

Experiment No. - 6

Aim - Design and simulate the Band reject filter at a frequency 2 GHz.

Apparatus Required - CST Software.

heory

A band-reject filter, also known as a notch filter, is an electronic circuit or device designed to attenuate or reject a specific range of frequencies while allowing frequencies outside of that range to pass through. Here's a brief overview of the theory behind a band-reject filter:

Frequency Rejection: A band-reject filter is designed to reject a certain frequency range, often referred to as the "notch" or "stopband." This means it attenuates or blocks signals within this range while letting frequencies outside the notch pass with minimal attenuation.

Filter Response: It exhibits a characteristic frequency response curve with a deep notch in the attenuation at the center frequency of the notch. Frequencies within the notch experience high attenuation, while those outside the notch experience little attenuation.

Components: Band-reject filters can be constructed using various electronic components, including capacitors, inductors, and resistors, in different configurations. Passive filters and active filters with operational amplifiers are common designs.

Formula - The bandwidth is given by:

$$BW = f_H - f_L$$

The center frequency (f_c) of the bandreject filter is the midpoint between the lower and upper cutoff frequencies:

$$f_c = \frac{f_L + f_H}{2}$$

Types: There are various types of band-reject filters, including passive notch filters, active notch filters, and digital notch filters. The choice depends on the specific application and requirements.

Applications: Band-reject filters are used in applications where you need to eliminate or reduce interference or noise at specific frequencies while preserving the rest of the signal. Common applications include audio equalization, noise reduction in audio signals, and removing power line interference from sensitive measurements.

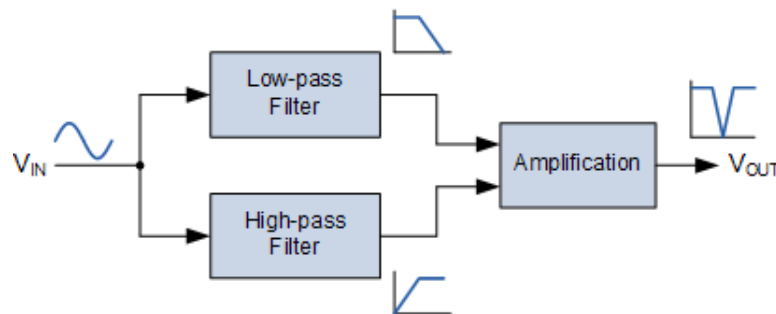


Fig. - Band Stop Filter Configuration

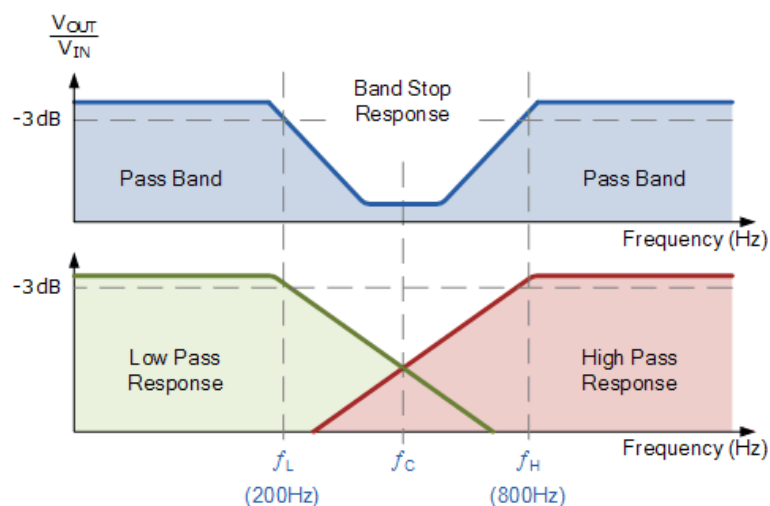


Fig. - Band Stop Filter Characteristics

A band reject filter, also known as a band stop filter or notch filter, is a filter that passes most frequencies unaltered, but attenuates those in a specific range to very low levels. It is the opposite of a band-pass filter.

Band reject filters can be implemented using a variety of different circuit topologies. One common approach is to use a combination of a low-pass filter and a high-pass filter in parallel. The low-pass filter is designed to pass frequencies below the stopband, while the high-pass filter is designed to pass frequencies above the stopband. The two filters are then connected in parallel, and the output of the parallel combination is the band reject filter output.

Another common approach to implementing band reject filters is to use a resonator. A resonator is a circuit that has a natural frequency at which it oscillates. When a signal is applied to a resonator at its natural frequency, the resonator will oscillate strongly. However, when a signal is applied to a resonator at a frequency other than its natural frequency, the resonator will oscillate weakly.

Band reject filters can be designed to have a wide or narrow stopband. A wideband band reject filter has a stopband that is many times wider than its passbands. A narrowband band reject filter, also known as a notch filter, has a stopband that is very narrow, typically only a few hertz wide.

The performance of a band reject filter is characterized by its stopband attenuation and its passband ripple. The stopband attenuation is the amount of attenuation that the filter provides to signals within the stopband. The passband ripple is the amount of variation in the filter's gain across the pass bands.

Band reject filters are an important tool in signal processing and electronics. They are used in a wide variety of applications to improve the performance of electronic systems.

Here is a simple example of how to design a band reject filter:

Determine the lower and upper cut-off frequencies of the filter. These are the frequencies that you want to reject.

Choose a type of band reject filter to design. There are many different types of band reject filters, each with its own advantages and disadvantages. Some common types of band reject filters include:

- (i) RC band reject filters
- (ii) RLC band reject filters
- (iii) Active band reject filters

Procedure – Band reject

Designing a band-reject filter (also known as a notch filter) using CST Microwave Studio (CST MWS) or similar electromagnetic simulation software involves several steps. Below is a general procedure for designing a band-reject filter, along with measurements you can perform in CST:

Step 1: Define Specifications

- Determine the center frequency (f_0) of the stopband (the frequency you want to reject).
- Specify the desired bandwidth (BW) of the notch.
- Define the filter's insertion loss (IL) and return loss (RL) requirements.
- Decide on the filter topology (e.g., coupled resonator, waveguide, microstrip, etc.).

Step 2: Initial Design

- Create a new project in CST MWS.
- Choose the appropriate solver and set up the simulation environment (e.g., 3D, 2D, frequency domain, or time domain).
- Start with an initial filter design based on your specifications.

Step 3: Simulation and Optimization

- Simulate the initial design to obtain S-parameters (S_{11} , S_{21} , etc.) and analyze the performance.

- Use the optimization tools in CST to fine-tune the filter parameters (e.g., dimensions, coupling coefficients, resonator positions, etc.) to meet your specifications.
- Iterate the optimization process until the desired filter response is achieved.

Step 4: Manufacturing and Fabrication

- Once you have a finalized design, export the layout or design specifications

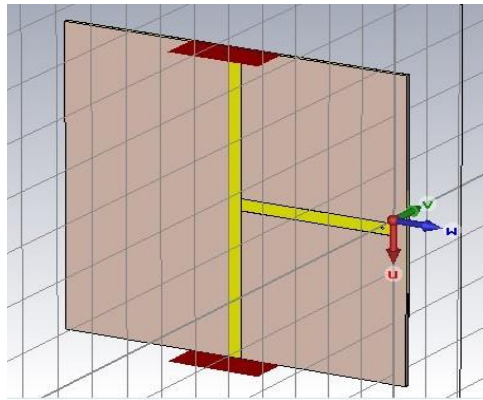
for fabrication.

- This may include generating Gerber files for PCB fabrication or detailed drawings for other manufacturing methods.
- Select the appropriate materials and manufacturing processes for your filter design.

Step 5: Simulation Validation

- Import the fabricated filter structure into CST MWS for validation.
- Simulate the fabricated filter to compare the actual performance with the simulated results.
- Adjust any discrepancies between simulation and measurement by fine-tuning the physical design if necessary

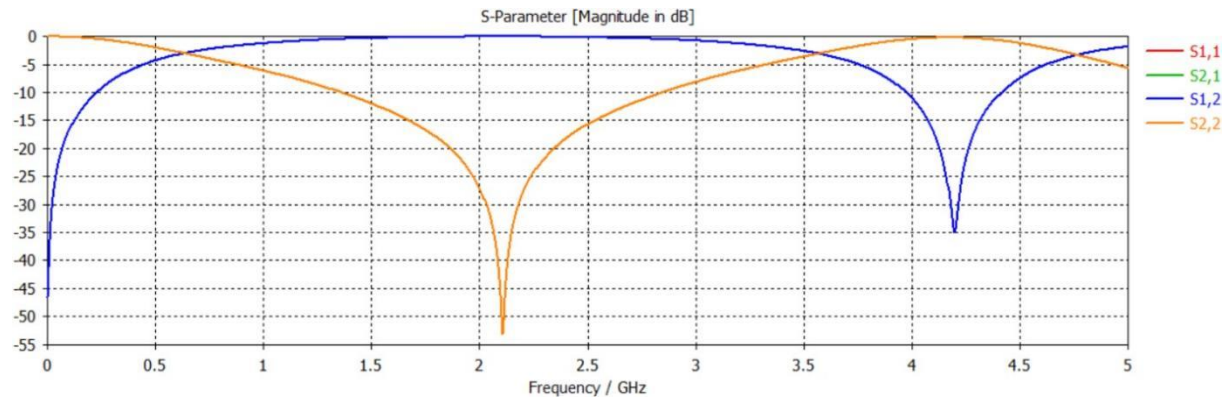
Design and Design measurement Planar Band reject filter



Name	Values
(1) Substrate	30 X 30
(2) Substrate thickness	0.787 (mm)
(3) Substrate material	Rogers RT 5870 (lossy)
(4) Ground	30 X 30
(5) Ground thickness	0.035
(6) Ground material	Copper
(7) Feed	1.175 X 30
(8) Feed thickness	0.822
(9) Feed material	Copper
(10) Stub	1.175 X 1.175
(11) Stub thickness	0.787 0.787 + 0.035
(12) Stub material	Copper

Result

S – Parameter



Conclusion: Band reject filter at a frequency 2 GHz has been designed and simulated.