BIAS TEE

BSF(Band Stop Filter) Subsection:

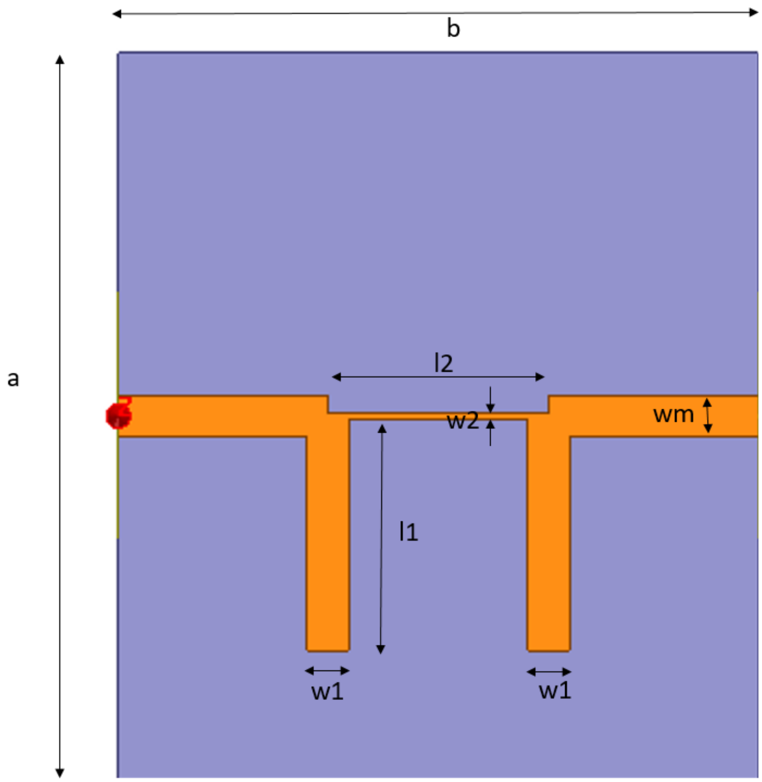

Fig. 28. The layout of Band Stop Filter

- **Components:**
  - Metal: **Copper**
    - Conductivity: 58000000 Siemens/m
    - Relative Permittivity (εr): 1
  - Substrate: **Rogers RO4003C**
    - Relative Permittivity (εr): 3.55
    - Dielectric Loss Tangent ($tan\delta$): 0.0027
- **Design Specifications:**
  - a = 20mm
  - b = 17.63mm
  - h = 0.508mm (Substrate thickness)

- $t = 0.017mm$ (Metal thickness)
- $w_m = 1.136mm$
- $w_2 = 0.172mm$
- $l_1 = 5.766mm$
- $w_1 = 1.136mm$
- $l_2 = 6.097mm$

Design Criteria:

- Center Frequency: 7.8 GHz

Results:

- **Plot of S11 and S21 parameter obtained from simulation**

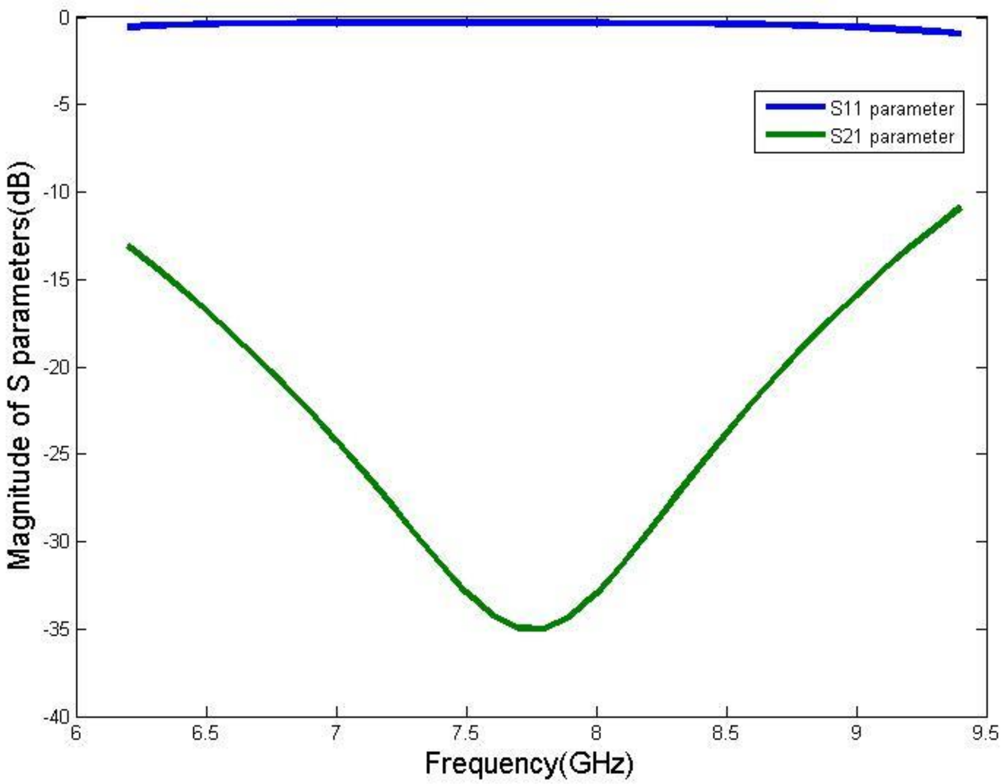

Fig. 29. The magnitude of simulated S11 and S21 parameters of BSF

- **The plot of simulated and calculated results of S11 and S21**

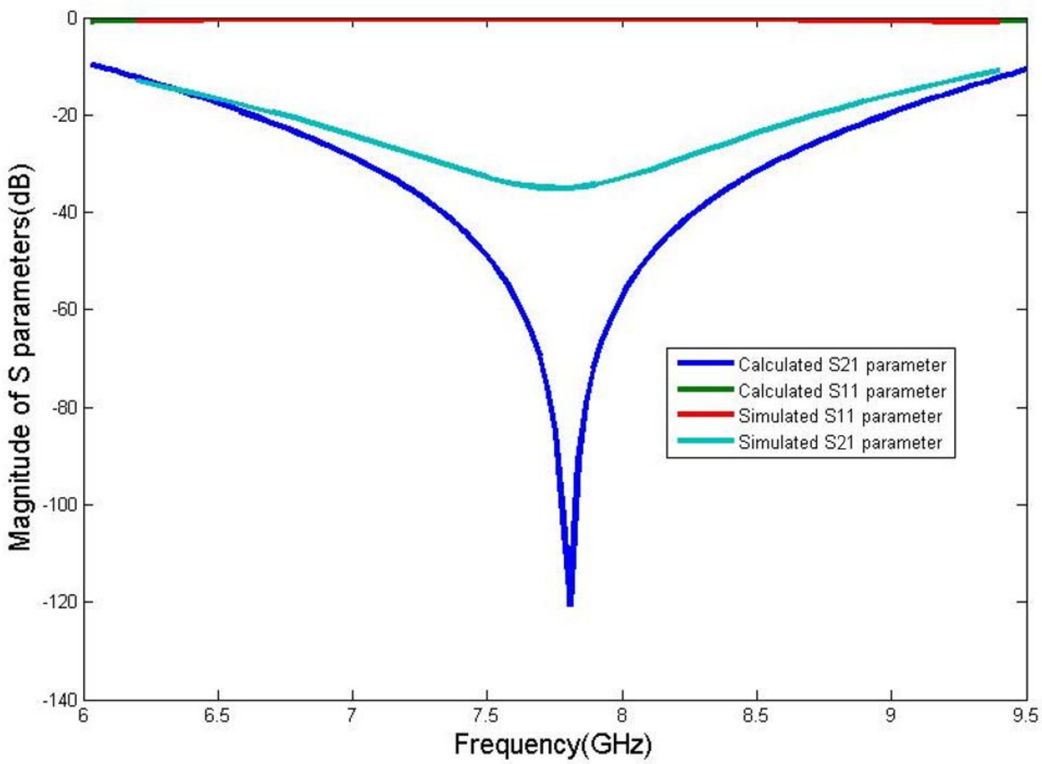

Fig. 30. Simulated and Calculated Results of S11 and S21 parameters of BSF

- **<u>Calculation:</u>**

The ABCD parameter of the BSF subsection can be found by using the following equation

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix} \begin{bmatrix} cos\theta_s & jZ_s sin\theta_s \\ jY_s sin\theta_s & cos\theta_s \end{bmatrix} \begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix} \quad \textbf{(from 14)}$$

The BSF is first divided into three regions. The shunt stubs are represented by their equivalent input susceptance *Y* and the connecting section as a section of a transmission line. The characteristic impedance *Zse* should be as high as possible. Similarly, *Zs* should be as low as possible. electrical lengths are π/2 at the design frequency *f*0. Then, at any a frequency *f*,

$$\boldsymbol{\theta_{sh,se} = \frac{\pi}{2}\left(\frac{f}{f_0}\right)} \tag{17}$$

Now we can find the S (1,1) from the ABCD parameters using the following equation

$$\boldsymbol{S(1,1) = \frac{A+\frac{B}{Z_0}-CZ_0-D}{A+\frac{B}{Z_0}+CZ_0+D}} \qquad \textbf{(from 16)}$$

$$\boldsymbol{S(2,1) = \frac{2}{A+\frac{B}{Z_0}+CZ_0+D}} \tag{18}$$

Using these equations in MATLAB, we can get |S (1,1) | and |S (2,1) | plot and simultaneously we can simulate in the full-wave simulator.

- **<u>Conclusion:</u>**

  - The U-shaped BSF is designed using microstrip lines to reject the frequency with the centre frequency of 7.8 GHz. The plot in Fig. 29 confirms a dip at a frequency of 7.8 GHz for the S21 parameter.

  - The characteristic impedance of the Series stub is 120 ohm and the characteristic of the single stub is 50 ohm in the design. This combination of impedances gave the proper result as desired.

  - The simulated result is also verified using the calculated plot obtained from MATLAB with the help of the equations mentioned above. The simulated and the calculated plot are in close agreement for the Band Stop Filter.

  - The width of the series stub should be as low as possible. The impedance of shunt stub should be started with a low impedance and the length is to be tuned such that we achieve a satisfactory dip in the S21 magnitude plot at the centre frequency desired.

  - Two shunt open-stubs provide transmission zeros at a frequency at which its length is quarter-wavelength or its odd multiple. At the design frequency *f*0, the separation between the stubs is also quarter-wavelength to provide an asymmetrical response.

  - Low shunt impedance of the open-stubs and high series impedance of the connecting section increase the bandwidth as well as the level of rejection of the filter

- We observe a flat plot for the S11 parameter in dB as expected since the calculated plot also shows the same result.

- The use of BSF can be further extended as a subsection in the Bias Tee where there is a need of Inductor to reject AC signal. However, the inductor at high frequency does not give a good response due to the parasitic effects.

- Thus the use of BSF becomes more convenient to reject the AC signals of certain frequency instead of an inductor. The DC bias is provided on one port of the BSF and the one port of the Bias T is connected to the other.