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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.

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Sanjit Kumar Mitra,Carl F. Kurth

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Slow-Wave Substrate-Integrated Waveguide Jing-Ya Deng, Jia-Yuan Yin, Fengxia Li, Yulong Liu, Li-Xin Guo, Xiao-Hua Ma, 2025-10-14 Comprehensive text on the fundamentals of systematic design methods and analysis for slow wave substrate integrated waveguide Enriched with practical examples and illustrations Slow Wave Substrate Integrated Waveguides introduces the application of slow wave substrate integrated waveguides in miniaturized and integrated antennas The book details the advantages of microstrip lines and metal waveguides with low cost low loss and easy to integrate with planar circuits delves into slow wave structure in the design of antennas and devices allowing for additional distributed capacitors and inductors and discusses how to overcome the technical challenges associated with miniaturizing slow wave microwave devices and antennas Topics explored in this book include The potential for larger multi beam antennas to improve communication system capacity Devices such as couplers miniaturized phase shifters and waveguide cross junctions Antennas such as bidirectionally fed slow wave substrate integrated waveguide monopulse slot array antennas and miniaturized H plane horn antennas with 30 dB sidelobes Transmission lines beamforming networks and future perspectives in the field Slow Wave Substrate Integrated Waveguides is an essential reference for students and professionals in the fields of physics optics electromagnetics communications seeking to improve the spectrum efficiency energy efficiency and cost efficiency of wireless communication systems

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