Developement of a Ku-Band Diplexer

Bachelor thesis

Hassab Youcef

Technische Universität Hamburg-Harburg
Institut für Hochfrequenztechnik

January 26, 2019

IHF Institut für Hochfrequenztechnik

Outline

TUHH

Outline

TUHH

Lead

TUHH

- Satellite communication
  - major technological advancement
  - vital role in communication systems
  - many applications limited on space and mass
- Filters and Diplexers
  - key components in communication systems
  - interessting signal processing propreties
- Growing need for compact and efficient filters.

System Schematic

TUHH

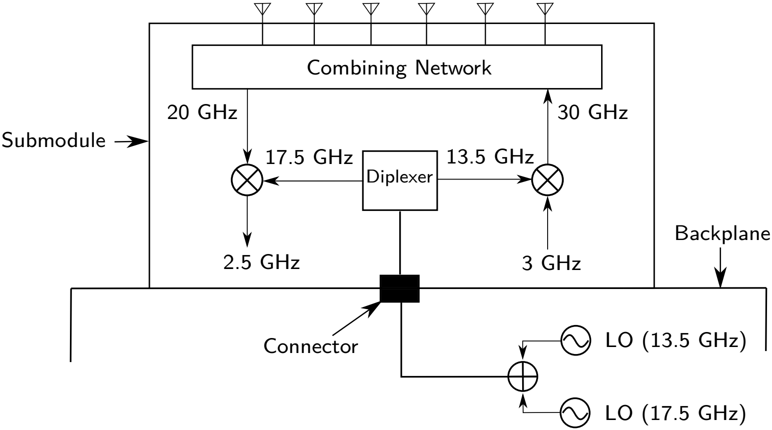


Figure: Simplified system schematic.

Requirements

TUHH

- Based on dual-mode microstrip resonators
- Integrable in stack-up
- Compact
- Performance:
  - return loss of at least 15 dB in 500 MHz bandwidths around 13.5 GHz and 17.5 GHz + minimal insertion losses.

Outline

Electrical Coupling

TUHH

Electrical coupling of two LC tuned circuits results in two resonance frequencies:

$$f_1 = \frac{1}{2\pi\sqrt{L(C - C_m)}} \tag{1}$$

and

$$f_2 = \frac{1}{2\pi\sqrt{L(C + C_m)}}. \tag{2}$$

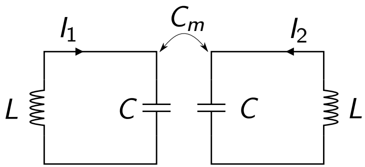


Figure: Electrically coupled resonator circuits.

Dual-Mode Resonators

TUHH

- Support two electromagnetic modes that possess the same resonance frequency (degenerate modes)
- Degenerate modes can be electrically coupled using a conductor perturbation

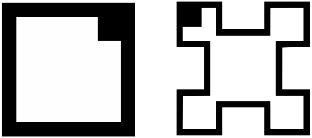


Figure: Typical microstrip dual-mode resonators.

Outline

TUHH

Layout

TUHH

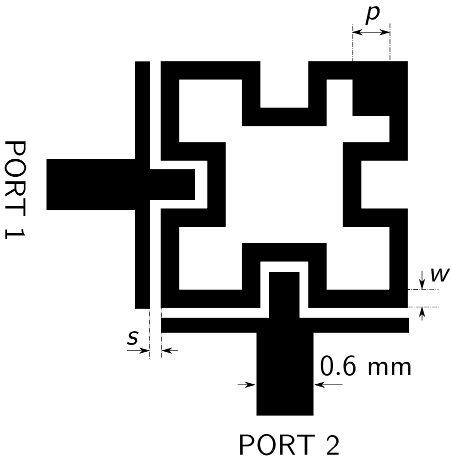


Figure: Layout of the dual-mode band-pass filter.

Simulation Results

TUHH

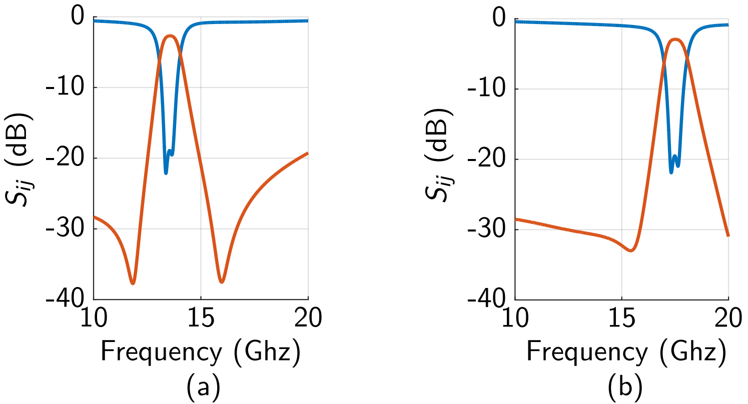


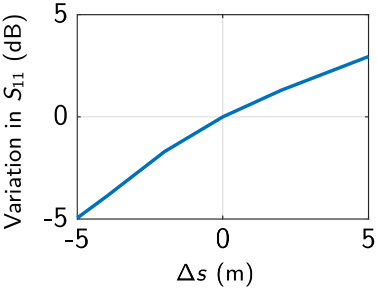
Figure: Simulation results — S_{21} and — S_{11} for the filters with (a) 13.5 GHz central frequency and (b) 17.5 GHz central frequency.

sensitivities

TUHH

$$\frac{\partial S_{11}}{\partial s} \approx 0.8\,\frac{\text{dB}}{\mu\text{m}} \qquad (3)$$

$$\frac{\partial S_{11}}{\partial p} \approx 0.4\,\frac{\text{dB}}{\mu\text{m}}. \qquad (4)$$



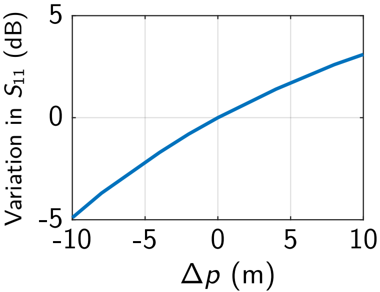
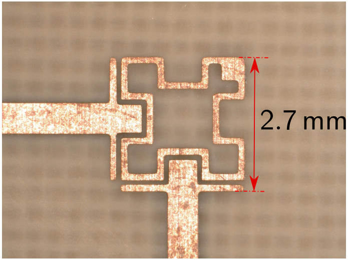


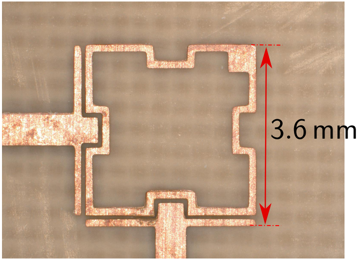
Figure: Effects of the variation in s and p on the return loss.

manufactured filters

TUHH



17.5 GHz filter



13.5 GHz filter

Figure: Pictures of the produced filters.

manufactured filters

TUHH

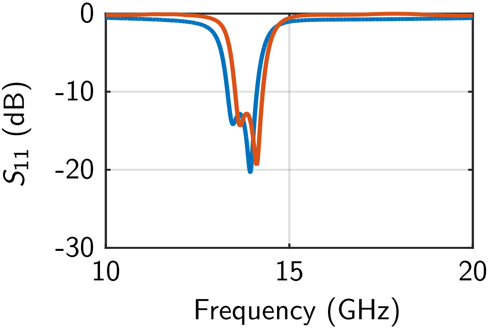


Figure: Comparison of the — simulated and — measured S_{11} parameter of a manufactured 13.5 GHz filter.

manufactured filters

TUHH

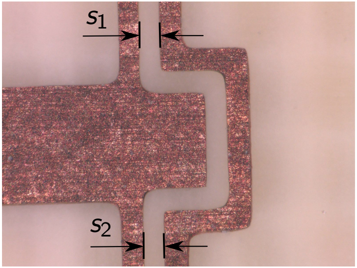


Figure: Asymmetrical gaps of the manufactured filter.

The measured variations in the gaps are $\Delta s_1 = 14 \mu m$ m and $\Delta s_2 = 6$ m. The average variation is given by $\Delta s = 10$ m.

Outline

Outline

TUHH