Design and Implementation of a Novel Microstrip Filter

G.T.Bharathy, S.Bhavanisankari, T.Tamilselvi, G.Bhargavi

Abstract: ***Microwave filters are circuits which perform signal processing functions, particularly to eliminate unwanted frequency components from the signal, to enhance wanted ones, or both. Electronic filters can be passive or active(depends on components used) Analog or digital(depends on input signal) High-pass, Low-pass, Band-pass, Band-stop or all other pass (depends on frequency) Infinite impulse response (IIR type) or Finite impulse response (FIR type) (Depends on response) Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave frequency signals. Microwave components such as antennas, couplers, filters, power dividers etc can be formed using microstrip line. This paper aims on filter design, using microstrip transmission line, with a Non-Periodic technique especially using Defected Microstrip Structure to be operated in the C – Band frequency.***

Index Terms**: *Microstrip Filter, Defected Microstrip Structure, T - Shaped structure.***

I. INTRODUCTION

Many communication system has RF system which performs signal processing using RF Microstrip filter due to its low cost. The transmitters and receivers are generally operated in 800 MHz to 30 GHz. This paper concentrates on the filter which passes frequency of 4 GHz to 8GHz(C Band). Periodic and Non-Periodic microstrip line perturbation techniques are the two common techniques used in designing microstrip RF filter. Multiband Matched Band stop Filter, Dual-mode Ring Resonator, distorted UC-PGB (Uniplanar Compact photonic Band gap), high impedance surface Electromagnetic Bandgap, Ground Plane Aperture, Photonic Bandgap (PBG), Defected Ground Structure (DGS), Defected Microstrip Structure (DMS) are the RF Microstrip designs designed using the above two techniques. This paper elaborates on Non-Periodic technique especially using Defected Microstrip Structure. The drawback of Defected Ground Structure is leakage through ground plane, radiation through etched slot and distortion are overcome by Defected Microstrip Structure. By using DMS line properties there is effective increase in inductance and capacitance which gives stopband characteristics. The microstrip line can be realized in Defected Microstrip Structure by etching the slot. It improves the microwave circuit performance. Based on the structure the Defected Microstrip Structure can be shaped in T,G,L and spiral. This paper focuses on designing a microstrip filter in T-Shape.

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II. BANDSTOP FILTER

The basic arrangement of the optimal Bandstop filter depends on the open circuited transmission line stub network.

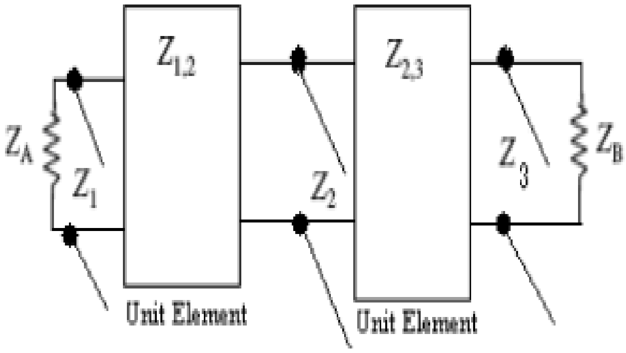

Fig.1 Transmission line representation of BSF

III. DEFECTED MICROSTRIP STRUCTURE

Periodic structures commonly display passband and stopband description in a variety of bands of wave number determined by the nature of the structure. Defected microstrip structure (DMS) is constructed by etching distinct slot patterns in the microstrip line, and it exhibits the properties of slow-wave, eliminating microwaves in certain frequencies that are analogous to the defected ground structure (DGS) but without any management of the ground plane. DMS is effortlessly incorporated with other microwave circuits, and it has an efficiently reduced circuit size in relation to DGS. DMS Increase in the electric length of the microstrip line DMS, makes the effective capacitance and inductance to increase. Resonances are created due to the defection in the microstrip line. Several novel, compact microwave components and antennas can be constructed with the help of the advantages and characteristics of DMS.

Microwave discontinuity like gap, T-shape, bend, step and etc. are some common elements that are used to form a microwave structures which leads to specific design performances.

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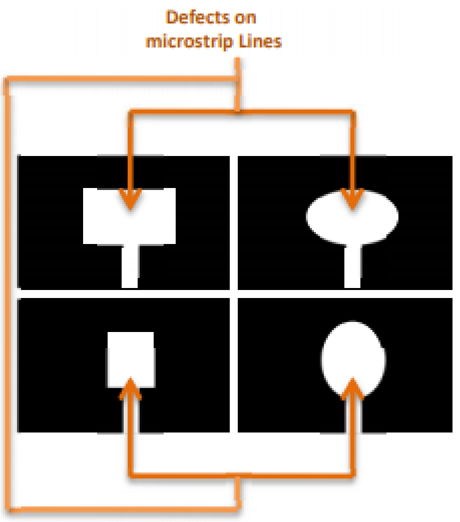


Fig.2. Defected Microstrip Structure

IV. MICROSTRIP FILTERS

Relationship between the desired frequency characteristics and the parameters of the filter structure is required to construct specific filters. The distributed parameters can be related to the corresponding parameters of lumped element prototypes. Richard's Transformation and Kuroda's Identities (λ/8 Lines), are most commonly used for which X = jZo. Richard's idea is to use variable Zo (width of microstrip). Finally the filter design has to be scaled to the desired λc and Zo (typically 50Ω).

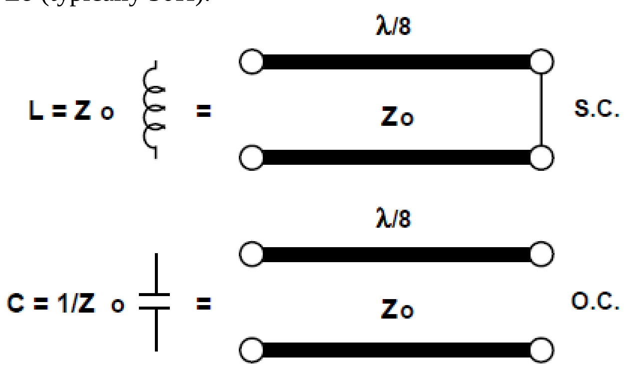


Fig.3 Lumped Elements and its Equivalent Distributed Line.

Kuroda's idea is use the λ/8 line of appropriate Zo to transform awkward or unrealizable elements to those with more tractable values and geometry. The series inductive stub in the diagram here can be replaced by a shunt capacitive stub on the other end of the λ/8 line, with different values of characteristic impedance determined by

$k = n2 = 1+Z1/Z2$ (1)

consider a prototype network with the values

L = Z1 = 0.5 and Z2 = 1

$k = n2 = 1+Z1/Z2 = 1.5$ (2)

The equivalent network has , the series transmission line element with Z = 1.5Z1 = 0.75 and the shunt capacitive stub has Z = 1.5Z2 = 1.5. Kuroda's four identities are a resources using which the series stubs that arise from series L or C are eliminated in the prototype networks.

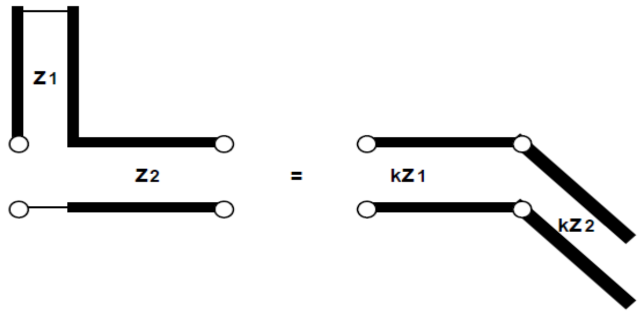


Fig.4 Prototype Network With an Inductor

The filter is designed by the following steps:

- Lumped element low pass prototype
- The series inductors are converted to series stubs, and the shunt capacitors is converted to shunt stubs
- λ/8 lines with Zo = 1 are added at input and output
- Obtain the physical dimensions by transforming the design to 50Ω.

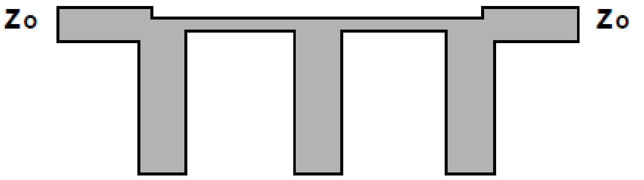


Fig.5 Microstrip Structure

V. DESIGN SPECIFICATIONS

The filter is simulated with start frequency of 4GHz and stop frequency of 8 GHz with step 0.01 GHz. For designing microstrip filter.

The substrate specifications are:

H(Height of the substrate)= 31 mil

εr(Relative Permitivity)= 2.33

T(Conductor thickness)=17 um

TanD(Dielectric loss Tangent)=0.005

Variable and equation block specifications:

w50= 2.31 mm

w54= 2.00 mm

w81= 1.00 mm

w129= 0.32 mm

Microstrip line specifications:

W(Width)= w50

L(Length)=2.5 mm

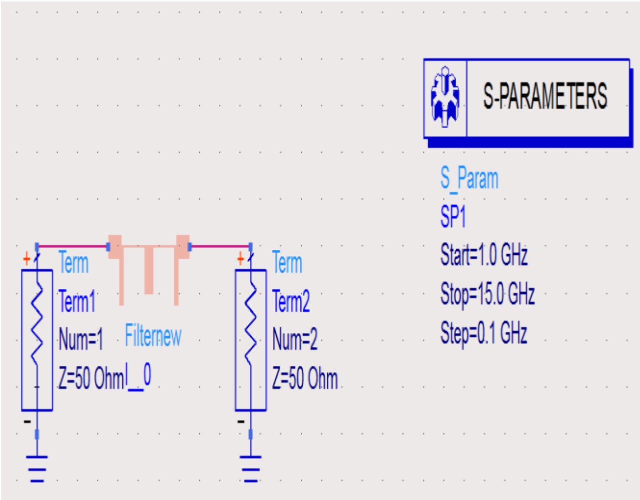
Microstrip Tee junction specifications:

M TEE 1:	**M TEE 2:**	**M TEE 3:**
W1=w50	W1=w129	W1=w129
W2=w129	W2=w129	W2=w50
W3=w81	W3=w54	W3=w81

Microstrip open circuit stub:

MLOC 1,3:	**MLOC 2:**
W=w81	W=w54
L=4.55 mm	L= 4.45 mm

VI. SIMULATION RESULTS



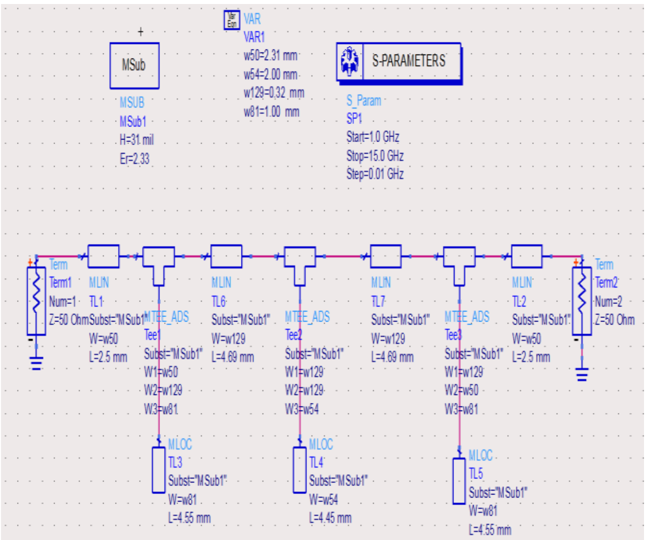
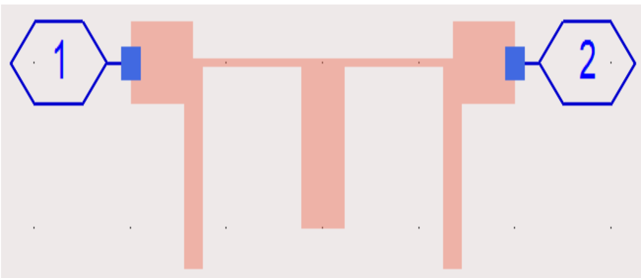


Fig. 6 ADS Schematic Model of the Filter



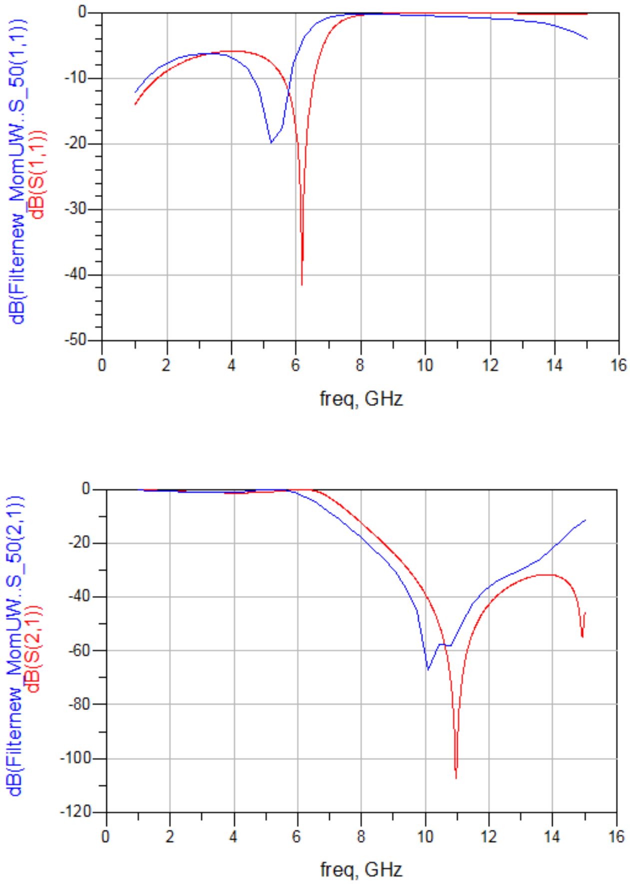


Fig.7 S Parameter Simulation

EM Layout

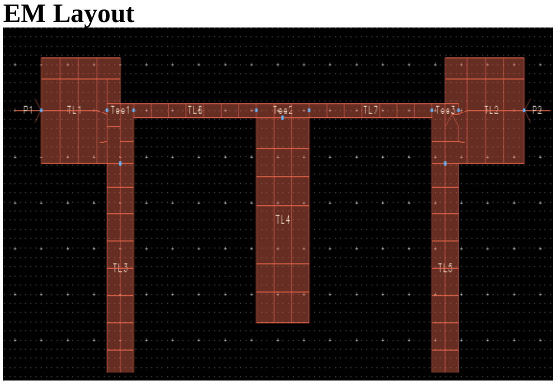


Fig. 8 ADS EM Layout of the Filter

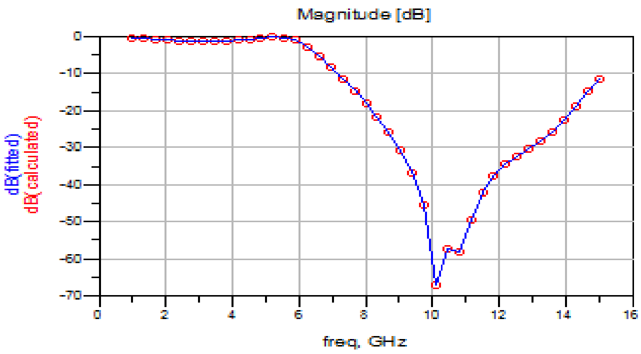


Fig. 9 Magnitude Plot of the S parameters

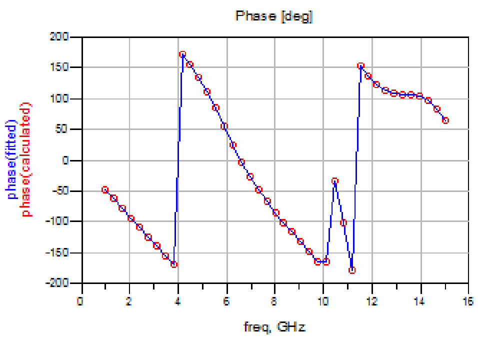


Fig. 10 Phase Plot of the S parameters

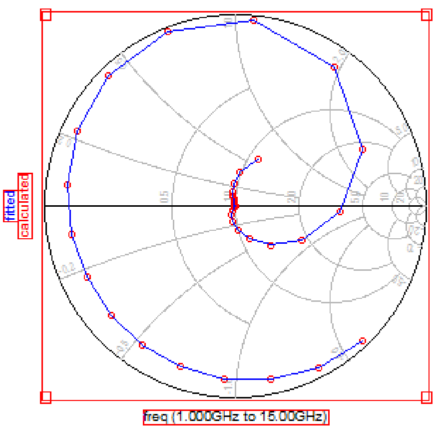


Fig. 11 Polar Plot of the S parameters

The simulations are carried out using ADS software. The schematic model and the EM Layout results shows that the designed microstrip filter works perfectly in the desired C - band frequency.

VII. CONCLUSION

A microstrip configuration is introduced to realize relatively wide bandstop filters. The reliable design process, beside the filter's low profile, weight, and manufacturing cost, makes this filter a good candidate for stopband in C - Band applications. Concurrence between measured and simulated results explains the toughness and dependability of the design method.

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