Overcoupled Response Improvement with Miniaturizing of Rectangular Dual-Mode Filter by Slow-Wave Modified Resonator

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Abstract: Accompanied with an overcoupled response, a conventional dual-mode rectangular resonator bandpass filter (BPF) inherently has a hump response with a rather wide 3 dB bandwidth and a high insertion loss in the middle of the passband. To improve such a drawback, a miniature dual-mode BPF with a slow-wave modified rectangular resonator is presented in this study. Through a periodic U-shaped inward folding of the resonator, a slow-wave propagation is resulted for two degenerate modes in the guided-wave paths. Having an inter-digital like I/O feed lines for an optimal signal coupling and a perturbation element at the topmost of the slow-wave resonator, the characteristic of fundamental frequency is significantly improved to have sharper rejection skirts with introducing transmission zeros and a single peak response within the bandpass region instead of double peaks response. Due to an utmost use of interior space with an equal amount of 5 inward folding at both sides of the resonator, size reduction could be realized to 41 and 57% against the conventional rectangular ring and square ring, respectively. Besides, the feed lines are also kept along a straight line to favor for a flexible accommodation with the microwave networks.

Key words: Bandpass filter, dual-mode, miniature, overcoupled response, slow-wave resonator

INTRODUCTION

Attractive features of low radiation loss, low fabrication cost and narrow passband bandwidth, the microstrip dual-mode bandpass filters (BPFs) first proposed by Wolff (1972) have been widely used in modern microwave communications. An impressive characteristic of a dual-mode BPF is its compact size because each dual-mode resonator could be used as a doubly tuned resonator circuit, which thus reduces the number of resonators by half required for a given degree of filter (Hong and Lancaster, 2001). On the other hand, a major drawback of using a ring resonator is its curvature, a square loop instead of circular ring had then been proposed for applying in a dual-mode bandpass filter (Hong and Lancaster, 1995a, b). Because of having a 4 fold symmetry property, a square loop resonator provides an easy allocation of orthogonal feed lines at the rim of the resonator. Figure 1 shows such a typical dual-mode BPF with a small perturbation element. When the mean parameters l of this square loop resonator is designed with an integral multiple of a guided

![Figure 1: A conventional dual-mode bandpass filter with a square loop resonator fed by a pair of orthogonal feed lines](image-url)

wavelength $\lambda$, the resonance is resulted. Such a relation could be simply expressed as: