Chengyang ZHANG, Ying XUE, Qingyuan LU, Jianxin CHEN, 2026. Miniaturized bandpass filter with a wide upper stopband using isomeric resonators in a cavity. *ENGINEERING Information Technology & Electronic Engineering*, 27(1):250023. https://doi.org/10.1631/ENG.ITEE.2025.0023

Miniaturized bandpass filter with a wide upper stopband using isomeric resonators in a cavity

Key words: Compact filter; Wide upper stopband; Ridge waveguide resonator; Half-wavelength resonant slot; Tuning post; Transmission zero

Corresponding author: Jianxin CHEN
E-mail: jjxchen@hotmail.com
ORCID: https://orcid.org/0000-0002-8703-5294

Motivation

1. Modern communication systems impose stringent requirements on filter miniaturization, low insertion loss, and wide upper stopband rejection.
2. Notably, conventional rectangular waveguide (WG) bandpass filters (BPFs) provide excellent low-loss and high-power performance; however, their bulky physical size severely limits miniaturization and integration.
3. Ridge WG technology has been introduced to reduce size and improve stopband performance; however, existing ridge WG filters still rely on cascaded coupling of single resonators, resulting in a relatively large filter length.
4. Moreover, in traditional inline cavity BPFs, the transmission zero (TZ) in the upper stopband cannot be independently controlled, since the cross-coupling K_{13} is constrained once the main coupling K_{12} is fixed.

Main idea

1. To exploit the E-filed distribution characteristics of ridge WG resonators to achieve miniaturization while maintaining a wide spurious-free range.

2. The half-wavelength resonant slot (HWRS) resonator is introducted to replace the ridge WG resonator, which further reduces the dimension of the BPF. The thickness of the HWRS resonator l_5 provides an additional control mechanism for K_{13}.

3. To realize a compact three-pole inline cavity BPF with extended and precisely controllable upper stopband transmission zeros.

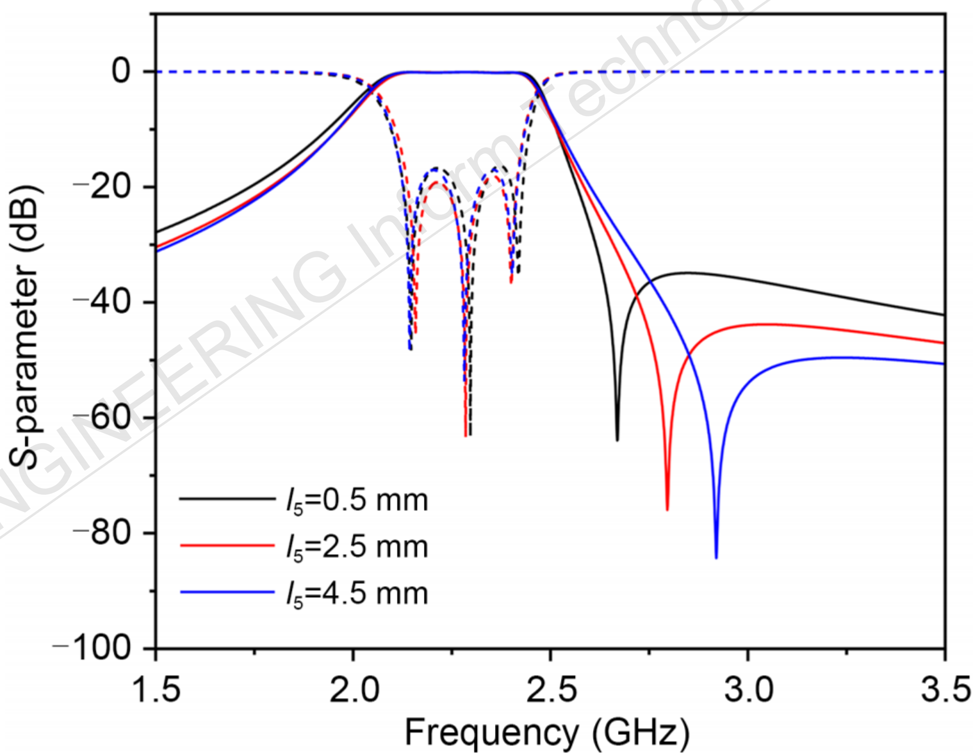
Method

1. By analysis of the ridge waveguide resonator's E-filed distributions, a tuning post (Tup) is strategically embedded in the central region of the ridge to modulate the resonant frequency of the fundamental mode.

2. Parametric analysis of the HWRS resonator shows that the resonant frequency depends on l_5 and the length of the total slot length d_0, implying that under the condition of meeting the required coupling coefficient, the resonant coupling structure can be designed to be extremely thin. Meanwhile, the cross-coupling coefficient can be partially controlled by l_5.

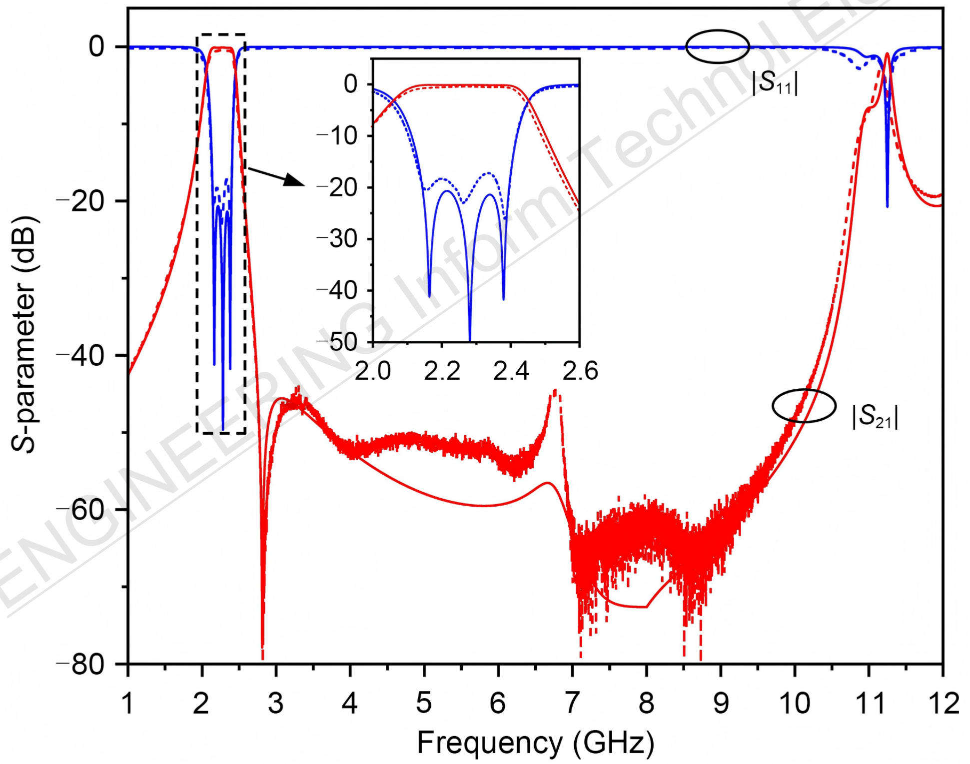
Major results

1. Simulation results of the proposed bandpass filter with different thickness of the HWRS resonator l_5



Major results (Cont'd)

2. Simulation (solid lines) and measurement (dashed lines) results



Major results (Cont'd)

3. Comparison of the performance with other bandpass filters

Reference	Technology	f_0 (GHz)	3-dB fractional bandwidth (%)	Order	Insertion loss (dB)	ζ	3D size (λ_0^3)
Zhu et al. (2024)	Waveguide (WG)	3.72	4.5	3	0.24	0.18	0.72×0.62×0.54
Widaa and Höft (2023)	Dielectric resonator-loaded WG	3.967	0.5	2	1.3	N.A.	0.82×0.26×0.16
Qin et al. (2024)	Dielectric WG	3.45	2.8	3	0.8	1.47	0.34×0.34×0.07
Ruiz-Cruz et al. (2005)	Ridge WG	4	14.6	3	0.3	0.2	0.82×0.33×0.33
Chen et al. (2024)	Ridge WG	3.5	20	3	0.25	1.94	0.44×0.29×0.15
This paper	Ridge WG and resonant slot	2.2	19	3	0.45	3.63	0.23×0.18×0.09

Note: $\zeta=(f_{max}-f_{min})/f_0$, where f_{max} and f_{min} are the maximum and minimum frequencies when $|S_{21}|=-30$ dB in the upper stopband, respectively. λ_0 represents the free space wavelength at f_0

Conclusions

1. Tup can independently control the fundamental mode, thereby obtaining a resonator with a compact and wide single-mode operating bandwidth.

2. The introduction of the HWRS resonator further reduced the dimension of the BPF while providing an approach for positioning the transmission zero (TZ) within the upper stopband to enhance selectivity.

3. In this research, a miniaturized cavity BPF using isomeric resonators is presented, achieving a size reduction of approximately 90% and wider upper stopband rejection compared with a filter based on a traditional ridge WG.

Jianxin CHEN (Senior Member, IEEE) was born in Nantong, Jiangsu, China, in 1979. He received the B.S. degree from Huaiyin Teachers College, Huaian, China, in 2001, the M.S. degree from the University of Electronic Science and Technology of China (UESTC), Chengdu, China, in 2004, and the Ph.D. degree from the City University of Hong Kong, Kowloon, Hong Kong, in 2008. Since 2009, he has been with Nantong University, Nantong, where he is currently a Professor. He has authored or coauthored more than 100 internationally referred journal and conference papers. He holds 25 Chinese patents and three U.S. patents. His research interests include microwave active/passive circuits and antennas, low-temperature cofired ceramic (LTCC)-based microwave/ millimeter-wave devices, dielectric resonator (DR), and waveguide filters and antennas. Dr. Chen was the recipient of the New Century Excellent Talents in University of the Ministry of Education for China in 2011. He was a supervisor of several conference best paper award winners.