KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

Electrical Engineering Department

EE 407

Microwave Engineering

Course Project

Design of microwave LPF

OBJECTIVE:

In this project, design of microwave LPF is Designed and implemented. This Chepyshev LPF with 0.5 dB Ripple have cutoff frequency of 1GHz.

INTRODUCTION:

Filters are two-port networks used to control the frequency response in an RF or microwave system by allowing transmission at frequencies within the pass band of the filter, and attenuation within the stop-band of the filter. There are several types of filters low-pass filter, high-pass filter, band-pass filter and band-stop. Binomial or Butterworth or Maximally flat response, Equal-ripple or Chebyshev response, Linear Phase response are three deferent types of practical filter. the first type can offer minimum insertion loss by providing flattest possible pass-band response. The Equal-ripple or Chebyshev response can satisfy a requirement for the sharpest cutoff region. the last type is important in multiplexing filters used in communication systems to avoid distortion at the cost of filters sharp-cutoff characteristics.

The design LPF have the flowing specification :

1. cutoff frequency at 1GHz.
2. N=3 Chepyshev 0.5 dB Ripple.
3. the circuit begins with series element.

DESIGN:

The values of the reactance elements of Chepyshev LPF with 0.5 dB Ripple with at cutoff frequency 1GHz At cutoff w = 1 rad/sec➔ f = 2π Hz from the table below.

N	g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9	g_{10}
1	0.699	**1.000**								
2	1.403	0.707	**1.984**							
3	1.596	1.097	1.596	**1.000**						
4	1.670	1.193	2.366	0.842	**1.984**					
5	1.706	1.230	2.541	1.230	1.706	**1.000**				
6	1.725	1.248	2.606	1.314	2.476	0.870	**1.984**			
7	1.737	1.258	2.638	1.344	2.638	1.258	1.737	**1.000**		
8	1.745	1.265	2.656	1.359	2.696	1.339	2.509	0.880	**1.984**	
9	1.751	1.269	2.668	1.367	2. 724	1.367	2.668	1.269	1.750	**1.000**
10	1.754	1.272	2.675	1.373	2. 739	1.381	2.723	1.349	2.524	0.884

For equal-ripple LFP with 0.5 dB Ripple & g_0=1 & ω_C=1

For N=3 and the circuit begins with series element we have the following:

At cutoff f = 1 GHz ➔ $w_c = 2\pi$ G rad/sec

L1 = 1.596

L3 =1.596

C2 = 1.097

R = 1

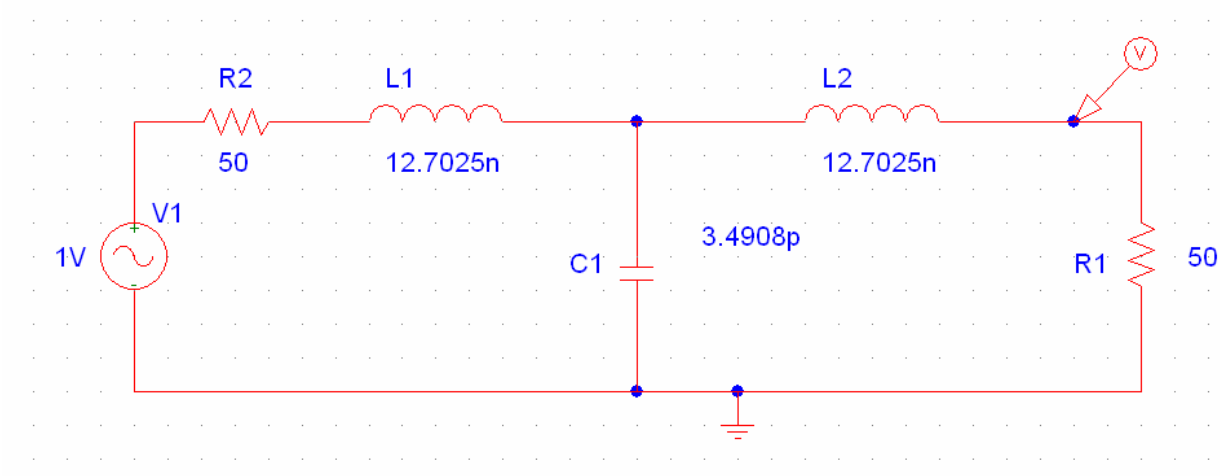
$$L'_1 = \frac{L1}{w_c} \times R' = \frac{1.596}{2\pi \times 10^9} \times 50 = 12.7025 \text{ nH}$$

$$L'_3 = \frac{L3}{w_c} \times R' = \frac{1.596}{2\pi \times 10^9} \times 50 = 12.7025 \text{ nH}$$

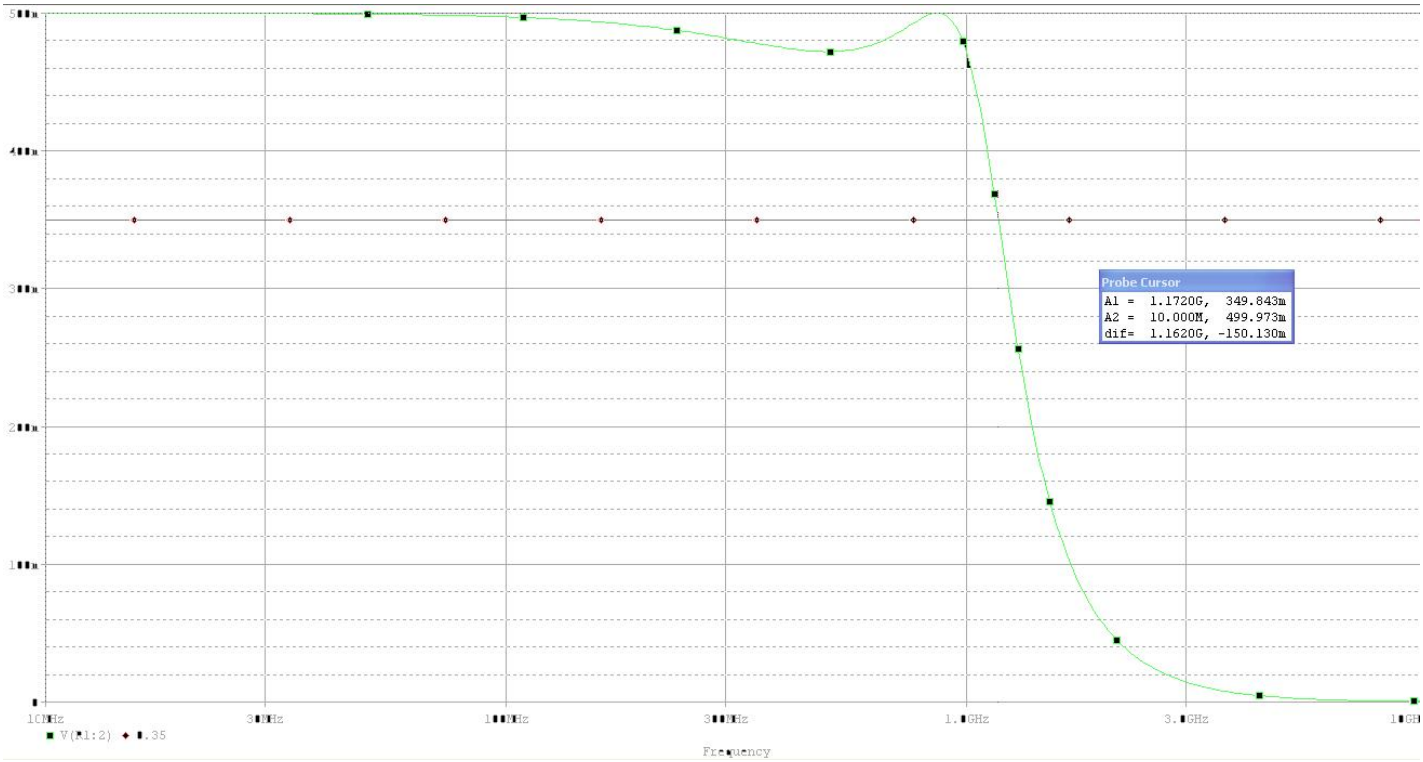
$$C'_2 = \frac{C2}{w_c \times R'} = \frac{1.097}{2\pi \times 10^9 \times 50} = 3.4908 \text{ pF}$$

$R' = 50\ \Omega$

The circuit have simulated using PSpice as shown below:



The response of the LPS in the above circuit is:

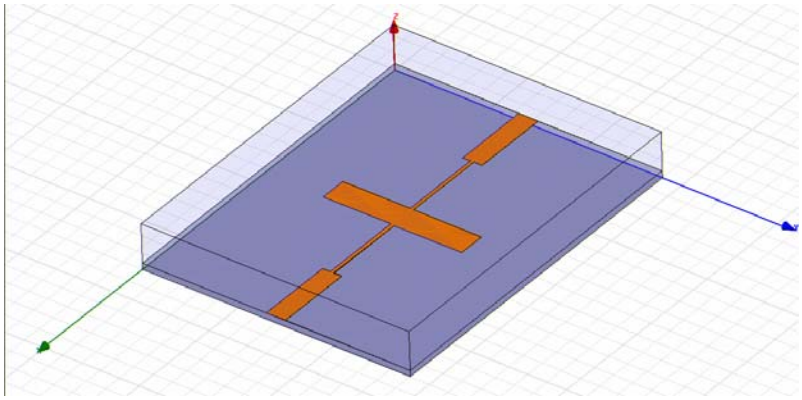


After calculating the values of the reactance element of the LPF, the dimension (W,L) of the reactance element is calculated.

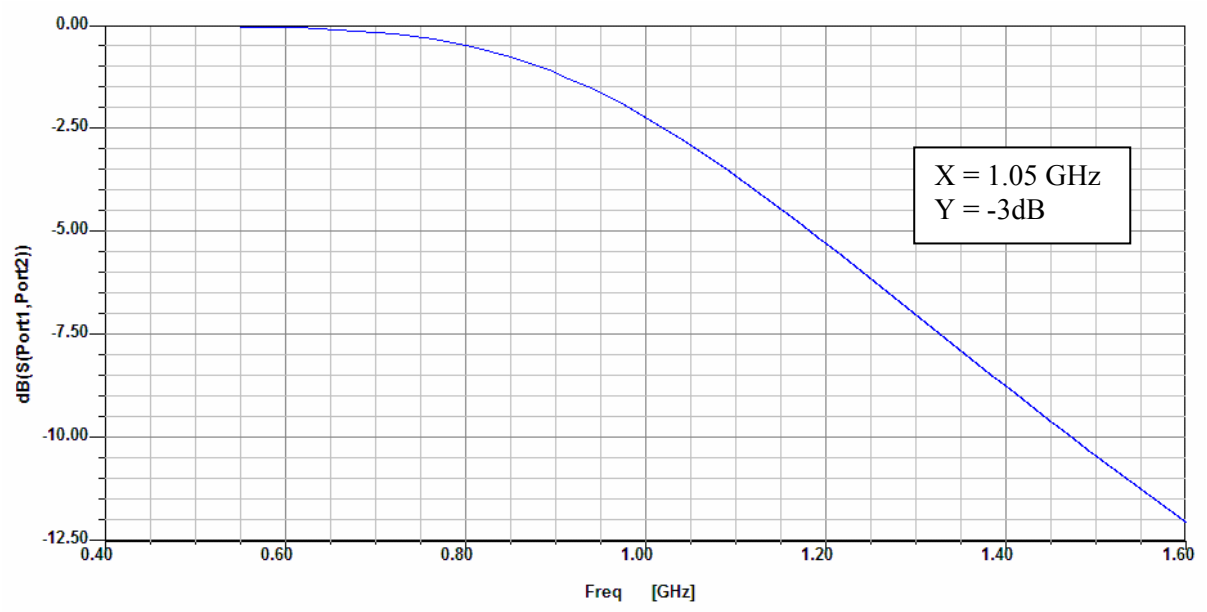
For $Z_c = 10\ \Omega$, $Z_L = 120\ \Omega$, $Z_o = 50\ \Omega$:

$L_L = 21.4$ mm, $W_L = 0.92$ mm, $L_c = 7$ mm and $W_c = 36.2$ mm and the width of the feed line of 50 Ω impedance is 5 mm.

Then The circuit is simulated using Professional Simulator. The model of the microwave LPF with cutoff frequency of 1GHz is shown below.

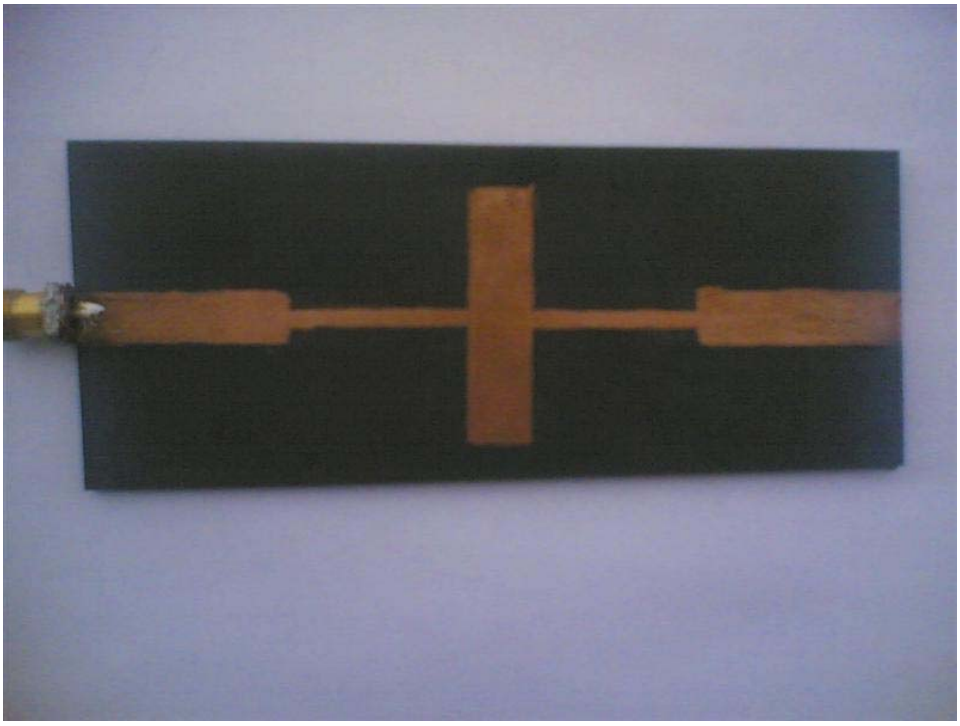


The response (S21) of the above model is:

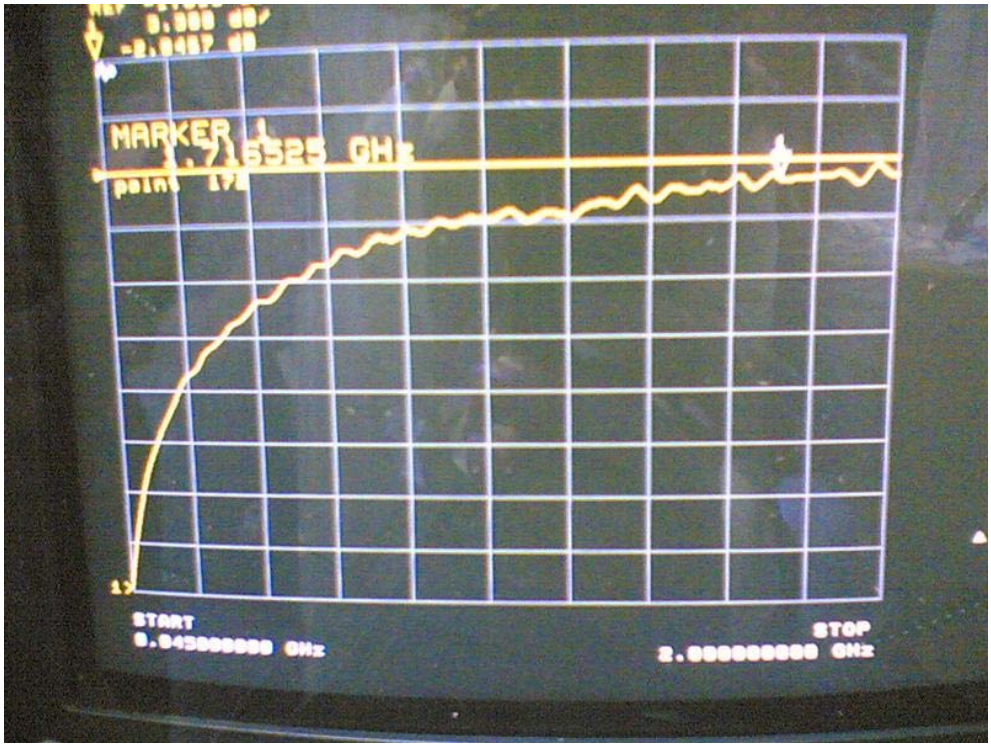


Experimental results:

The filter is fabricated using PCB as shown below:



This filter is examined by the Network Analyzer and the response is the following:



The cutoff frequency is 1.716 GHz

Conclusion:

we have design and simulate and build a microwave Chepyshev LPF with 0.5 dB Ripple which have cutoff frequency of 1GHz.