

A photograph of a printed circuit board (PCB) with a green substrate. The board features a complex microstrip layout, including a series of vertical parallel lines, a horizontal line with a series of small rectangular slots, and several circular vias. A black semi-transparent box is overlaid on the right side of the image, containing white text.

2.3 GHz Microstrip Low Pass Filter

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Outline:

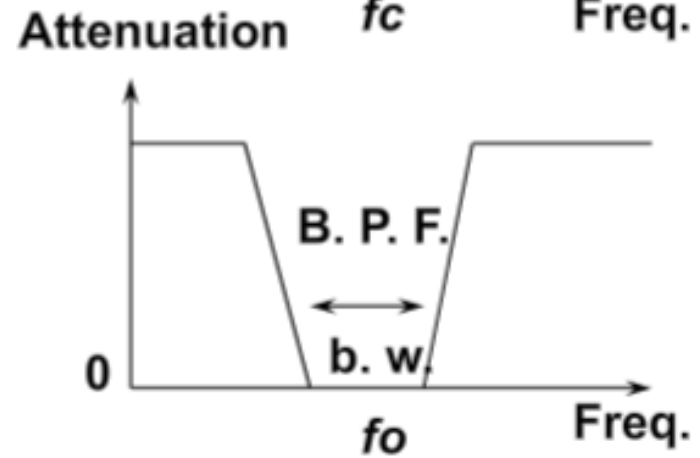
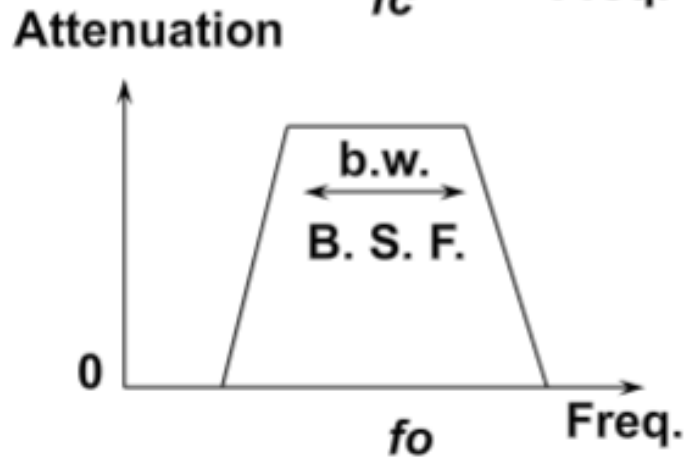
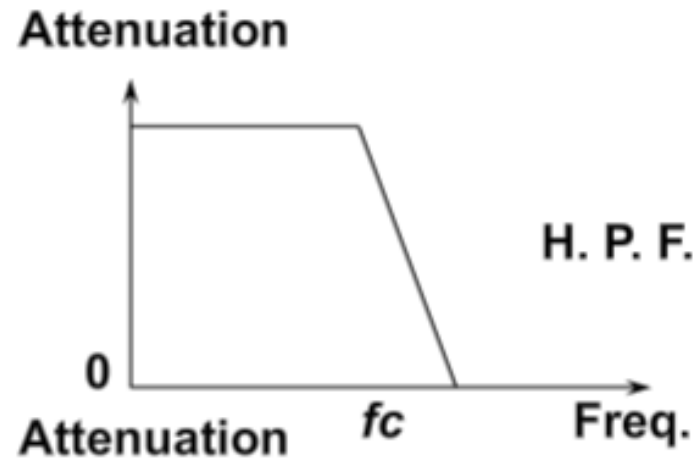
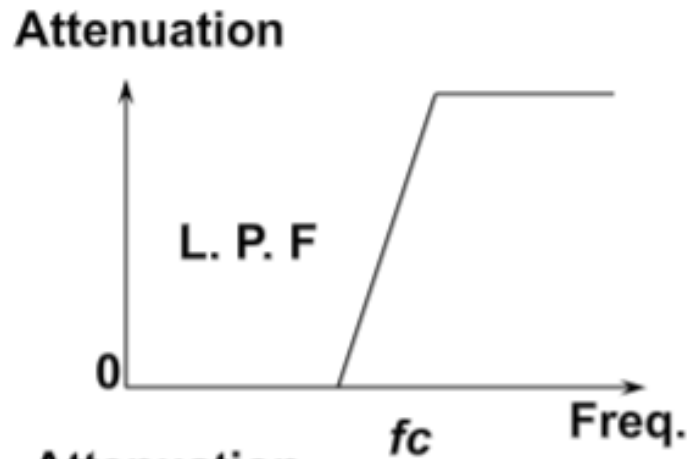
- Goal of the project
- Basic definitions
- Applications of subject
- Description
- Design Steps
- Simulation and analysis
- Conclusion
- Acknowledgement
- Audience Questions

Goals of this project:

- To learn basic principles of electromagnetic devices
- To learn how to use electromagnetic simulation software
- To learn how to write formal technical papers
- To get experience of microstrip design

Definitions

CLASIFICATION OF FILTERS BY PASS BAND TYPES



CLASSIFICATION BY TRANSMISSION MEDIUM

- **LUMPED & QUASI LUMPED ELEMENTS**
- **COAXIAL TRANSMISSION LINES**
- **MICROSTRIP LINES**
- **SUSPENDED SUBSTRATE LINES**
- **STRIP LINES**
- **RECTANGULAR OR CYLENDRICAL
WAVEGUIDES**
- **HIGH DIELECTRIC CONSATANT FILLED (OR
PARTIALLY LOADED) COAXIAL LINES OR
WAVEGUIDES**

Applications

IMPORTANCE OF MICROWAVE FILTERS

- **FREQUENCY SPECTRUM ALLOCATION AND PRESERVATION**
- **INTERFERENCE REDUCTION OR ELIMINATION - RECEIVERS PROTECTION**
- **ELIMINATION OF UNWANTED HARMONICS & INTERMOD. PRODUCTS GENERATED FROM NONLINEAR DEVICES (MULTIPLIERS, MIXERS, POWER AMPLIFIERS)**
- **SIGNAL PROCESSING & SPECTRUM SHAPING**
- **FREQUENCY MULTIPLEXING**

APPLICATIONS OF MICROWAVE FILTERS

- **COMMUNICATION SYSTEMS:**
 - TERRESTRIAL MICROWAVE LINKS: RECEIVERS PROTECTION FILTERS, TRANSMITTER FILTERS, CHANNEL DROPPING FILTERS, TRANSMITTER HARMONIC FILTERS, LOCAL OSCILLATOR FILTERS, MIXERS IMAGE REJECT FILTERS
 - SATELLITE SYSTEMS:
 - » SPACE CRAFT: FRONT END RECEIVE FILTERS, INPUT MULTIPLEXERS CHANNELIZATION FILTERS, OUTPUT MULTIPLEXERS FILTERS, TRANSMITTERS HARMONIC REJECTION FILTERS
 - » EARTH STATIONS : LNA'S TRANSMIT REJECT FILTERS, HPA'S HARMONIC REJECT FILTERS, UP & DOWN CONVERTERS FILTERS

APPLICATIONS (ctd.)

- MOBILE AND CELLULAR SYSTEMS :
 - BASE STATIONS RECEIVE PROTECTION
 - BASE STATIONS TRANSMITTERS FILTERS
 - SUBSCRIBERS HAND SETS DIPLEXERS
 - SATELLITE MOBILE APPLICATIONS
 - » AERONAUTICAL TX/RX SYSTEMS
 - » MARITIME SATELLITE TERMINALS
 - » LAND MOBILE SATELLITE TERMINALS
- RADAR SYSTEMS
- HIGH POWER APPLICATIONS

Description

- In this paper, we propose a 2.3GHz microstrip low pass filter and it is implemented on FR4 substrate of relative permittivity 4.4, loss tangent 0.02 with a thickness of 1.55mm.
- The analysis of the low pass filter is performed using the Sonnet simulator.
- Snapshots of the simulation and the graphical results obtained are shown in the paper.
- The simulation results are given and parametric studies were presented in detail.

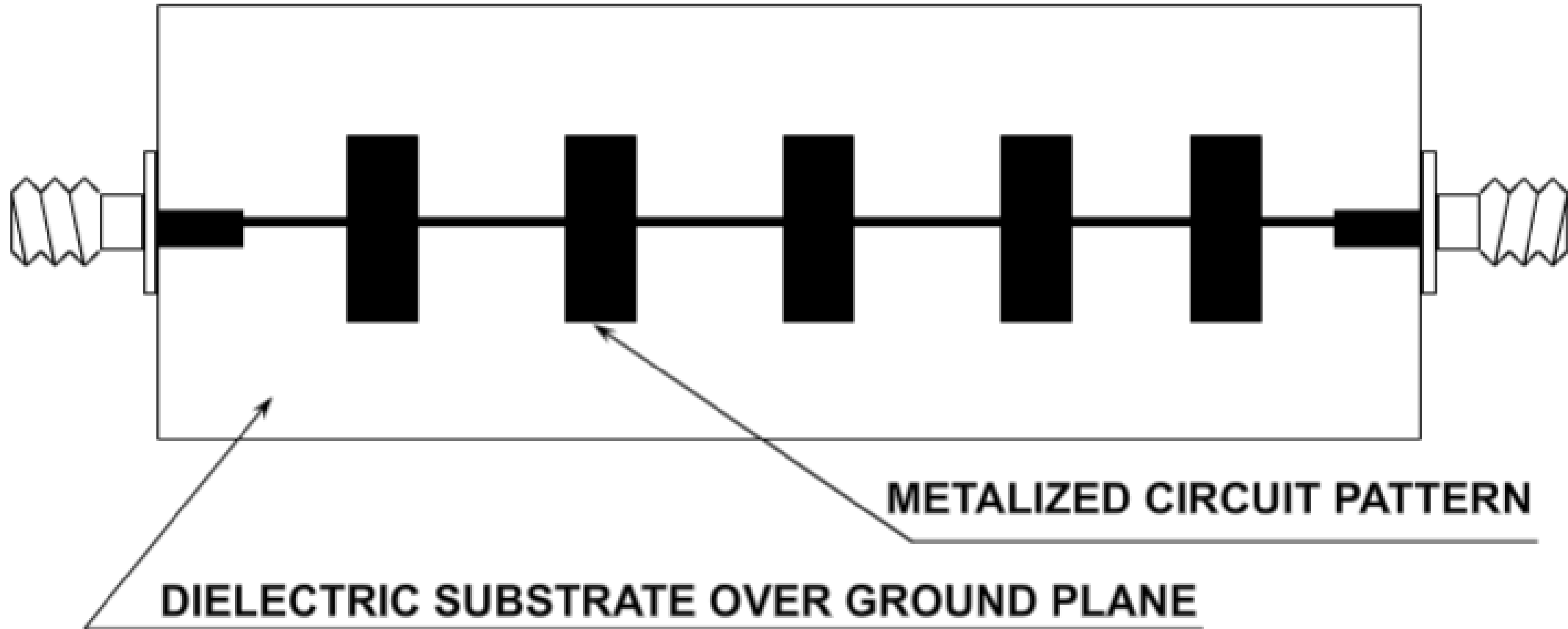
Description

This low pass filter (LPF) passes low frequencies and attenuates by reducing the amplitude of the signal frequencies higher than its cut off frequency.

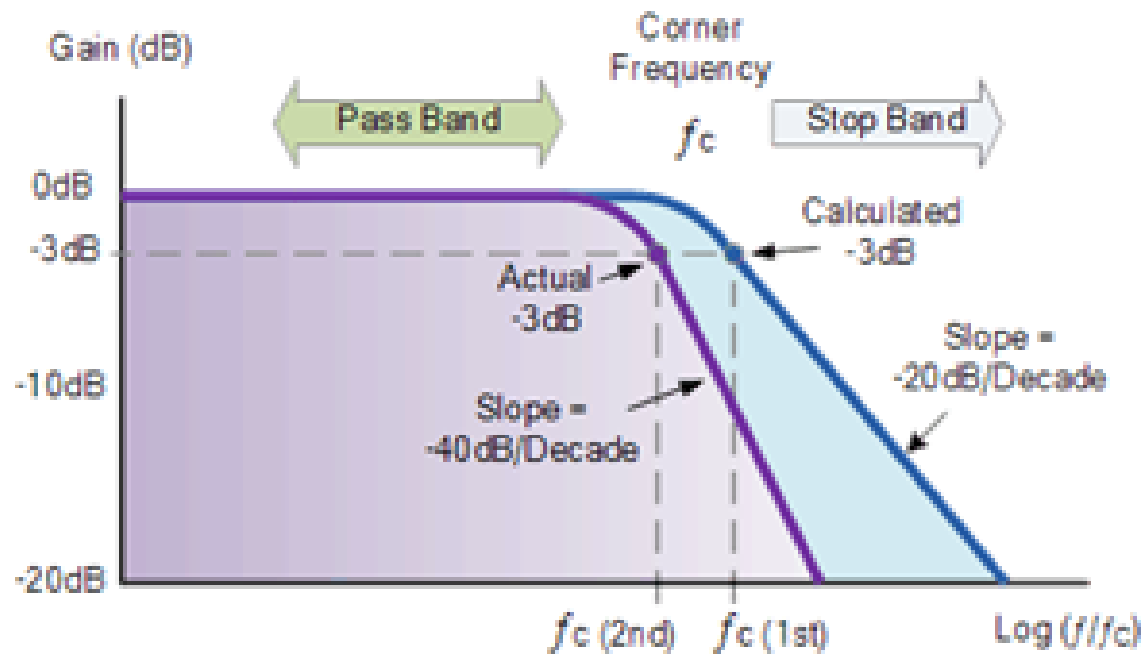
Low pass filters are used to filter noise from a circuit. 'Noise' is a high frequency signal. When passed through a low pass filter most of the noise is removed and a clear sound is produced.

Low pass filters are also used in various audio applications and are sometimes known as high-cut or treble cut filters.

MICROSTRIP LOW PASS FILTERS



Picture shows how frequency response of lowpass filter should look like:



Design steps

In general, the design of microstrip lowpass filters involves two main steps.

The first one is to select an appropriate low pass prototype. The choice of the type of response, including passband ripple and the number of reactive elements, will depend on the required specifications.

The desired source impedance is normally 50 ohms for microstrip filters.

In this paper, a design of lowpass filter and its implementation to microstrip line is done and frequency responses are analyzed.

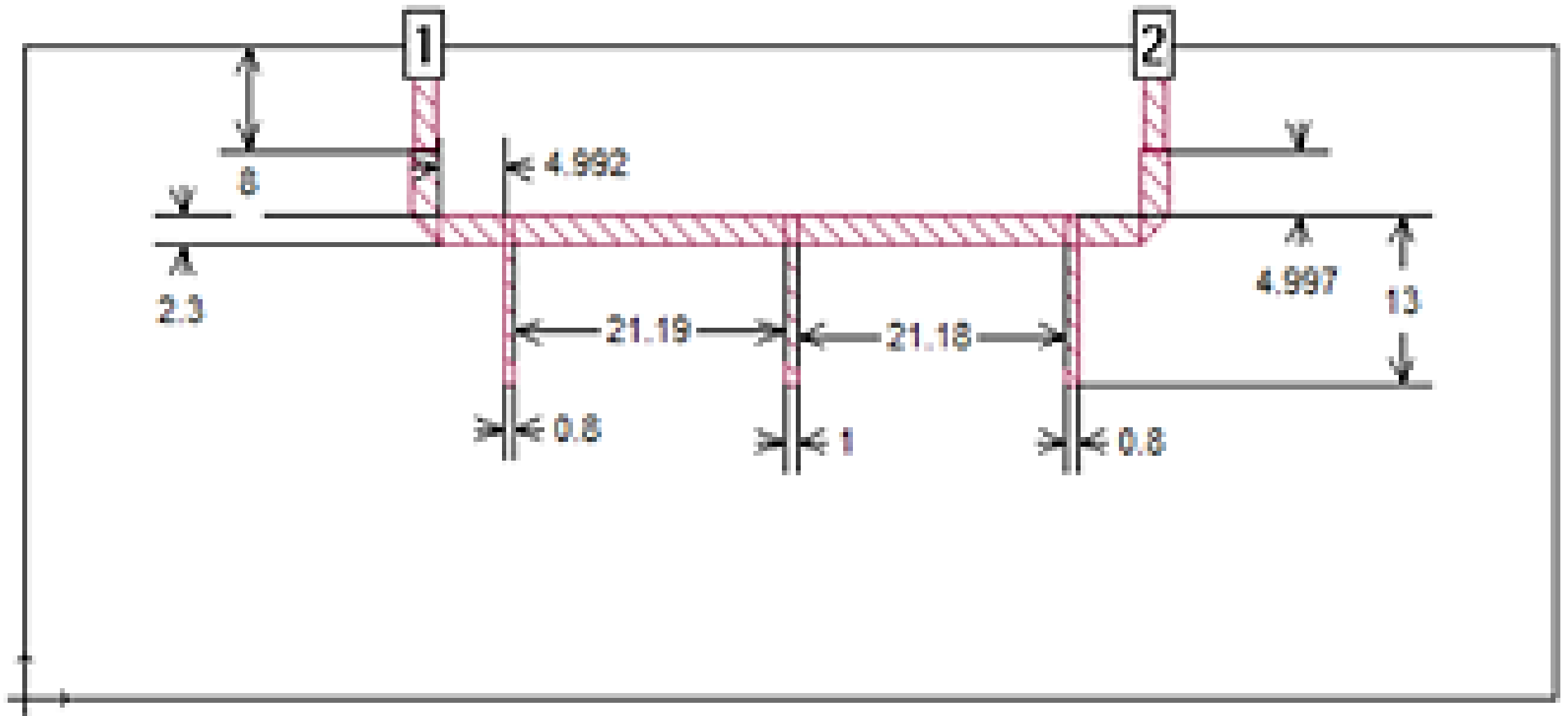
Measurements were carried out on an Sonnet simulator.

The filter components have been drawn using copper conductor on a double side printed FR4 substrate (120 mm x 50mm) of thickness 1.55 mm and permittivity 4.4.

The ground plane has been laid at the bottom of the substrate.

The simulated LPF has a 3dB cutoff frequency at 2.3 GHz. The low Pass Filter structure has 3 poles, which are connected to each other.

The microstrip line computed to be 2.3mm for a characteristic impedance $Z_0 = 50$ ohm, is on the top.



We did some alterations to the reference paper design.

In the reference paper the filter has four vertical rods ,we removed one and made the filter symmetric by placing the remaining three evenly across the microstrip line.

Next, we changed the length and width of the rods until we were satisfied with the frequency response.

Hence the resulting design is as is in the figure 2. As we did that we collected the results along the way.

The results are shown in the Table I and Table II.

Table I

Length (mm) L1=L2	FREQ. (GHz)
10.7	2.36
10.9	2.39
11.2	2.36
11.5	2.33

Table II

Width(mm)		FREQUENCY(GHz)
$W_1 = 1$	$W_2 = 1.2$	2.29
$W_1 = 1.2$	$W_2 = 1.4$	2.25
$W_1 = 0.6$	$W_2 = 0.8$	2.38
$W_1 = 0.4$	$W_2 = 0.6$	2.44

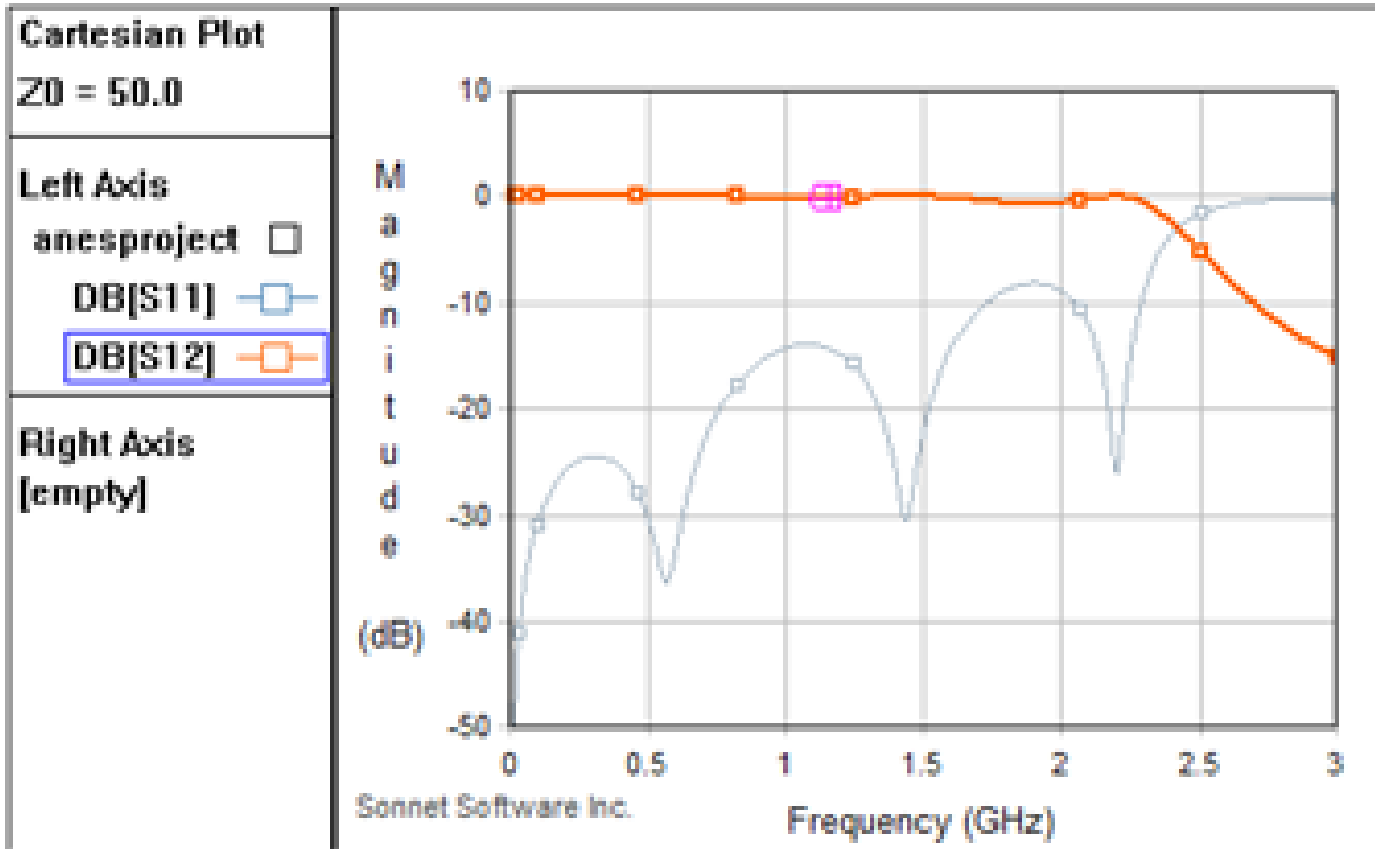
SIMULATION AND ANALYSIS

The microstrip layout is simulated using Sonnet project editor and the simulated performance is compared with the results given in the reference papers.

We obtained good agreement between the theoretical and simulated responses.

However, we have not fabricated this filter due to simplicity and similarity to the reference papers.

S parameters graph



Picture shows calculated and simulated responses of the proposed filter frequency is being cut of at 2.3GHz

Conclusion

- In this work main target is to design and simulate a 2.3GHz microstrip low pass filter, which is implemented on FR4 substrate of relative permittivity 4.4, loss tangent 0.02 with a thickness of 1.55mm.
- The microstrip line is computed to be 2.3mm for a characteristic impedance $Z_0 = 50$ ohm.
- Overall this project was successful and it was a good learning opportunity.

Acknowledgment

We would like to express our special thanks of gratitude to our professor Sehabeddin Taha Imeci for his able guidance and support in completing our project.

We would also like to extend our gratitude to the RDC Amar Hodža and Sonnet Project Editor for providing us with all the facility that was needed for completion of our project.

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Thank you for your time

Any questions.

