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DESIGN AND SIMULATION OF MICROWAVE DUAL BAND FILTER

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Abstract:-

The stepped impedance technique is a popular method to achieve size reduction of planner circuit, dual band operation and improvement of stopband response for filters. Dual-band bandpass filters with controllable fractional bandwidths (FBWs) are constructed by cascading the multiple λ/2 stepped-impedance resonators (SIRs) through the distributed parallel-coupled microstrip lines (PCMLs). By suitably choosing the aspect ratio of two strip widths or impedances in the SIR, the first two resonant frequencies are allocated to 2.4 and 5.2 GHz for dual-band filter application. The prototype of the bandpass filter achieved insertion loss of 1.25 and 1.87 dB, 11 of 29 and 40 dB, and bandwidth of 21% and 12.7% at 2.4 and 5.2 GHz, respectively.

KEYWORDS:- Stepped impedance, Dualband filter ,PASS band, Planner circuit.

1. Introduction

To implement low-pass filters in microstrip or stripline alternating sections of very high and very low characteristic impedance lines are used .Such filters are usually referred to as stepped-impedance, or hi-Z, low-Z filters. This technique can be applied to all parts of a filter structure, therefore allowing a much larger range of bandwidth control than previous filters for which the stepped-impedance technique is applied to stubs only[1]. Most importantly, bandwidth control

is easy: simply by changing the stepped-impedance ratios,the two bandwidths can be controlled independently by the exact relationship given in this paper.

Microstripbandpass filter using stepped impedance resonators is designed in low-temperature co-fired ceramic technology for dual-band applications at 2.4 and 5.2 GHz(Yue Ping Zhang and Mei Sun, 2006).ADUAL-BAND filter is a key component of a radio transceiver in a dual-band wireless communication system. Intuitively, a dual-band filter can be realized with the combination of two single-band filters. Alternatively, the dual-band filter can be realized using resonators

that consist of open or short stubs in parallel or in series to create two passbands with three transmission zeros.

Using ABCD parameters of a length l of line having characteristic impedance Z0

the conversion can then be used to find the Z-parameters as

$$Z_{11} = Z_{22} = -j Z_0 \cot \beta l = A/C \qquad \text{……….(1)}$$

$$Z_{12} = Z_{21} = 1/C = -j Z_0 \cos \beta l. \qquad \text{……….(2)}$$

The series elements of the Z-equivalent circuit are

…….(3)

While the shunt element of theT-equivalent is Z12. So if βl < π/2 ,the series elements

have a positive reactance (inductors), while the shunt element has a negative reactance (capacitor). We thus have the equivalent circuit shown in Figure (a) above. where

………..(4) (a) (b)

Now assume a short length of line (say βl < π/4) and a large characteristic impedance

$$X = Z_0 \beta l \qquad \text{………..(5)}$$

$$B \approx 0 \qquad \text{………..(6)}$$

which implies the equivalent circuit of figure (a series inductor). For a short length of line and a small characteristic impedance, approximately reduces to

$$X \approx 0 \qquad \text{………(7)}$$

$$B = Y_0 \beta l \qquad \text{………(8)}$$

which implies the equivalent circuit of Figure c

the series inductors of a low-pass prototype can be replaced with high-impedance line sections (Zo = Zh), and the shunt capacitors can be replaced with low-impedance line sections (Zo = Zl).

The ratio Zh/ Zl should be as high as possible, so the actual values of Zh and Zl are usually set

to the highest and lowest characteristic impedance that can be practically fabricated. The

lengths of the lines can then be determined from (5) (6) and (7)(8). To get the best response

near cutoff, these lengths should be evaluated at ω = ωc. Combining the results of (8.84)

and (5,6) with the scaling equations of (7,8) allows the electrical lengths of the inductor

sections to be calculated as

$$\beta l = LR0 / Zh \qquad \text{.........(9)}$$

and the electrical length of the capacitor section is

$$\beta l = CZl / R0 \qquad \text{.........(10)}$$

where R0 is the filter impedance and L and C are the normalized element values (the g ks)

2.Dual Band criterion

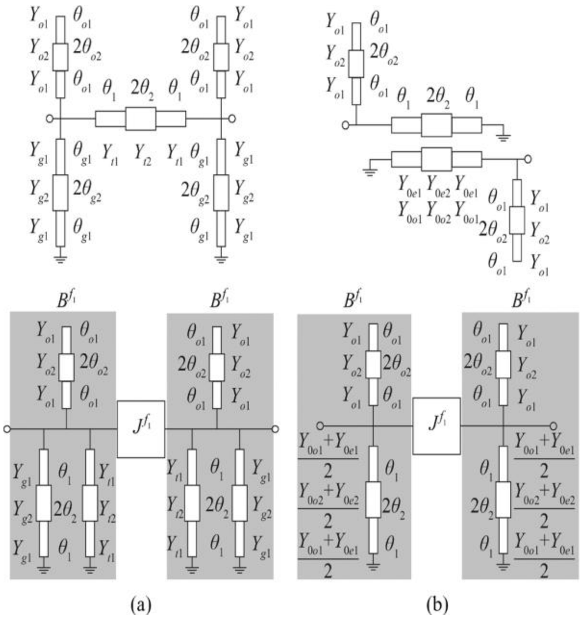


Figure above shows two types of basic filters and below that their equivalent circuits when stepped impedance technique is applied

The condition

$$2(\theta_1 + \theta_2) = 2(\theta_{g1} + \theta_{g2}) = 2(\theta_{o1} + \theta_{o2}) = 180^0 / (1+m)$$

Gives dual band performance at f_1 and mf_1 ($m > 1$)

Let the electrical length is given by

$$\theta_1 = \theta_2 = \theta_{g1} = \theta_{g2} \text{and} \quad \theta_{o1} = \theta_{o2}$$

so the stepped impedance ratio is given by

$$Rz_1 = Yt_2 / Yt_1 = Y_{g2} / Y_{g1} = Y_{0e2} / Y_{0e1} = Y_{0o2} / Y_{0o1} \qquad \text{…………..(2.1)}$$

$$Rz_2 = Y_{o2} / Y_{o1} \qquad \text{…………..(2.2)}$$

The -inverter value and the susceptance (B) of the resonator at f_1 , obtained from the even- and odd-mode analysis.

3. DESIGN OF DUAL BAND FILTERS

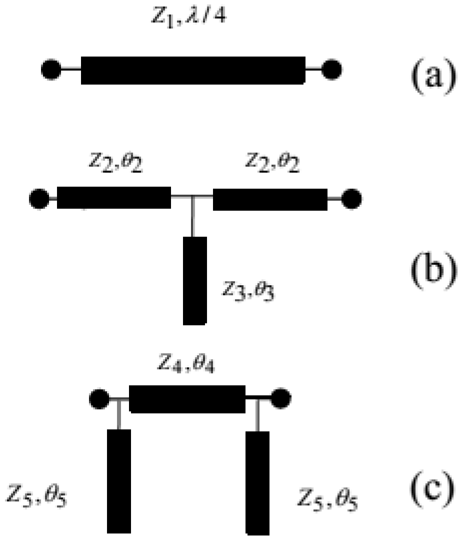


Fig. 2. λ/4 transmission line and its equivalents.
(a) λ/4 section
(b) T-shape equivalent
(c) Π-shape equivalent

[2]

The λ/4 transmission line is transformed into its equivalent T shape by using the condition that

$$z_2 = z_1 / \tan \theta_{2 f_1}$$
$$z_3 = 0.5 z_2 \tan^2 (2\theta_{2 f_1})$$

Where f_1 is first resonance frequency

Similarly the QWTL is transformed into its π equivalent by using condition that

$$z_4 = \frac{z_1}{\sin(\theta_{4 f_1})}$$

$$z_5 = z_4 \tan(\theta_{5 f_1}).\tan(\theta_{4 f_1})$$

$f_2 / f_1 = R$ frequency ratio (resonant frequencies)

$\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = \theta = \pi / (R+1)$ for equal electrical length of line.

The following is the simulation of 3rd order dual band filter using stub resonators

$Z_0 = 50\ \Omega$, $\theta = \pi/(R+1)$ here $R = 2 = f_2 / f$

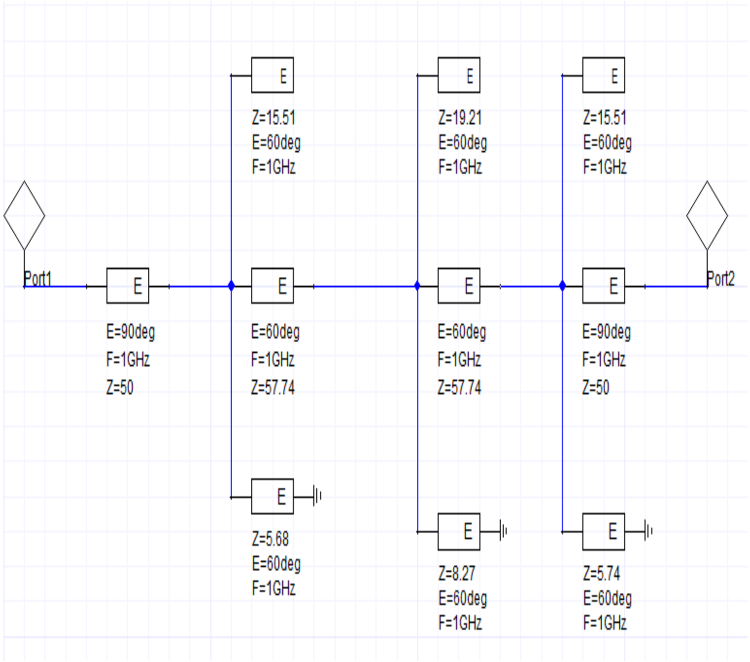
Δ = fractional Bandwidth

R_{FBW} = the ratio of fractional bandwidths at f_1 before and after the

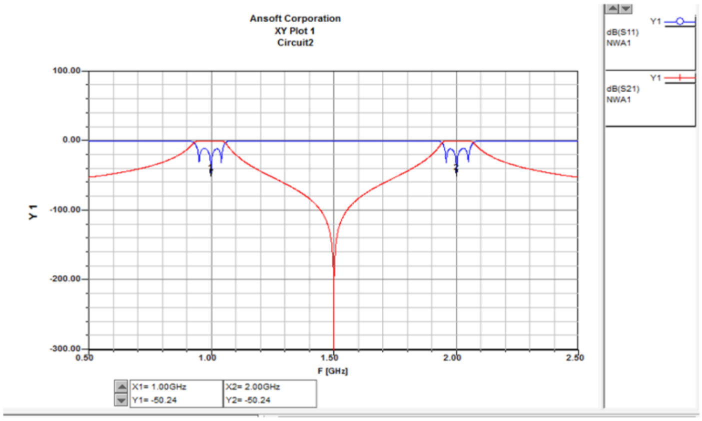
Transformation.

4. SIMULATION

Using ANSOFT Designer for simulation of microwave dual band filters

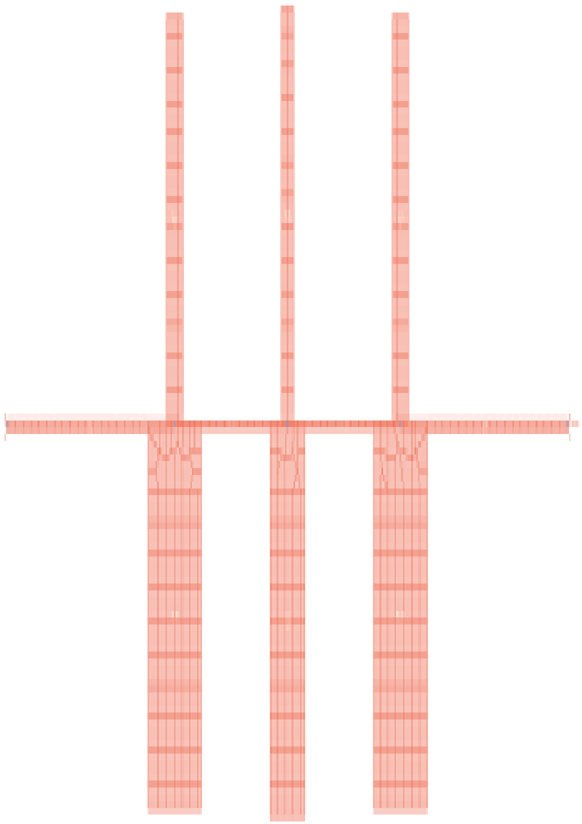


After run this design we got resultant value of reflection coefficient S-12 and transfer coefficient S-21 are given by this graph



Here f1=1 GHz and f2= 2GHz and that frequencies reflection coefficient should be minimum and transfer coefficient should be maximum than compression to other frequencies.

5. LAYOUT



This is the Layout of microstrip line or impedance of 3 rd order dual band filter.

6. CONCLUSION

These very well-characterized components allow circuit simulation results to provide very accurate results, and therefore minimize the necessity of time consuming full-wave simulation. various bandwidth relationships given in these paper provides the effectiveness for bandwidth control of dual-band filters. Various bandwidth relationships given in this project provides Design of dual band bandpass filter using microstrip line. layout of filter is also find out.

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