We02H-1-319-KB64

Design of Dual Stopband Filters for Interference Suppression

J.F. Valencia Sullca[1], S. Cogollos[1], V.E. Boria[1], M. Guglielmi[1], S. Bastioli[2], and R. Snyder[2]

[1]Universitat Politècnica de València, Valencia, Spain

[2]RS Microwave Company Inc., USA

OUTLINE

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- DESIGN EXAMPLE
- THE PROTOTYPE
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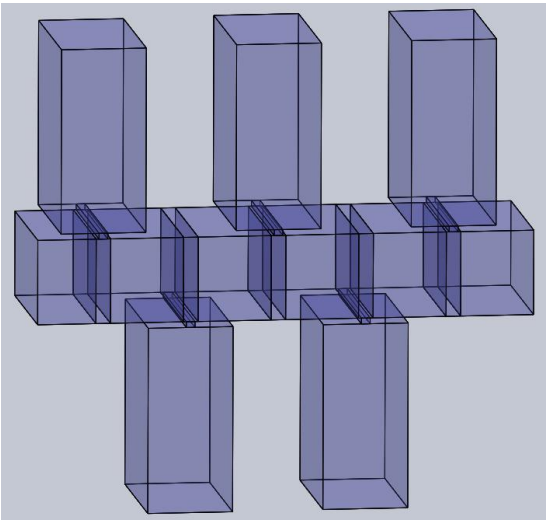
INTRODUCTION

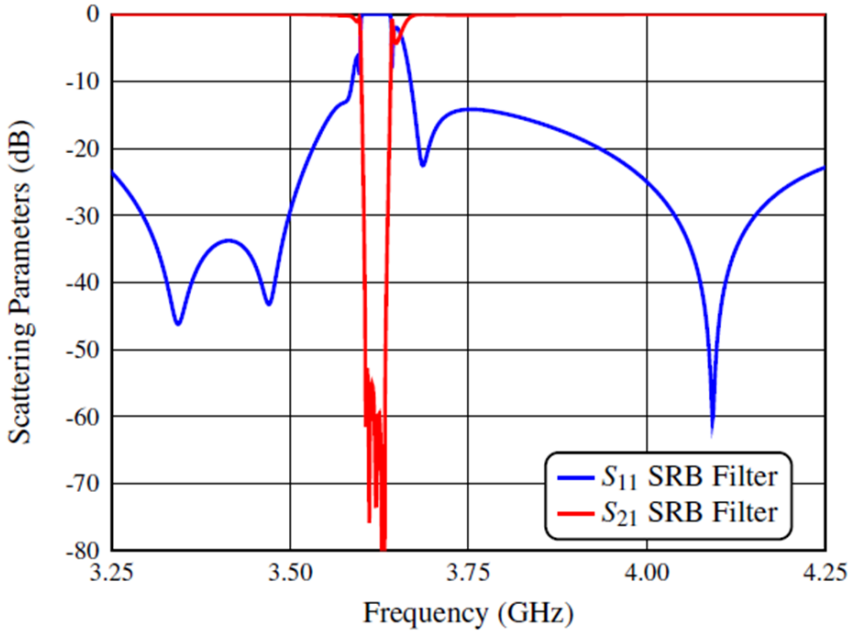
- When a broad band receiving system is co-located with high power emitters, receiver saturation is a major issue.
- Rejection of the local high power signals with minimal effect on the rest of the receiver passband is required.
- In this context, we present in this paper a method for providing two rejection bands (dual band rejection rather than dual passband) in a new and unique waveguide structure.
- Cavity resonators are combined with resonant irises to provide a pair of relatively narrow rejection bands (at least 25 MHz wide) located within a wide passband, achieving at least 50 dB rejection while maintaining passband loss to less than -1 dB.

BASIC DUAL-BAND REJECT FILTER

A standard reject-band filter in rectangular waveguide are composed of:



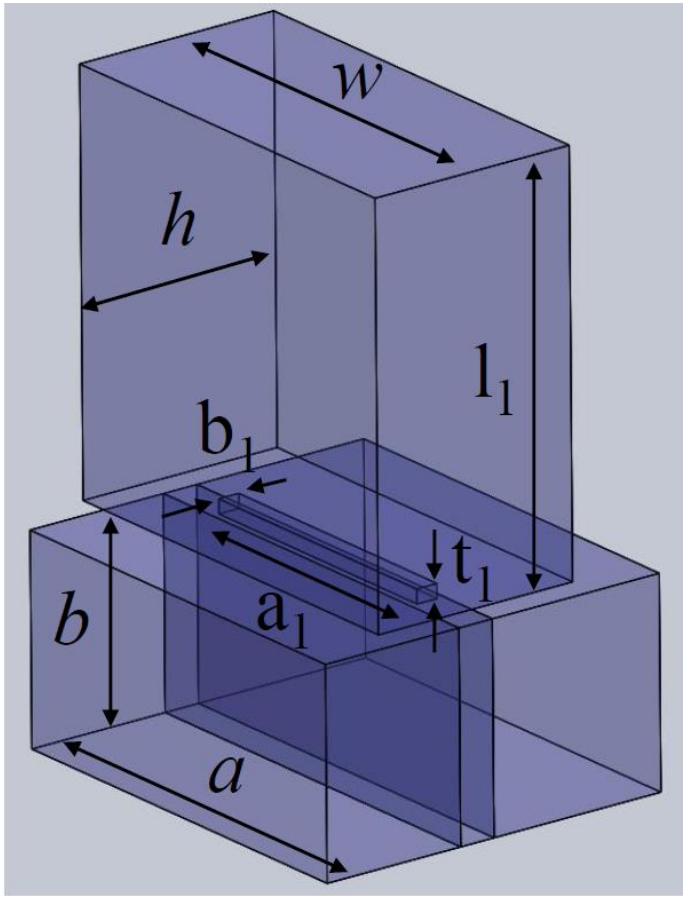
- Half-wavelength resonators connected to the top wall of a rectangular waveguide with capacitive irises that operate above cutoff.
- Resonators separated from each other by a length of waveguide equal to multiples of one-quarter wavelength.
- Narrow band (about 26 MHz), rejection -55 dB.



BASIC DUAL-BAND REJECT FILTER

Unit cell of the novel dual-band reject filter (UCDBR):

- Decrease the width of the aperture connecting the main waveguide to the reject band resonator so that it becomes a resonant aperture (RA) in the frequency range of interest.
- Use the vertical stub to provide an additional resonance.

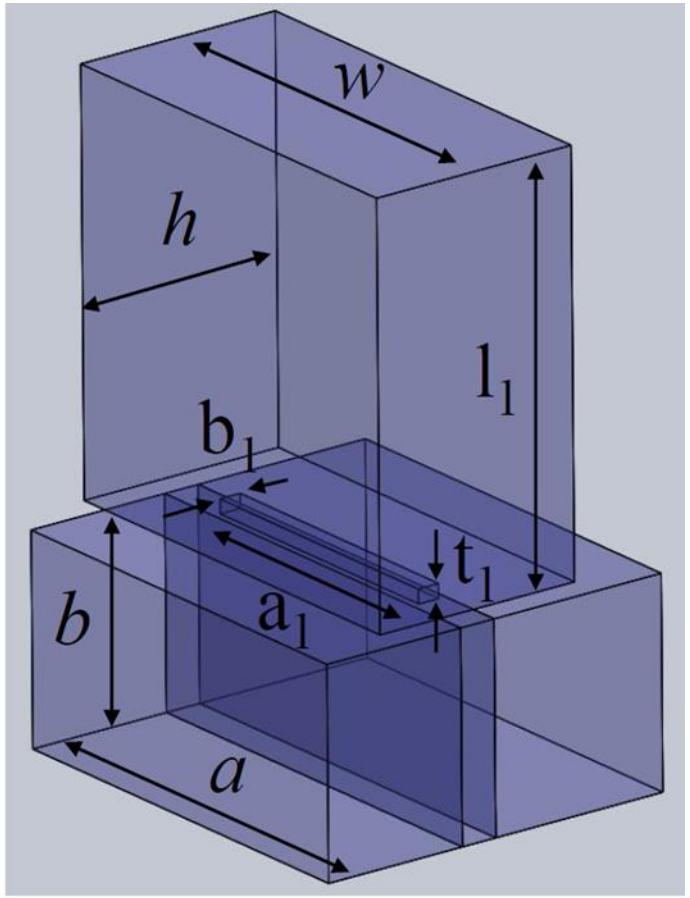


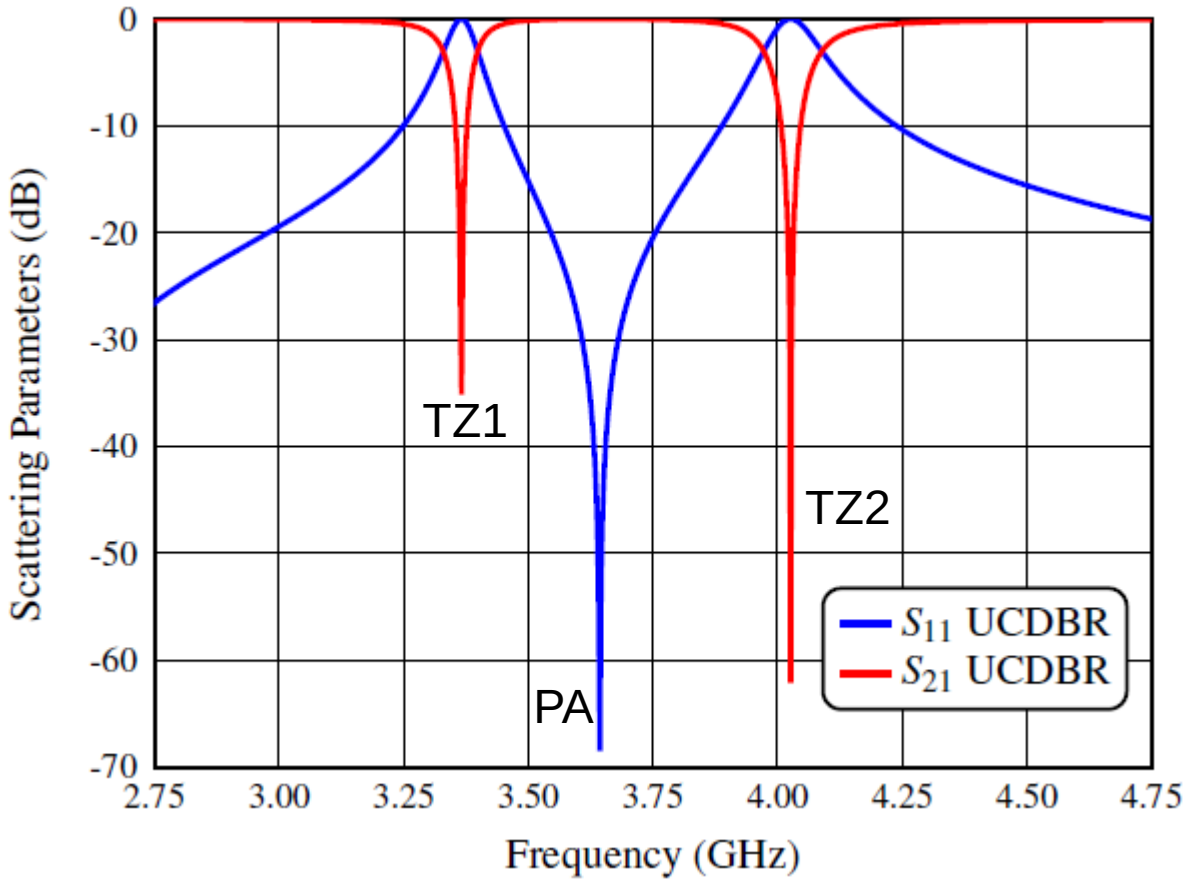
Structure of the unit cell of the dual-band reject filter.

BASIC DUAL-BAND REJECT FILTER

- The RA and the vertical stub are dimensioned to resonate at the same frequency, between the two reject bands (half-wavelength stub resonance).
- When the vertical stub resonates, the RA is short-circuited and the structure provides a perfect pass-band (point of adaptation PA).
- At lower frequency the vertical stub is capacitive and it lowers the resonant frequency of the RA (TZ1).
- At Higher frequencies the vertical stub is inductive and increases the resonant frequency of the RA (TZ2).

BASIC DUAL-BAND REJECT FILTER





Simulated performance of the unit cell of the dual-band reject filter.

DESIGN EXAMPLE

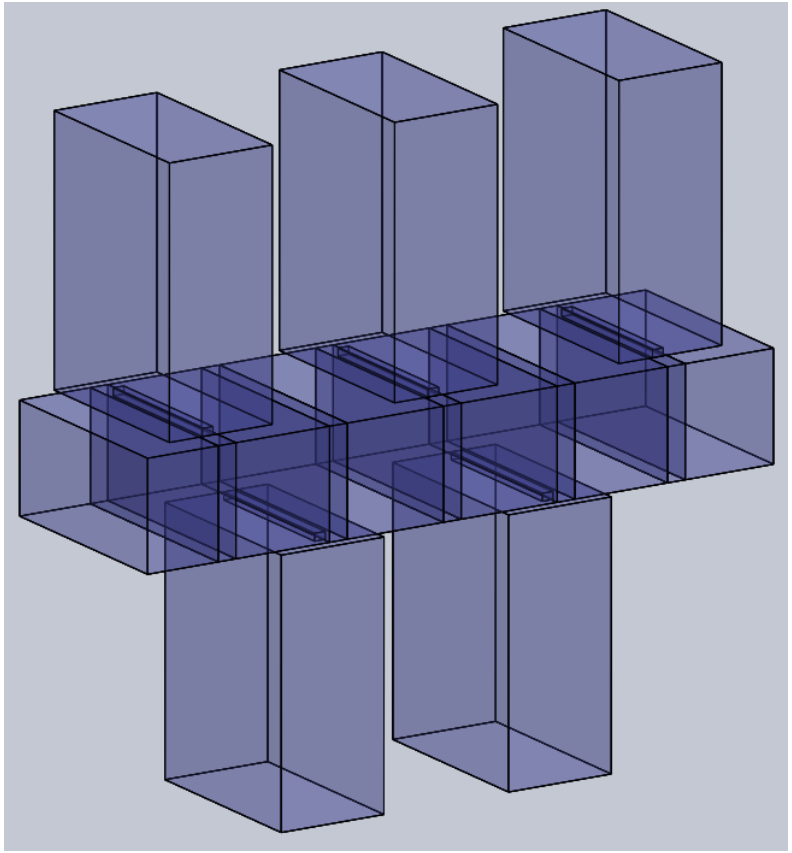
- If we cascade a number of UCDBRs, the interactions are not very strong.

- This allows for a very straightforward filter design procedure:

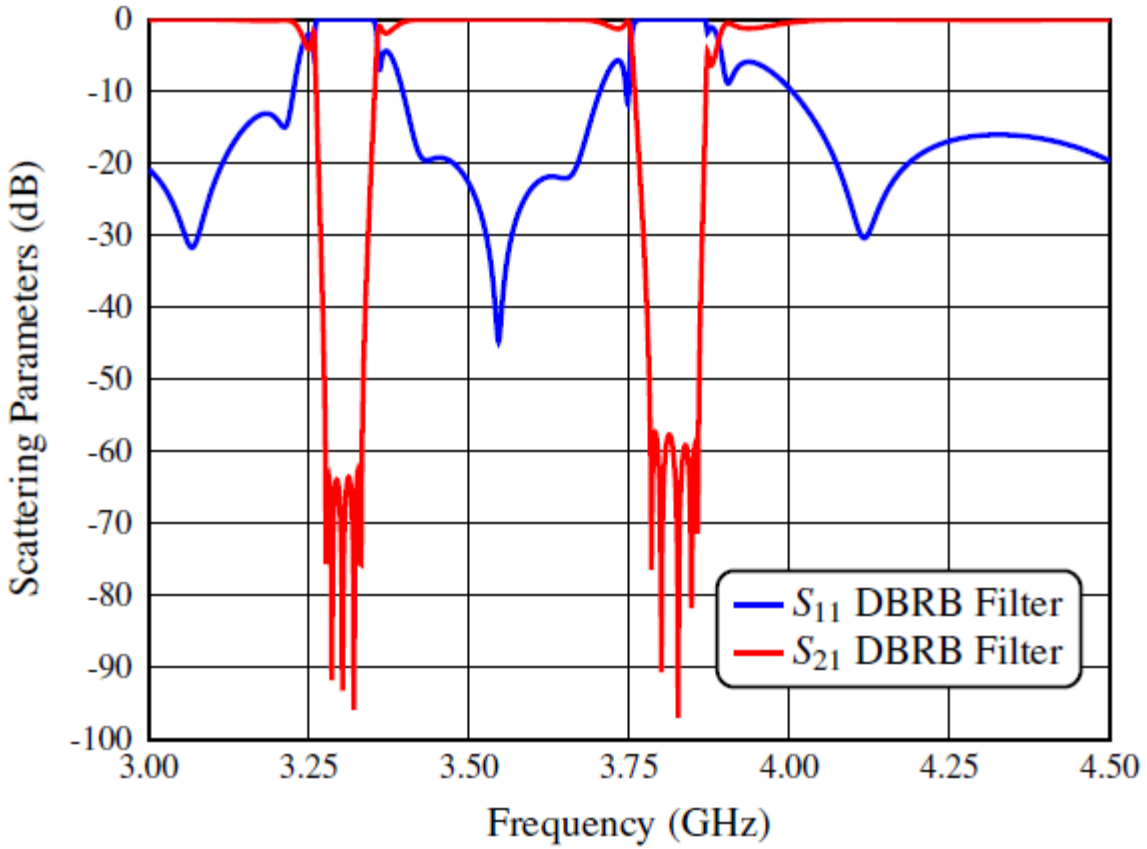
  - It is possible to start the design by defining first individual cells to produce TZs at the desired frequency locations.

  - The various cells can then be cascaded, and an optimizer can finally be used to obtain the desired final performance.

DESIGN EXAMPLE



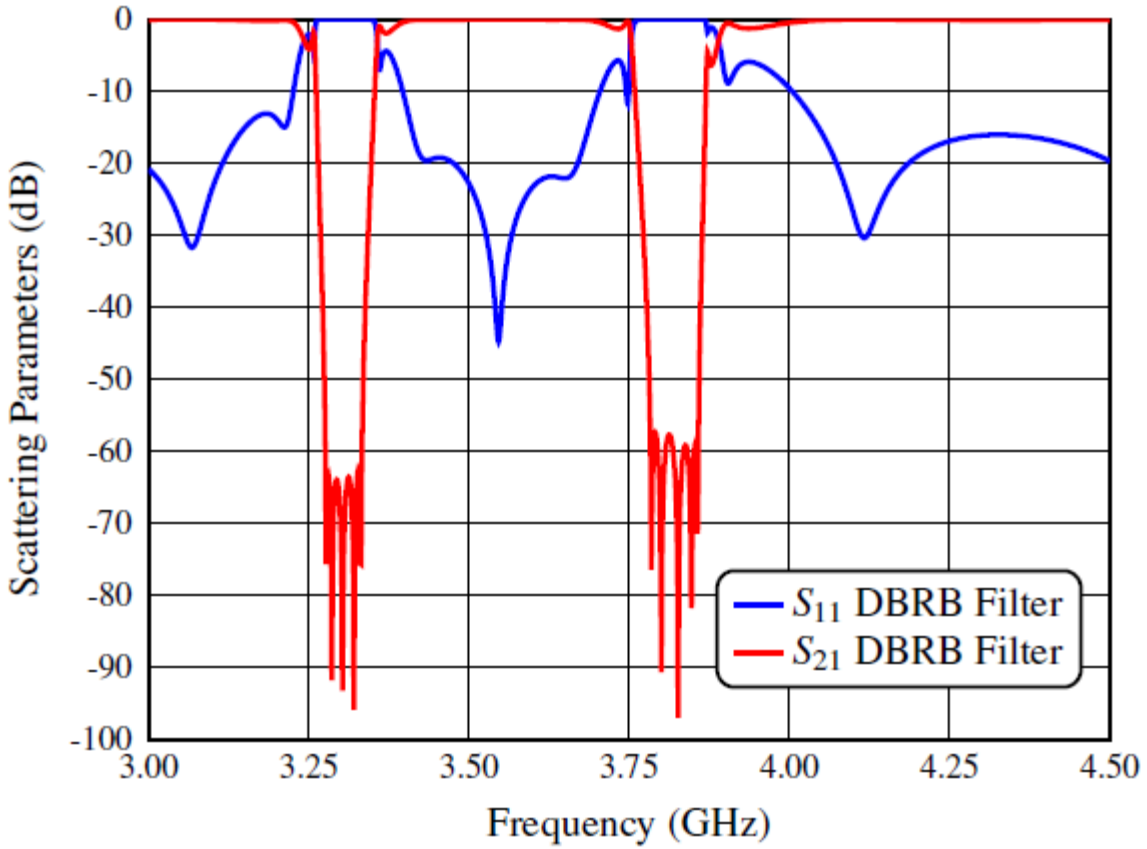
Structure of the five-pole dual-band reject filter.



Simulated performance of the five-pole dual-band reject filter.

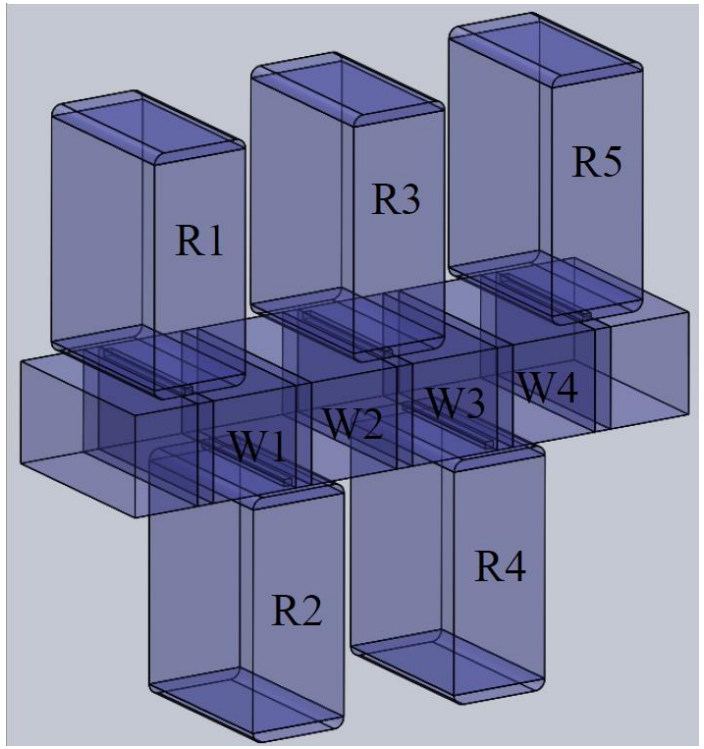
DESIGN EXAMPLE

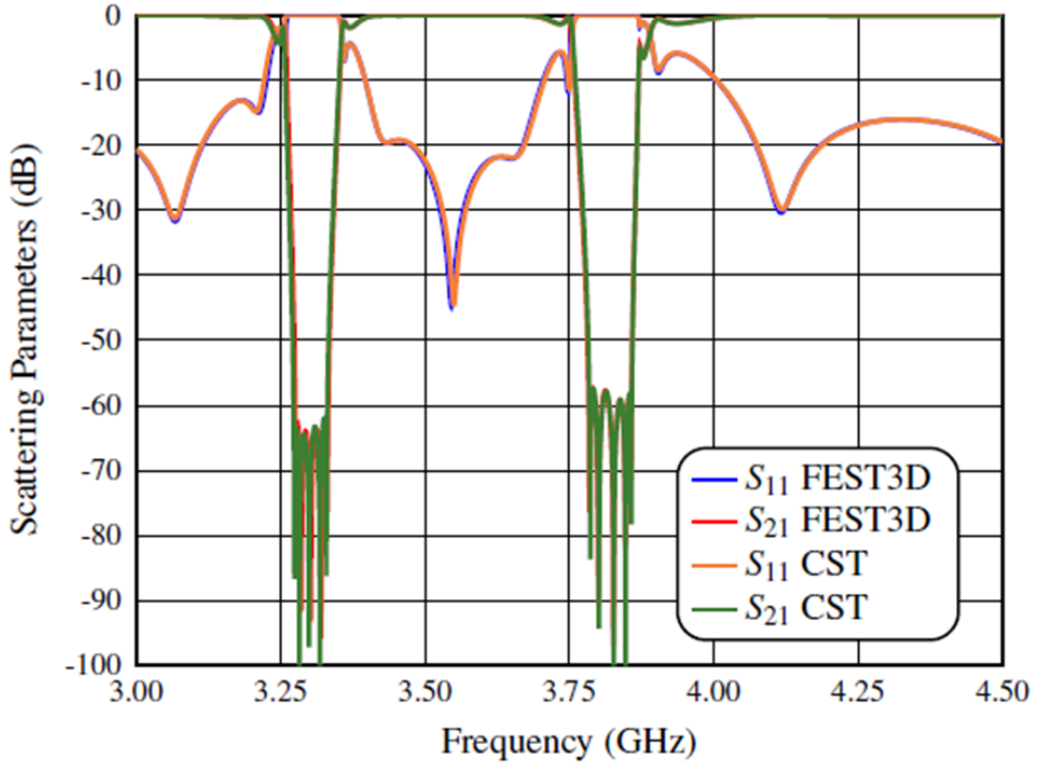
- Obtain a rejection level that is greater than 57 dB.
- Two rejection bands:
  - 53 MHz (lower)
  - 72 MH (upper)
- Three -1 dB passband regions between the rejection band.



Simulated performance of the five-pole dual-band reject filter.

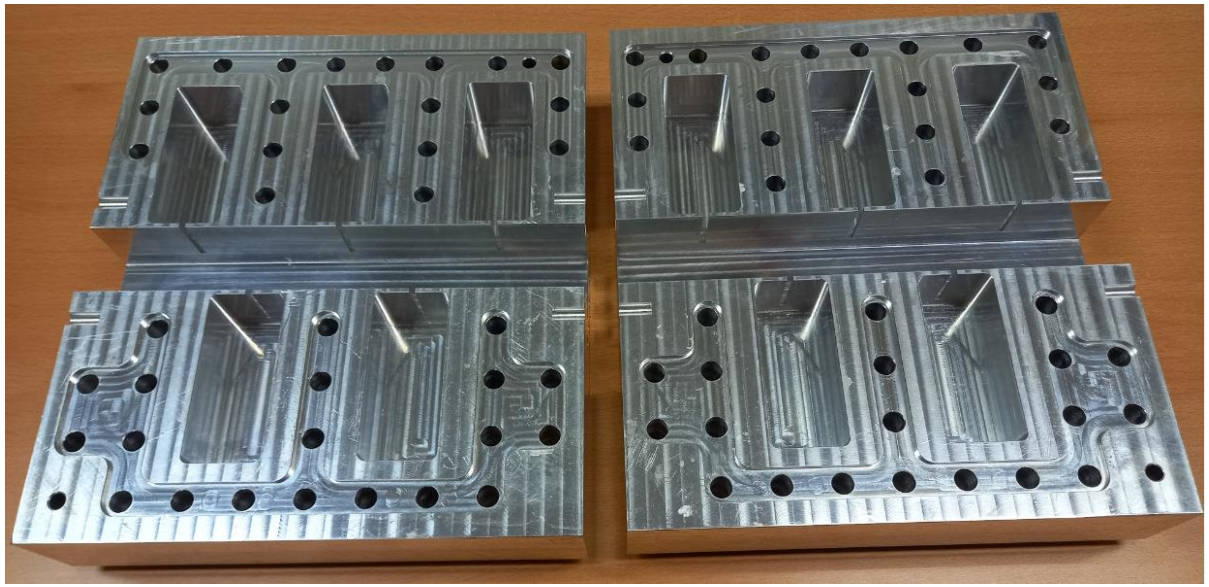
DESIGN EXAMPLE

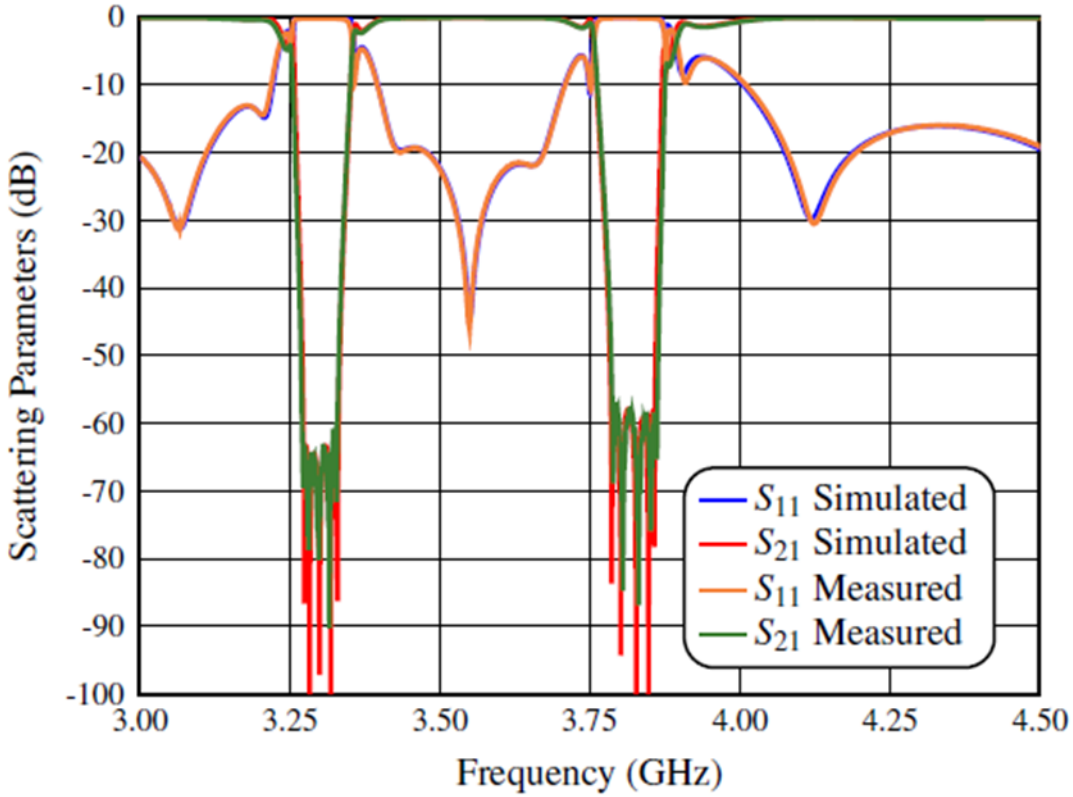




- The High Accuracy (HA) design has been carried out using aggressive space mapping (ASM) with FEST3D (LA) and CST (HA).
- All concave corners of the vertical resonators have been changed into rounded corners with $r = 3\ mm$.

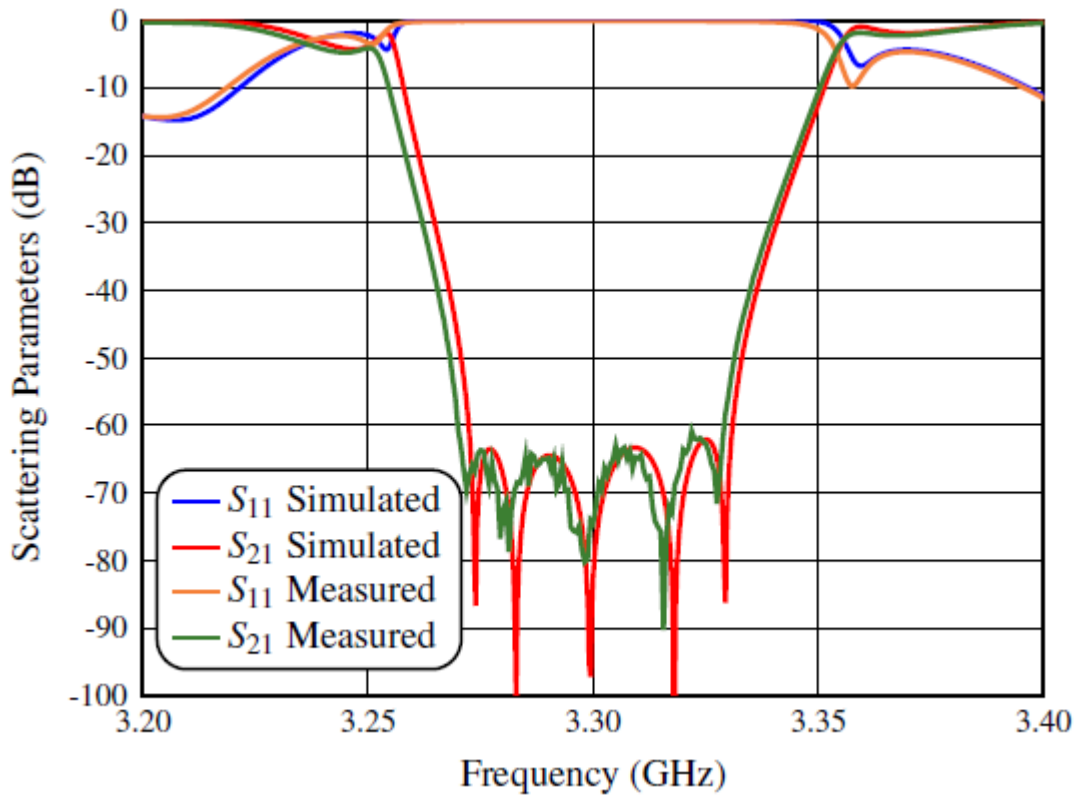
MANUFACTURED PROTOTYPE

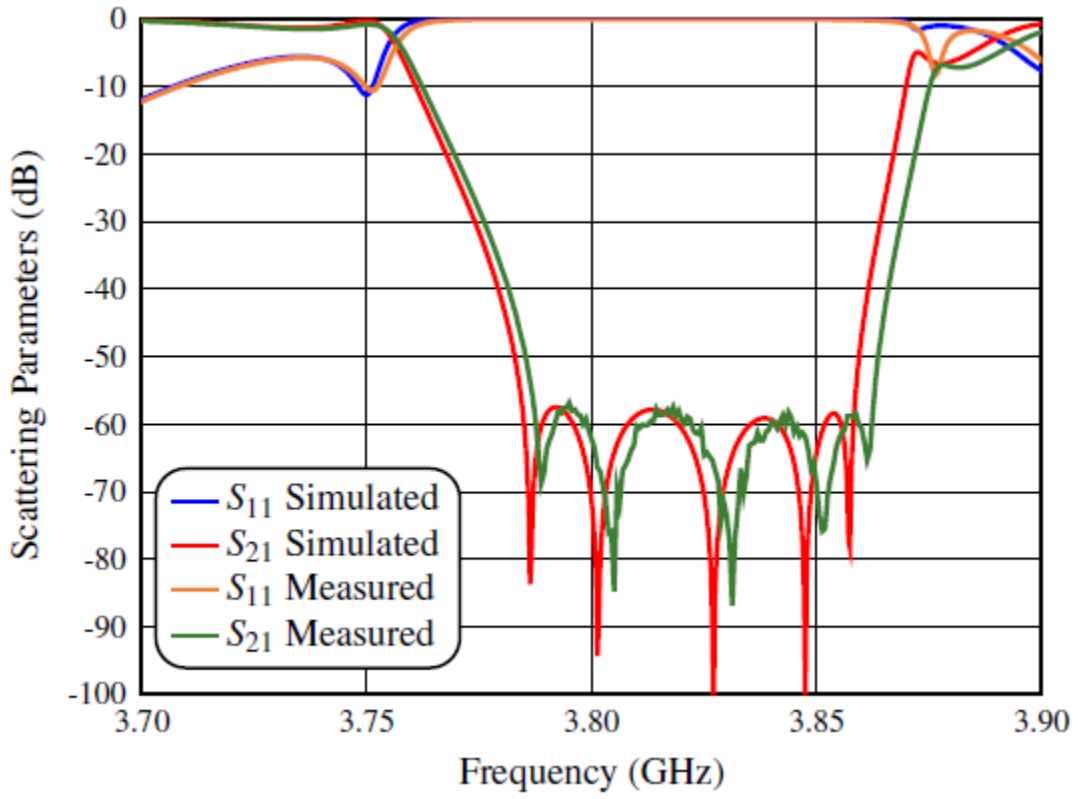




- The agreement between simulations and measurements is basically perfect.
- The -1 dB passbands are identical to the simulated ones.
- The minimum insertion loss in the passbands is 0.03 dB.

MEASUREMENTS





However, a very small shift in frequency is indeed present.

CONCLUSIONS

- We have discussed a novel dual-band reject filter in rectangular waveguide based on the use of resonant apertures.
- The dual-band performance has been obtained with a very simple modification of the classic reject-band filter structure.
- A dual-band reject filter has been designed, fabricated and measured, showing an excellent agreement between simulation and measurement, thereby fully validating both the structure and the design procedure.