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MICROWAVE DIRECTIONAL FILTERS

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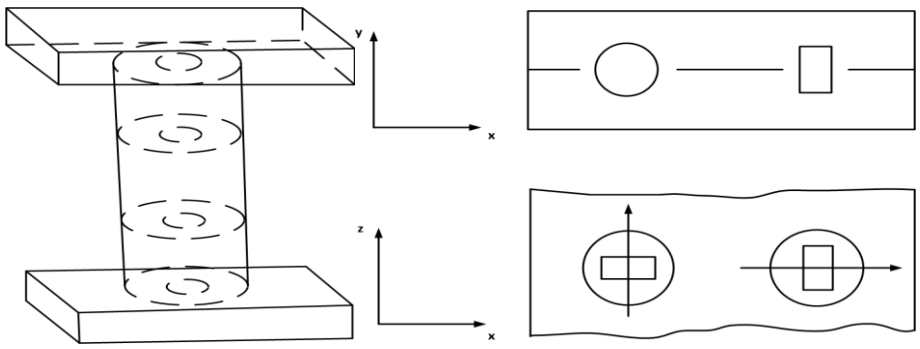
МІКРОХВИЛЬОВІ СПРЯМОВАНІ ФІЛЬТРИ

У статті описано конструкцію та властивості спрямованих фільтрів на основі кругових резонаторів і діелектричних резонаторів. Змодельовані метаматеріальні властивості спрямованих фільтрів у сучасній мікрохвильовій технології.

This article describes construction and properties of directional filters based on circular resonators and dielectric resonators. Simulated metamaterial properties of directional filters in modern microwave technology.

In modern microwave technology, directional filters - so-called directional filters - with directional properties are widely used, which were considered in [1]. Interest in them has re-emerged because these devices have some "metamaterial" properties.

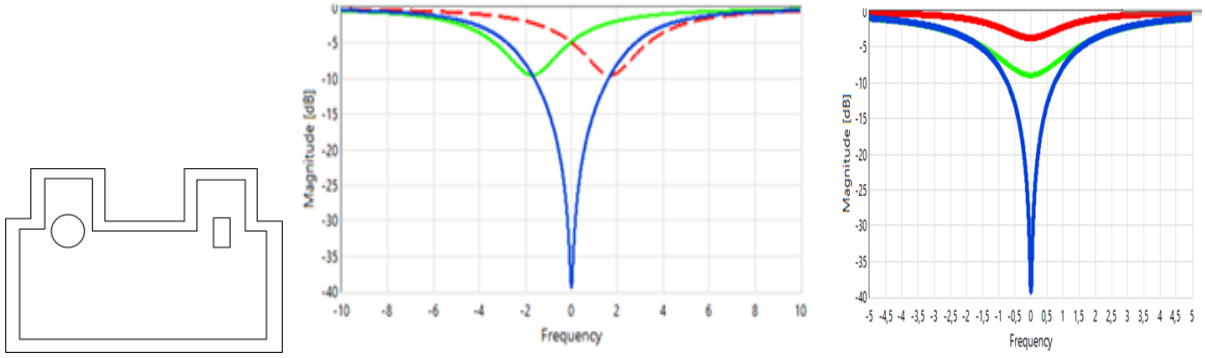
Fig. 1 (a) shows the waveguide structure of a directional filter from [2], this filter consisted of circular resonators excited by holes located in the circular polarization region of rectangular waveguides. A modernized version of such directional filter based on dielectric resonators (DR) in the circular polarization regions of rectangular waveguides was patented in 1987 [3], and its characteristics as well as the characteristics of bandpass (BPF) and rejector filters (RF) were published in [4], the structure of the specified filter is shown in Fig.1 (b)



(a) (b)

Fig. 1. (a) The waveguide structure of a directional filter;
(b) bandpass and rejector filters.

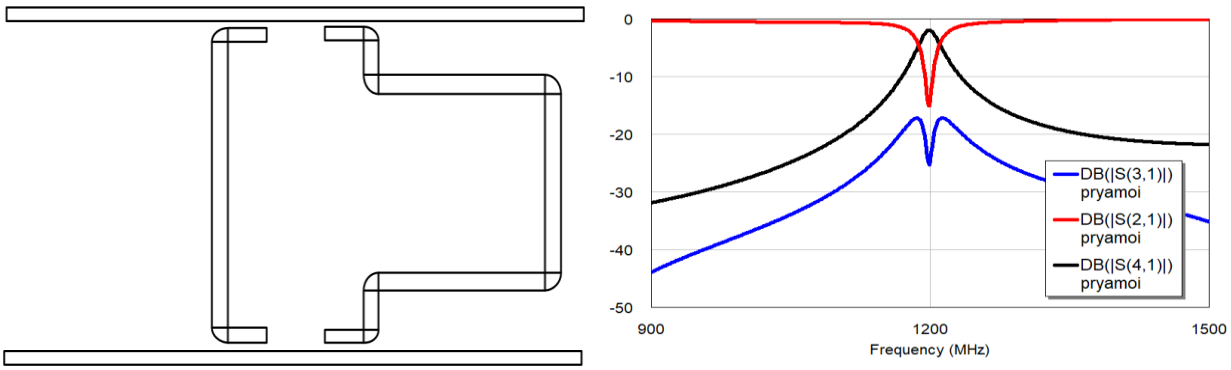
The RF, which consists of only one waveguide with two DRs in the circular polarization region Fig.2 (a) as described in [3], demonstrates a characteristic in the form of a "degenerate" oscillation, obtained as the interference of oscillations from individual resonators [4], which is commonly referenced as "Fano resonances" in modern literature [5].



(a) (b) (c)

Fig. 2. (a) The RF, which consists of only one waveguide with two DRs in the circular polarization region; (b), (c) modeled filter characteristics.

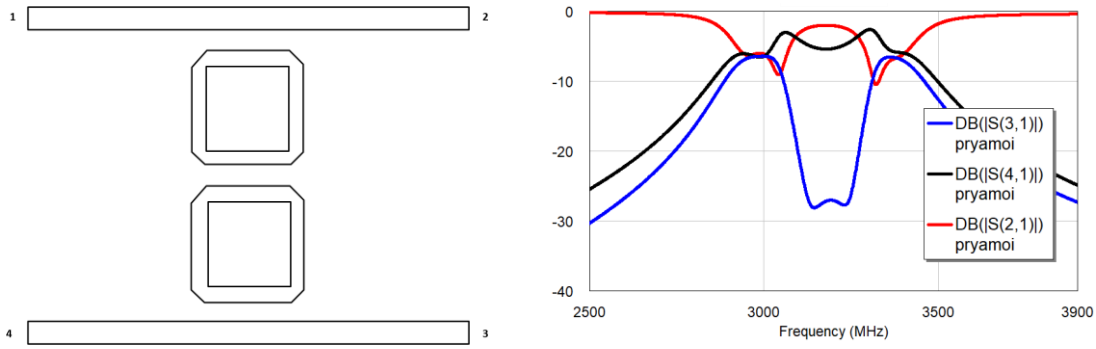
The filter shown in fig. 3 a) is formed by two microstrip resonators - "half-wave" and "wave" and when choosing the distance between the resonators so that at output 3 their oscillations are in phase, and at output 4 - in antiphase, we observe its characteristics presented in Fig. 3 b).



(a) (b)

Fig. 3. (a) filter formed by two microstrip resonators - "half-wave" and "wave" ;(b) simulated filter characteristics.

The red curve in fig. 3 b) similarly to the RF characteristic, demonstrates that at the resonance frequency the energy is "taken" from the line connecting outputs 1 and 2 to output 3.



(a) (b)

Fig. 4. (a) filter formed by interconnected resonators;
(b) simulated characteristics of the specified filter.

In a filter formed by interconnected resonators Fig. 4 (a), the energy in the region of the center frequency is distributed somewhat differently - it is divided between outputs 2 and 3 but is not supplied to output Fig. 4 (b).

Conclusion. design and properties of directional filters based on circular resonators and dielectric resonators were described. These filters have "metamaterial" properties and are widely used in modern microwave technology.

The characteristics of bandpass and rejector filters, as well as the characteristics of the filters formed by two microstrip resonators and resonators connected to each other, are given. It is important to emphasize the phenomena of "Fano resonances" observed in these filters, which are arise as the interference of oscillations from individual resonators.

References

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