UNIVERSITI TEKNOLOGI MARA

# MULTI-POINT VARACTOR-LOADED TUNABLE RING-BASED BANDPASS FILTERS

**MUHAMAD AIDI BIN ABDUL LATIP**

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## CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 19th December to conduct the final examination of Muhamad Aidi Bin Abdul Latip on his Master of Science thesis entitled "Multi-Point Varactor-Loaded Tunable Ring-Based Bandpass Filters". The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

**Aziati Husna Binti Awang, PhD**
Senior Lecturer
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Chairman)

**Nur Emileen Binti Abd Rashid, PhD**
Senior Lecturer
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Internal Examiner)

**Muhammad Ramlee Bin Kamarudin, PhD**
Associate Professor
Wireless Communication Centre
Universiti Teknologi Malaysia (External Examiner)

**SITI HALIJJAH SHARIFF, PhD**
Associate Professor
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date: 28th April, 2015

# ABSTRACT

Current demand of the microwave application systems requires an optimum exploitation of the frequency spectrum, leading to rigorous specifications imposed on microwave filters, in terms of cost, compactness and selectivity. Along such direction, tunable filters are becoming ideal solution to replace bulky and complicated filter banks, which are required to cater the multiple channels due increasing number of applications in the system. A novel concept of tunable dual-mode ring resonator filter involving quarter-wavelength coupled-lines has been introduced, based on the identification of the filter control parameters. However, no specific method or practical implementation of the concept has been proposed to achieve the concept. In addition, no precise technique or technology has been suggested to allow the addition of the tuning elements into the filter to allow the tuning. Therefore, the main objective of this thesis work is to realize the proposed tunable ring-based filter using one of the reliable tunable technologies which is varactor diode that can satisfy fast tuning speed, low cost, ease of fabrication and wide selection. In order to achieve this, a tuning circuit is proposed, designed and implemented. Then, the varactor-tuned circuit is applied into the quarter-wavelength side-coupled ring-resonator filter. The proven tuning circuit is also used to realize other types of tunable filters, based on two developed ring-based topologies. Furthermore, the complete circuits of the tunable bandpass filter are realized using microstrips on epoxy glass substrate and the measurement results are found to be in good agreement with the ones from simulation.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 BACKGROUND

The increasing demand of the microwave application systems requires an optimum exploitation to cover a large frequency spectrum. In order to avoid the frequency congestion, the more and more rigorous specifications are imposed at front-end elements of emission in telecommunication system chain especially on the filtering devices; hence the fact that filters to be one of the important areas specifically for wireless and mobile applications. In fact, the recent trend demands for high selectivity filter to cater multifunctional operation systems. On the other hand, the highly integrated communication systems with multiple channels will require the implementation of filter banks, which lead to greater size, weight and cost. Therefore, the use of highly selective tunable filters becomes an ideal solution. In the meanwhile, continuous efforts toward developing tunable filters are being done by many researchers, involving various technologies, including mechanical tuning, ferrite, RF MEMS, semiconductor varactors and ferroelectric materials. Naturally, most focus has been given on the technology with fast tuning speed, high selectivity, wideband coverage and compact size [1-15].

In view of this regard, it is noted that numerous topologies have been taken into account in realizing the tunable filters. These include the ring-based topologies, which offer high selectivity and circuit compactness, to vast applications involving filters, measurement of dielectric constant, phase velocity and dispersion [16-20]. The implementation of ring-based resonators for tunable filter applications is facing a problem, where most of the existing ring filter topologies are generally developed based on the extensive optimizations and simulations to achieve the desired response, since no synthesis is included in their designs. Such lack of synthesis leads to difficulties in tuning the filters, where the tuning elements might not be able to be identified, or no exact range of values can be determined in advance for the tuning elements.