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Simulation study of constant k, m derived and composite filter

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Abstract : *In this paper, design and simulation of constant k, m derived and composite filter is presented. The filters are designed at 2GHz.The filters are simulated in ansoft designer. The insertion loss of all the filters are observed and compared.*
Keywords: *constant k, m derived, composite filter*

I. Introduction

The filter is one the import component of electronic circuits and systems. There are different types of filters available which are used for different applications. The ideal filter gives maximum output without any loss in its pass band. It is not possible in practical application to make perfect filter. There is always some propagation loss, insertion loss and reflection loss present. In this paper, the design of constant k, m derived and composite filter is presented. The simulation of all the filters is carried out in ansoft designer.

II. Theory And Design

Constant K filter

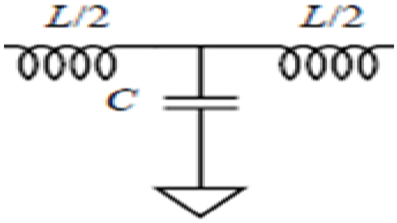

Figure 1. Low-pass constant K filter

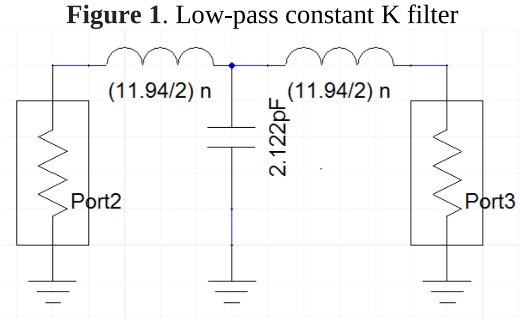

Figure 2. Low pass filter constant k filter in ansoft designer

Constant k filters are a type of electronic filters designed using the image method. They are the original and simplest filters produced by this methodology and consist of a ladder network of identical sections of passive components. The ratio of series impedance and shunt admittance of the is constant that is why the filters are often known as constant-k filters.

The filter is designed at 2GHz frequency using equations (1) to (3)[1].The calculated value of L=5.97nH and C=2.11pF. The Filter circuit is shown in Fig 1.

$$\omega_c = \frac{2}{\sqrt{LC}} \quad ....(1)$$

$$L = \frac{2R}{\omega_c} \quad ....(2)$$

$$C = \frac{2}{\omega_c R} \quad ....(3)$$

m derived filter

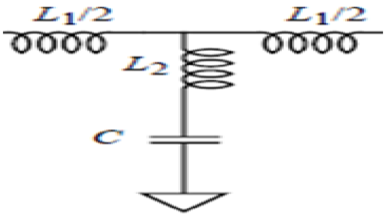

Figure 3 Low-pass m derived filter

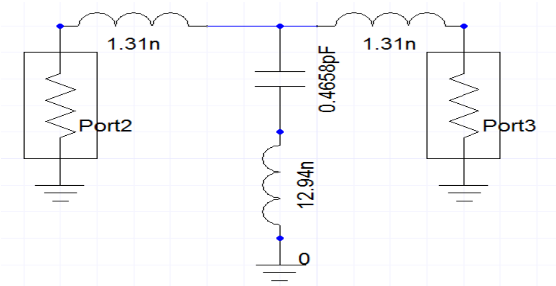

Figure 4 low pass filter m derived in ansoft designer

The m-derived filters are a type of electronic filters designed using the image method. This filter type was originally intended for use with telephone multiplexing and was an improvement on the existing constant k type filter. The disadvantage of the constant k filter is slow signal attenuation rate. This problem can be minimized by use of m derived filter. M derived filter is derived from constant k filter. Fig 2 shows m derived filter. The design equations of m derived are as follow [1].

$$m=\sqrt{1-(\frac{f_c}{f_\infty})^2} \quad \text{.................(4)}$$

$$\omega_c=\frac{2m}{\sqrt{L_1C}} \quad \text{......................(5)}$$

$$L_1=\frac{2mR}{\omega_c} \quad \text{..........................(6)}$$

$$L_2=\frac{(1-m^2)R}{2m\omega_c} \quad \text{.................(7)}$$

$$C=\frac{2m}{\omega_c R} \quad \text{............................(8)}$$

Where R resistance of the network f_c cut-off frequency f_∞ is the frequency at which attenuation is infinite.

The L and C of m derived filter are calculated for equations (4) to (8). The calculated value is shown in Fig 4(L_1=1.31nH, L_2=0.4658nH, C=12.94nF).

Composite filter

The composite low pass filter is designed using image parameter method. The limitation of constant-k type LPF is slow signal attenuation rate after the cut off .The limitation of m derived filter is attenuation in stop band is low. These limitations are minimized by use of composite filter. When we combine constant k filter in cascade with m derived filter, we can achieve desired attenuation and matching properties. But still there is requirement to address the problem of impedance matching at input and output port which can be solved by use of half m derived π section where m is 0.6. Fig 5 shows circuit of half m derived π section. Fig 6 shows composite filter circuit.

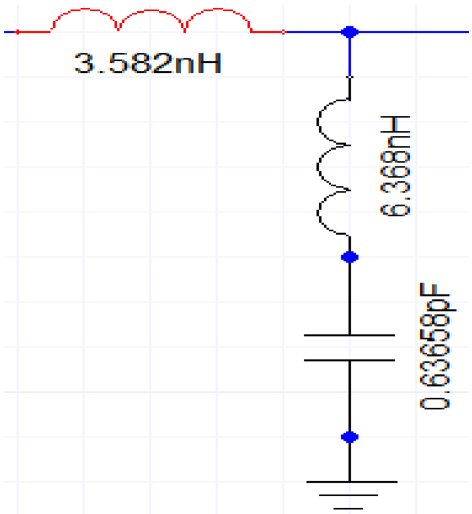

Figure 5. Half m derived pi section in ansoft designer

III. Simulation And Results

The simulation of all low pass filter mentioned in this paper is done in ansoft designer. Fig 2 show the circuit of low pass constant k filter in ansoft designer. Fig 7 shows simulated s_{21} of the constant k filter. The s_{21} is near -3 dB at 2GHz. Fig 10 shows simulated s_{11} of constant k filter. Fig 4 shows the circuit of low pass m derived filter in ansoft designer. Fig 8 shows simulated $s_{21}$of the constant k filter. The s_{21} is near -3 dB at 2GHz. Fig 11 shows simulated s_{11} of constant k filter. Fig 5 show the circuit of low pass constant k filter in ansoft designer. Fig 9 shows simulated $s_{21}$of the constant k filter. The s_{21} is near -3 dB at 2GHz. Fig 12 shows simulated s_{11} of constant k filter. The m derived filter has sharp attenuation at cut off frequency as shown in Fig 7 and 8. But in stop band the attenuation is low. The composite filter has sharp attenuation at cut off frequency and high attenuation in stop band.

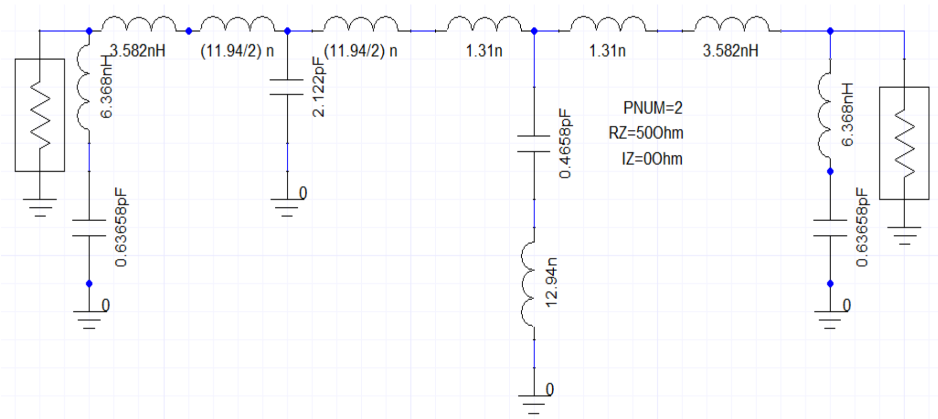

Figure 6. Composite low pass filter in ansoft designer

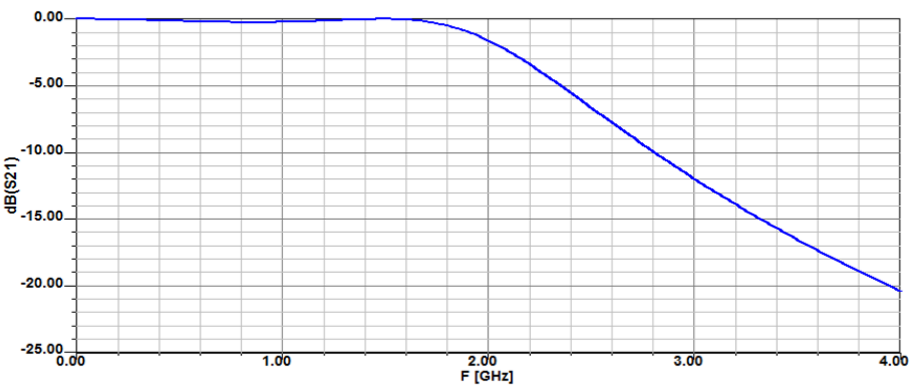

Figure 7. Simulated s_{21} of constant k low pass filter

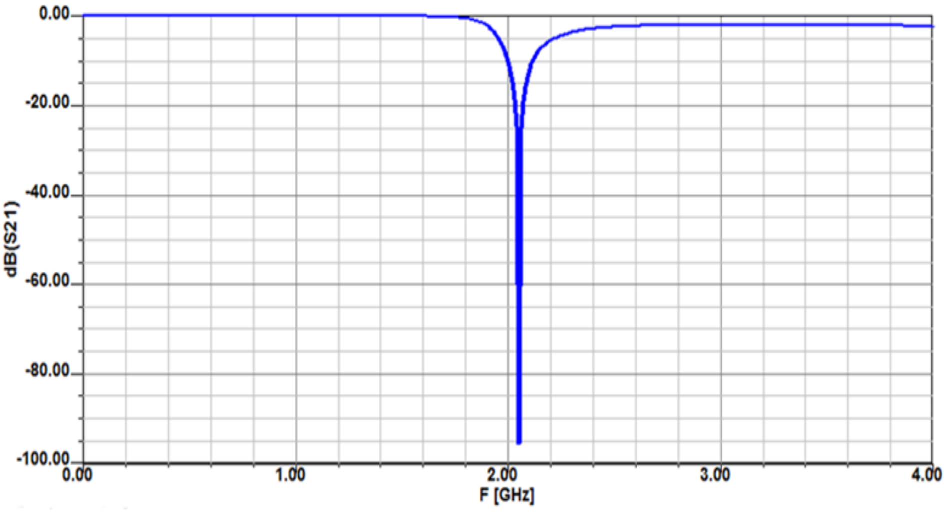

Figure 8. Simulated s_{21} of m derived low pass filter

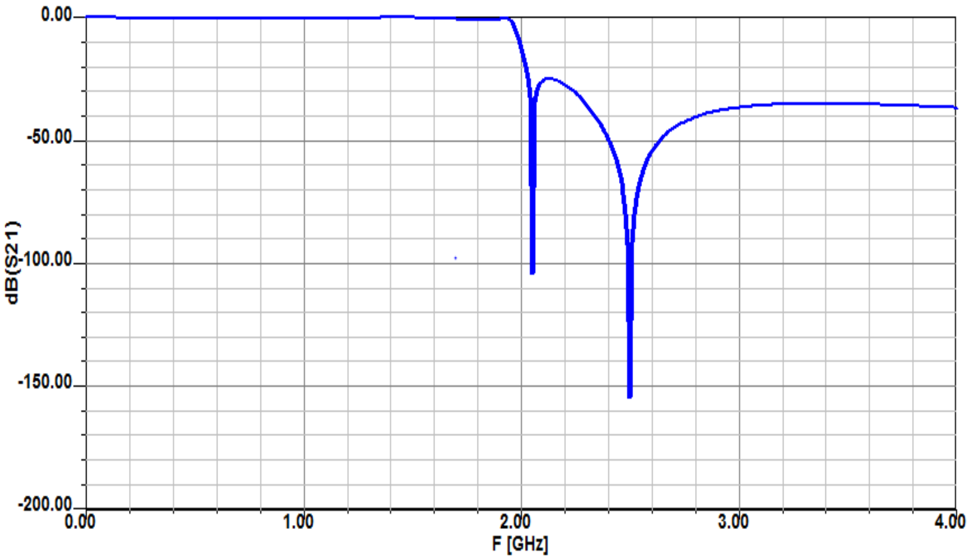

Figure 9. Simulated s_{21} of composite low pass filter

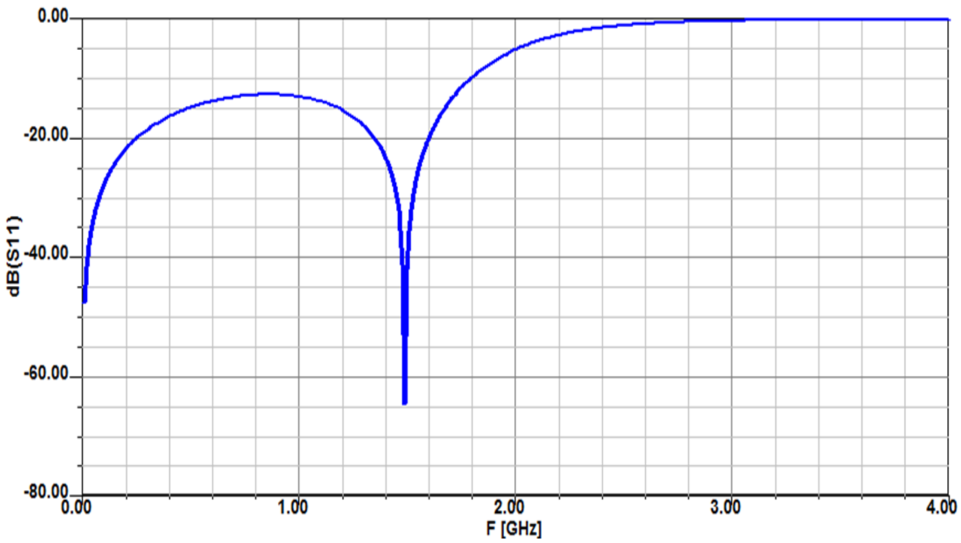

Figure 10. Simulated s_{11} of constant k low pass filter

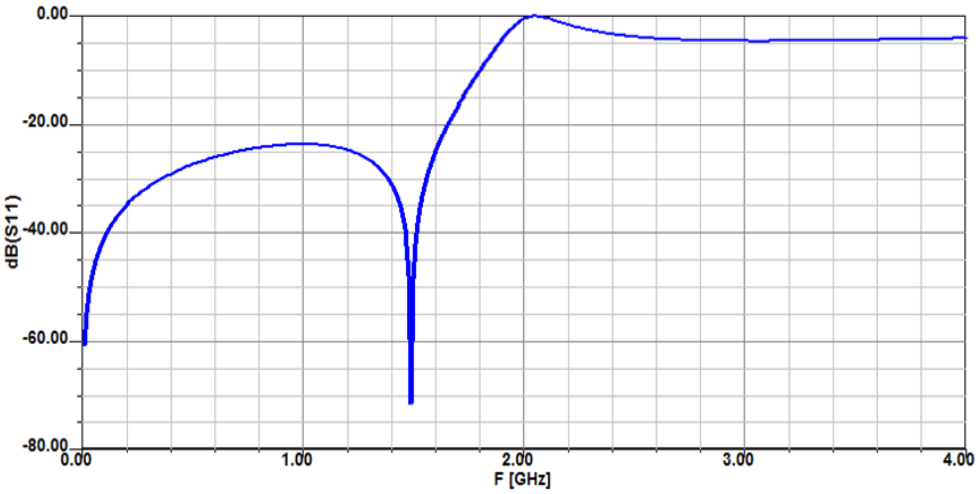

Figure 11. Simulated s_{11} of m derived low pass filter

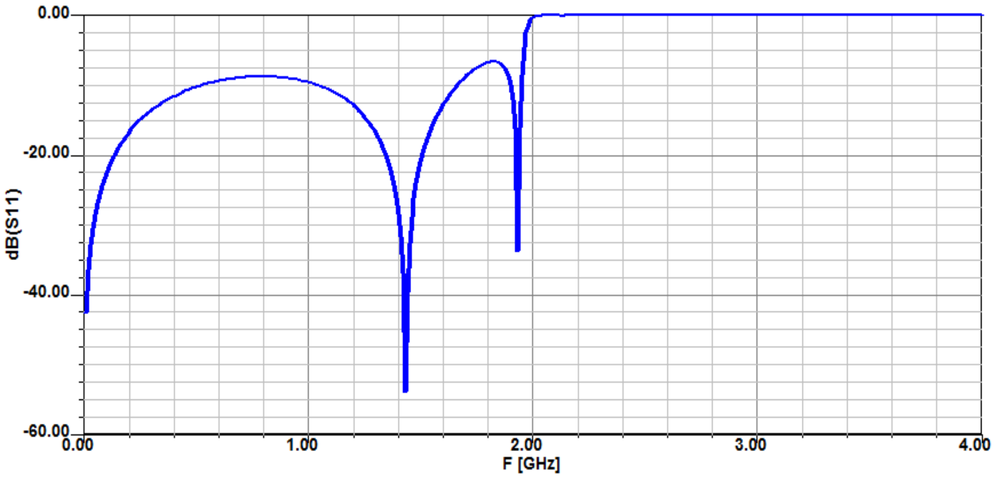

Figure 12. Simulated s_{11} of constant k low pass filter

III. Conclusion

The simulation study of constant k, m derived and composite low pass filter is done. The m derived filter gives sharp attenuation at cut off frequency and composite low pas filter has sharp attenuation at cut off as well as high attenuation in stop band.

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