UNIVERSITI TEKNOLOGI MARA

MICROWAVE PLANAR FILTER TOPOLOGIES BASED ON RING RESONATORS WITH COUPLED-LINES COMBINATION

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ABSTRACT

This research is divided into two topics, where ring resonator and coupled line will be, either, integrated or cascaded. In the first topic, quarter-wavelength coupled line ring resonator integration will be developed, which will result in a single mode resonator with two transmission zeros on both sides of the passband. The new filter will be presented by its equivalent circuits in order to derive the mathematical modeling and extract the controlling parameters which determine the position of the transmission zeros. Several filters are designed using the new synthesis to show its advantages and new applications. The synthesis of the new topology could be generalized to design higher order filters, which facilitates the design of such filter. Moreover, the filter will be cascaded to offer higher orders and more selective filters. 2^{nd}, 3^{rd}, 4^{th} and 5th order filters will be designed and simulated to show the feasibility of the new topology.

In the second part, the concept of the ring resonator and coupled lines will be further explored, where the quarter-wavelength coupled line will be cascaded with the ring resonator. Such a topology will offer high selective and wideband filter compared to conventional coupled line filter. Furthermore, the new topology reduces the number of controlling parameters, thereby, achieving ease of designing and fabrication.

Several techniques are proposed to miniaturize the filter size by using curved coupled line cascaded with curvy ring resonator or by adding a square patch to the inner corner of the ring resonator. Moreover, the same concept is used where the quarter-wavelength coupled lines are cascaded with multiple ring resonators to achieve high selective, wideband and shorter circuitry filters, when compared with conventional coupled line filter. Eleven filters will be designed and fabricated using planar circuitry technology, where measurements using vector network analyzer show the agreement of measured and simulated results.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

Modern microwave systems have shown explosive developments in this era, which are accompanied by the strict specification required in the communication and wireless applications such as high quality service, lower cost, and small size [1-2].

Since the growth of wireless services in the recent few decades, there has also been an escalation in innovations towards systems with faster data rates, wider bandwidths and increased reliability [3-4]. And this has posed a challenge in the prerequisites of modern filter developments in terms of loss minimization, selectivity, stopband enhancement and cost efficiency. Inversely, as the system becomes more complex, its size has continued to get smaller due to modern day advancements, such as chip integration [5].

Indeed, microwave filters are very essential and vital element in microwave components, which provide selectivity of frequency in radars, satellite communication, and electronics warfare in microwave frequencies, where the function of the filter is to allow certain frequencies to pass, while attenuates the unwanted frequency band [6-8]. In general, the filter performance is described in two aspects: the electrical performance of the filter in terms of selectivity, return loss, insertion loss, and the mechanical performance aspect which requires that the filter be small in size and weight.

Bandpass filters are implemented in many RF and microwave application as frequency selective device [9-10]. Filters in microwave frequencies are realized by implementing distributed circuit rather than lumped elements which suffer from parasitic effects. Therefore, planar transmission line, such as, microstrip line technology, takes place in implementing passive microwave components. Moreover, microstrip filters have several attractive features in terms of compactness and low cost.

Microstrip bandpass filters can be developed using different topologies, such as, parallel coupled lines, combline, hairpin, and interdigital. Another attractive topology to design bandpass filter is by implementing ring-based resonator. This type of filter offers transmission zeros in the response which enhances filter selectivity, and