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# Miniaturized Inline Bandpass Filters Based on Triple-Mode Integrated Coaxial-Waveguide Resonators

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**ABSTRACT** This work presents a design technique to implement miniaturized cross-coupled bandpass filters in inline physical configurations based on triple-mode resonators. Triple-mode resonances are obtained by using integrated coaxial-waveguide cavity resonators. They consist of two coaxial conducting posts placed in the sidewalls of a rectangular waveguide cavity. In the proposed triplet, a transmission zero (TZ) can be positioned at any of the two sides of the passband by simply locating the coaxial posts either on the same wall or on opposite walls of the rectangular waveguide cavity. Coaxial-to-waveguide mode coupling is implemented by means of coupling screws, which adds flexibility in terms of tuning easiness. Three 9.9-GHz proof-of-concept prototypes corresponding to third- and sixth-order integrated coaxial-waveguide bandpass filters are designed at the electromagnetic-simulation level. Furthermore, the triplet with a TZ below the passband is manufactured and characterized to experimentally validate the engineered 3-D RF filter principle and its underlying design theory.

**INDEX TERMS** 3-D filter, bandpass filter, coaxial filter, inline filter, microwave filter, transmission zero (TZ), waveguide filter.

## I. INTRODUCTION

WAVEGUIDE and coaxial-cavity bandpass filtering devices are commonly used in transceiver RF front-ends of modern communication systems to efficiently acquire the desired signal band and suppress out-of-band interference and noise [1]–[4]. The current tightly-spaced spectrum-allocation planning requires highly-selective bandpass filters with sharp-rejection responses. Besides, in order to accommodate the ever-increasing number of RF chains to support emerging multi-input-multi-output (MIMO) applications, the transceiver architecture is evolving towards miniaturized implementations requiring highly-compact RF components. Filter selectivity can be increased by augmenting its order through the incorporation of more resonators but at the expense of increased size/volume and higher in-band insertion loss, which may be unacceptable for lightweight and high-performance RF communication transceivers. Alternatively,

transmission zeros (TZs) are commonly exploited to increase the selectivity in RF bandpass filters. They can be realized by creating cross couplings between nonadjacent resonators in the form of triplets [5]–[7] or quadruplets [8]–[11] to produce destructive RF signal interferences, as well as through their combination in cascaded or folded forms. In the past decade, significant effort has been carried out to develop filters with TZs in inline configurations, both in waveguide and coaxial-resonator technologies. Thus, several design approaches of inline waveguide bandpass filters with TZs using frequency-dependent couplings have been reported as in [9], [12]–[14]. For inline coaxial combline filters, cross couplings can be produced by rotating the inner cylinders to shape pseudo-elliptic-type filtering responses [15]–[17]. In [18] and [19], strongly-coupled coaxial-resonator pairs are used to implement inline bandpass filters with TZs. In [20], several inline schemes for coaxial combline filters with TZs are presented.

# Miniaturized And Integrated Filters

**Sanjit Kumar Mitra, Carl F. Kurth**



## **Miniaturized And Integrated Filters:**

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on using substrate integrated waveguides for designing antennas antenna arrays filters and other parts of a modern transceiver Substrate Integrated Waveguide is an important technology for 5G applications and beyond Readers will gain a deep understanding of how to leverage SIW for developing advanced microwave and millimeter wave systems The book's coverage extends from basic communication principles to the intricate design of SIW based circuits and systems ensuring that the reader is equipped with the necessary knowledge to innovate in this rapidly evolving field Targeted at RF engineers academic researchers and post graduate students this book stands out by offering a holistic perspective on SIW technology It goes beyond just the basics integrating both theoretical foundations and practical design approaches This book serves as an essential resource for those seeking to master SIW technology Whether for academic study or practical application it provides the tools and insights necessary to contribute to the next generation of communication systems particularly in terms of 5G and future technologies

Microwave Integrated Circuits Konishi,1991-03-29 Presents to a wide range of students and engineers up to date techniques of MICs with readily comprehensible explanations providing a unified description of MICs clarifying physical content including sufficient data to be directly useful to active engineers and providing a path of entry into the

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young researchers it also addresses professionals involved in active basic and applied research Making a strong link between education research and product development this book discusses prospects for future progress     **Active Inductorless Filters** Sanjit Kumar Mitra,1971     *Micromechanical Wine-glass Resonators with Semi-automatic Post Fabrication Trimming* Mohamed Ahmed Abdelmoneum,2005     *Microelectromechanical Systems* ,2007     *Miniaturized Planar RF Integrated Filters with Good Harmonic Suppression* Huamin Shi,2005     **Optical and Wireless Technologies** Manish Tiwari,Yaseera Ismail,Karan Verma,Amit Kumar Garg,2022-09-13 This book comprises select proceedings of the 5th International Conference on Optical and Wireless Technologies OWT 2021 The contents of this book focus on research carried out in optical communication optoelectronics optics wireless communication wireless networks sensors mobile communications and antenna and wave propagation The book also explores the combined use of various optical and wireless technologies in next generation applications and their latest developments in the applications such as photonics high speed communication systems and networks visible light communication nanophotonics and wireless and MIMO systems This book serves as a reference to scientists academicians engineers and policy makers interested in the field of optical and wireless technologies     [Integrated Circuits for Wireless Communications](#) Asad A. Abidi,Paul R. Gray,Robert G. Meyer,1998-12-24 Electrical Engineering Integrated Circuits for Wireless Communications High frequency integrated circuit design is a booming area of growth that is driven not only by the expanding capabilities of underlying circuit technologies like CMOS but also by the dramatic increase in wireless communications products that depend on them Integrated Circuits for Wireless Communications includes seminal and classic papers in the field and is the first all in one resource to address this increasingly important topic Internationally known and highly regarded in the field editors Asad Abidi Paul Gray and Robert G Meyer have meticulously compiled more than 100 papers and articles covering the very latest high level integrated circuits techniques and solutions in use today Integrated Circuits for Wireless Communications is devised expressly to provide IC design engineers system architects and integrators with a practical understanding of subjects ranging from architecture choices for integrated transceivers to actual circuit designs in all viable IC technologies such as bipolar CMOS and GaAs The papers selected represent a breadth of coverage and level of expertise that is simply unmatched in the field Topics covered include Radio architectures Receivers Transmitters and transceivers Power amplifiers and RF switches Oscillators Passive components Systems applications

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