNF) with EBG structure has been demonstrated in S band at 2.4 GHz and C band at 5.1 GHz for Bluetooth and WLAN applications With a rejection of -40dB, performance of Dual Band Notch filter is compared by their lesser supplement loss also advanced coming back loss. The Imitations as well as Experimental consequences have been confirmed that the zone of the Inverted U-like construction has been carried out by Utilizing Broad Side Coupled.

***Keywords - EBG Structures, Suspende*d StripLine (SSL).**

I. INTRODUCTION

Step Filter is individual of the input structure obstructs in present day Electronic Warfare (EW) frameworks. It assumes a noteworthy job of sifting through the undesirable flags and passing the ideal flag. Dynamic gadgets, for example, oscillators and blender are regularly trailed by Dual Band Notch Filters to evacuate the higher request music and other undesirable misleading signs. Additionally various microwave parts including of Diplexers and switches are likewise contained Notch Filter (NF). The suspended strip line (SSL) has turned out to be a brilliant transmission-line framework to acknowledge diverse sorts of channels [1-4]. Because of the bigger cross segment with a lot of electromagnetic field in air, the powerful dielectric steady of the Suspended Strip Line is fairly low, and transmission-line components get very huge [5]. Along these lines, Suspended Strip Line channels ordinarily are not as little as profoundly incorporated microwave and millimeter-wave front-closes require today. These Notch Filters ordinarily have the tight stopband qualities. As wide stop band reaction is essential in Notch Filters, the systems of Electromagnetic Band/Gap-(E/B/G) constructions, Photonic-Band-Gap/(P-B-G) intermittent arrangements [6] also the Defected/Ground/Plane Structures (D/G/S) [7] are elective arrangements.

EBG structures are intermittent structures that show special electromagnetic highlights, for instance, recurrence band hole for external rollers as well as in-arrange replication coefficient aimed at occurrence smooth seas. Because of these novel properties, Electromagnetic/Band/Gap-(E/B/G) Materials are prominent in logical society. For the most part, Electromagnetic-Band-Gap-(E/B/G) arrangements be situated characterized as counterfeit Intervallic assemblies to facilities deflect or help the spread of electromagnetic breakers in a predetermined group of occurrences for every single episode point and all polarization states [8]. EM waves act in such materials like that of electronic conduct in semiconductors subsequently it is additionally named as Energy bandgap structure. The moderate wave conducts in Passband qualities of Electromagnetic Band Gap (EBG) structures can be utilized as a moderate wave mode for size scaled down microwave gadgets and circuits. To create smaller plans utilizing the "Uniplanar Compact Electromagnetic Band Gap (EBG) Structures" where, the moderate wave impact is delivered by a Distributed LC two-dimensional structure, which permits an impressive size decrease in the circuit. In Micro wave channels, EBG structures are used for consonant concealment and improving channel execution with diminished element of the part. Electromagnetic Band Gap (EBG) structures can be arranged as 1-D, 2-D or 3-D. Ordinary Electromagnetic Band Gap (EBG) structures are 1-D/2-D/3-D Periodic configurations that fulfill Bragg's circumstances, i.e., between cell detachment (period) is near partial directed wavelength

In this paper, we have originated an alternative 2-Dimentional Suspended Strip line based Electromagnetic Band Gap (EBG) structure by periodically loading rectangular coupled Stub strip Components printed on dielectric substrate. Productive and exact Hybrid MoM-Immittance Approach [9] has been utilized for all the recreation works. These 2-D EBG structures have generous focal points as far as conservatives, temperature steadiness and creation, which make them progressively appealing for microwave gadgets. The real normal for EBG structures is to show band-gap highlight in the concealment of surface-wave proliferation.

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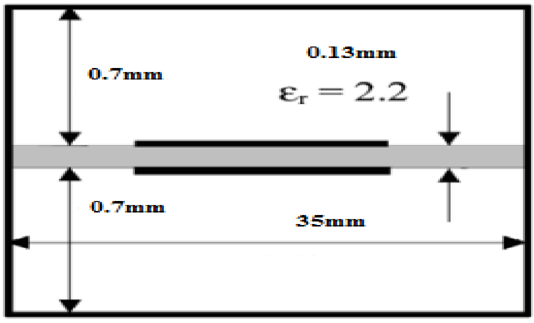

Figure.1 Suspended Stripline Topology illustrating the current layer Stack up definition with methdolgy adopted, where 0.7 mm for air space ,35 mm for length of pcb,2.2 for Er,0.13 is thickness of rt droid substrate

II. FILTER DESIGN AND ANALYSIS

The EBG based filter takes stood intended using R.T Duroid 5880 substrate by a dielectric continuous of 2.2 besides width of 5 mil to operate in S and C Band. The EBG structured Dual Band Notch Filter has been specially modeled with Suspended Strip line Structure (SSS).The Suspended strip line structure has lot of advantages over the conventional strip line especially like high Q-Factor, wide band characteristics and good temperature stability. Suspended strip line takes confirmed to be a appropriate broadcast line average through reasonable damage then a wide series of probable circuit formations, specifically aimed at strainers. Fig.1 displays the cross segment view of the Suspended Strip Line used in design. The proposed UWB Notch Filter using EBG structures is shown in Fig. 3. This geometry consists of ’5’ Inverted U-shaped coupling elements to realize the UWB Notch filter. The Broad coupled lines are used in the Notch Filter consume a connection top at the midpoint frequency’s of 2.4 GHz and 5.1 GHz. The novel Notch comprises 5 coupled line stubs in the bottom layer of the PCB introducing the effect of shunt capacitance.

The EBG section is planned utilizing the uniplanar compact– EBG (UC– EBG) structure which is a generally utilized Two-Dimensional (2-D) EBG structure detailed. The EBG segment comprises of the foliated UC– EBG cells. The Broad coupled lines are utilized in the Dual Band Notch Filter have a coupling crest at the middle recurrence of 2.4 and 5.1 GHz. The planned Notch Filter trademark impedance more often than not needs to be near 50 Ω inside the UWB pass band for wideband impedance coordinate. Each EBG unit cell, which has a length of 25 mm and with quarter wave line length of 11mm as appeared in Fig. 3.

To examine the EBG cell, the cell might be displayed with inductances and capacitances. Because of the symmetric design of each EBG unit cell, the equal circuit might be additionally symmetric as portrayed in Fig. 2. To confirm this model, the reproduction has been completed utilizing the circuit schematic in ADS. In each EBG unit cell, the width of the 50 Ω lines can be determined by utilizing essential planar transmission line conditions which are communicated as pursues

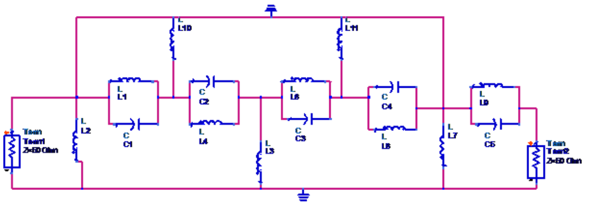

Figure.2 Lumped equivalent of Designed Dual Notch Filter, where L stands for Inductor, C stands for Capacitor. It is 10 Order Che charalfd. Filter.The Equivalent Circuit for the Notch Filter.

Where Y_0 denotes the terminating impedance and Y_U is the admittance of the immittance inverters

$$\left(\frac{Y_U}{Y_0}\right)^2 = \frac{1}{g_0 g_{n+1}} \qquad \text{eq (1)}$$

$$b_i = \omega_0 C_i = \frac{1}{\omega_0 L_i} = Y_0 \left(\frac{Y_U}{Y_0}\right)^2 \frac{g_0}{g_i \Omega} \frac{1}{cfBw} \qquad \text{For i=1 to n eq(2)}$$

Where bi are the saucepans slant parameters of arrangement parallel resonators. Clearly for a picked low pass model, with realized components esteems, the ideal susceptance slant parameters can without much of a stretch be resolved utilizing eq(1) and eq(2). The subsequent stage is to configuration microwave score resonators. Consider a two-port system with a solitary shunt part of

$Y = j\omega C + \frac{1}{(j\omega L)}$,eq(3) the series-branch has a parallel-resonant frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ eq(4)and has a Susceptance slope $b = \omega_0 C$. The broadcast restriction meant for this 2-port network completed among z_0

$$S_{21} = \frac{1}{1+\frac{Y_0}{2Y}} \qquad \text{eq(5)}$$

Aimed at narrow-band requests, the largeness of above equations may be approximated by

$$|S_{21}| = \frac{1}{\sqrt{1+\left[\frac{1}{4\left(\frac{b}{y_0}\right)}\frac{\omega_0}{\Delta\omega}\right]^2}} \qquad \text{eq(6)}$$

Where $\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right) \approx 2\frac{\Delta\omega}{\omega 0}$ using $\omega = \omega_0 + \Delta\omega$.This is at resonance when $\omega = \omega_0$ or $\Delta\omega = 0$, $|S_{21}|$=0, since the full arrangement branch shut out the transmission and causes a lessening shaft. The weakening will at that point be diminished or the estimation of |S21| will rise when the recurrence moves from ω_0. At the point when the recurrence moves with the end goal that

$$\frac{1}{4\left(\frac{b}{Y_0}\right)}\frac{\omega_0}{\Delta\omega_\pm} = \pm 1 \qquad \text{eq(7)}$$

The value of $|S_{21}|$ has risen 0.707 or -3 dB
-3dB bandwidth can be defined by

$$\Delta\omega_{3\,dB} = \Delta\omega_+ - \Delta\omega_- = \frac{\omega_0}{2\left(\frac{b}{Y_0}\right)} \qquad \text{eq(8)}$$

And thus

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$$\left(\frac{b}{Y0}\right) = \frac{\omega_0}{2\Delta\omega_{3\,dB}} = \frac{f_0}{2\Delta f_{3dB}} \qquad \text{eq(9)}$$

This Equation is helpful for extraction of the standardized susceptance slant parameters of a microwave band prevent resonators from its recurrence reaction by either EM recreation or estimation.

The above condition can be utilized paying little heed to genuine structure of microwave band stop resonators and paying little heed to whether the couplings are electric and attractive or blended.

$$\Omega = \Omega_c \alpha \tan\left(\frac{\pi}{2}\frac{f}{f_0}\right) \qquad \text{eq(10)}$$

Where Ω and Ωc are the standardized recurrence variable and the cutoff recurrence. f and f0 are the recurrence variable and the midband recurrence of the relating Notch channel, and FBW is the fragmentary transfer speed of the step channel

$$\alpha = \cot(\frac{\pi}{2}\left(\left(\frac{FBW}{-2}\right)\right) \qquad \text{eq(11)}$$

$$FBW = \frac{f_2 - f_1}{f_0} \text{ With } f_0 = \frac{f_1 + f_2}{2} \qquad \text{eq(12)}$$

f_1 and f_2 are the frequency points of the Notch Response

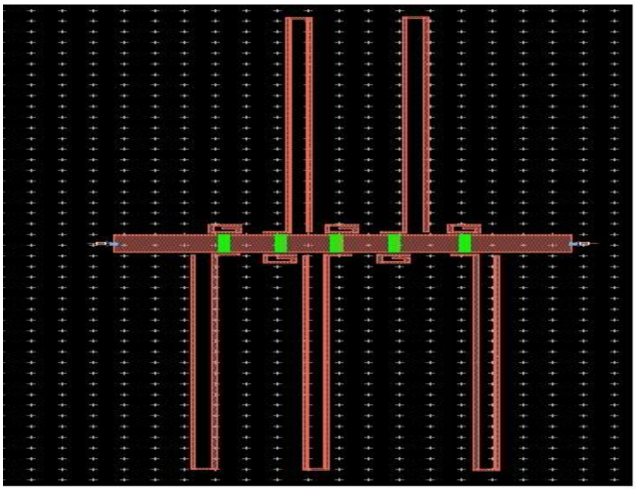

Figure.3 Notch Filter geometry (top view)

Indicates G Shaped EBG Structure, inverted U-Shaped Lamba/4,resonators.Green Stubs are broad band coupling capacitors.

Figures 4 and 5 show the momentum layouts of the proposed Notch Filter. Fig.6 shows the simulated performance of the designed Dual Notch Filter which as stop band rejection of -40dB for 400MHz band width at center frequency of 2.4GHz and 5.1 GHz with Pass band insertion loss of below -1dB

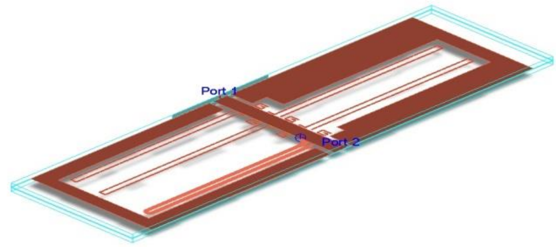

Figure.4 3-D momentum layout of Top side layer of the EBG-Notch Filter

This Tope Side Layer of EBG Structure is taken from measure simulation in Advanced Designing System Software

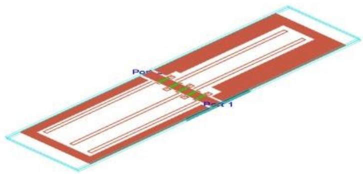

Figure.5 3-D momentum layout of Bottom side layer of the EBG-Notch Filter.This Tope Side Layer of EBG Structure is taken from measure simulation in Advanced Designing System Software

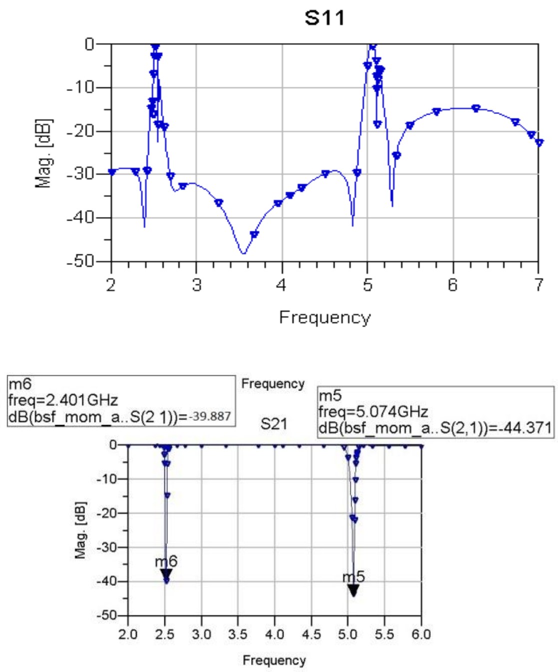

Figure.6 EM simulated Return loss and insertion loss characteristics of the EBG-Notch Filter.the plots are the S-parameters defined vaues in dB.the plots show Amplitude vs frequency characteristics.

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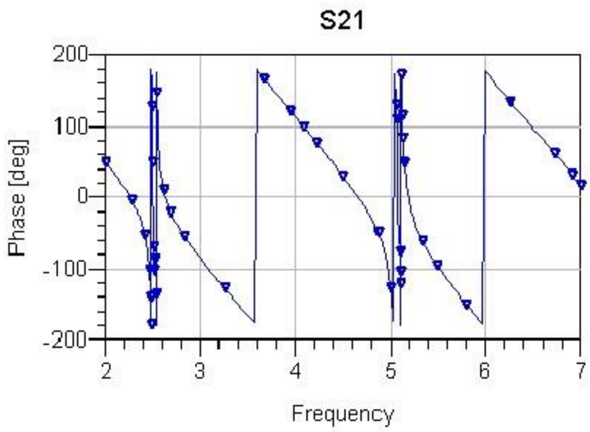

Figure.7 EM simulated phase vs frequency of the EBG-Notch Filter

III. MEASURED RESULTS

The proposed Dual Notch Filter is fabricated in a metal channel having the dimensions of 19 x 53 x 15 mm^3 shown in Figures 7 and 8 respectively. The Fabricated Dual Notch Filter has been measured with Agilent PNA-X.; Fig..10 shows the measured return loss and insertion loss which is comparable with the simulated results depicted.

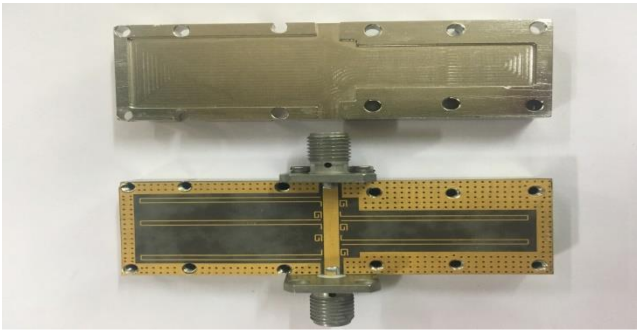

Figure.7 Photograph of the Fabricated Notch unit The photographs shows Fabricated, SMA Connectarised with multiple PTH ,Mounting holes on the Double layered PCB.

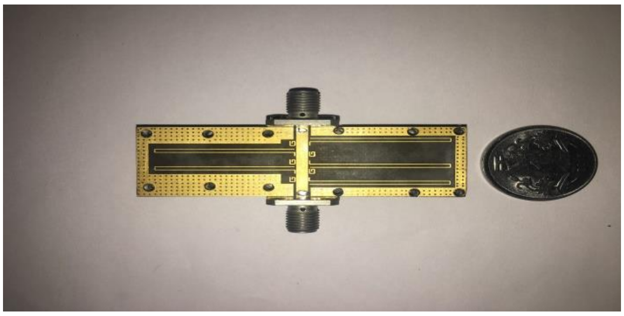

Figure.8 Photograph of the Fabricated Dual Notch unit (Top-View).The Photograph Indicates the Compact Dimensions With One Rupee Coin.

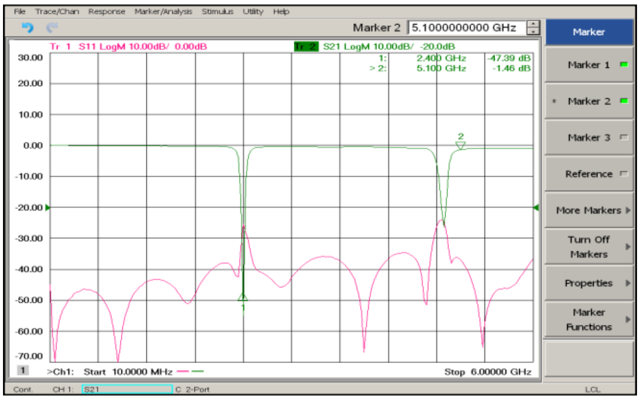

Figure.9 PNA-X- Trough ,Short and open Calibrated Measured return loss and insertion loss characteristics of the Proposed Dual Notch Filter.


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Figure.10 2-Port Configured online Measured return loss and insertion loss of Proposed Dual Notch Filter

IV. CONCLUSION

Quasi-Tem Based Ebg Suspended Strip Line Filters with Inverted U-Shaped of Quarter Wave Inverter and Broad Band Coupled Lines Were Incorporated, Which Have Been Illustrated and Demonstrated. Because Of Both Pure Capability Also Preliminary COUPLING LEAD TO ASYMMETRIC NOTCH RESPONSES, A MIXED COUPLING ALLOWS TO ACHIEVE A MUCH MORE SYMMETRIC AND Better Performance. In Addition, By Extending the Principle of Inductive Capacitive Coupling, The Ebg-Based Notch Filter Has Demonstrated with Double Layered Topology. The Realized and Tested Filter Shows an Excellent Agreement with The Simulated Response. The Presented Work Can Also Provide an Extra Gradation of Autonomy to Regulate The Band Gap Position; Broad Band Coupled Spacing Which Is Incorporated To Plan A Novel Reconfigurable Multi Section And Periodic Uni-Planar Ebg Structure

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