

**Design of Integrated Differential Dual-Band
Bandpass Filter-Antenna Module**

by

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**Master of Science
in
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**Faculty of Science and Technology
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ABSTRACT

For the modern wireless communication systems, the RF front-end circuits with function versatility and compact size attract great attention. In this thesis, the concept of integrated dual-band bandpass filter and antenna operated different frequencies is proposed and studied in both single-ended and differential structures. For the single-ended integrated filter-antenna (IFA) module, two three-port prototype IFA modules have been analyzed and experimentally measured. The proposed dual-band bandpass filter and slot antenna can work independently on single substrate. Moreover, the spurious passband rejection of dual-band filter is achieved due to the band-gap effect of annular slot antenna for the second IFA module.

On the other hand, based on the advantages of RF components in balanced structure, a differential dual-band bandpass filter with controllable transmission zeros is presented. The transmission zero conditions of asymmetric loaded parallel coupled-line (PCL) are derived. By terminating a stepped-impedance open stub on the symmetric plane, the common-mode transmission zeros of proposed differential dual-band filter can be relocated to realize about 40 dB in-band and 25 dB wideband common-mode suppression. Thus, with a pair of monopole antennas terminated on the symmetric plane, an innovative integrated differential dual-band bandpass filter-antenna module is proposed and simulated.

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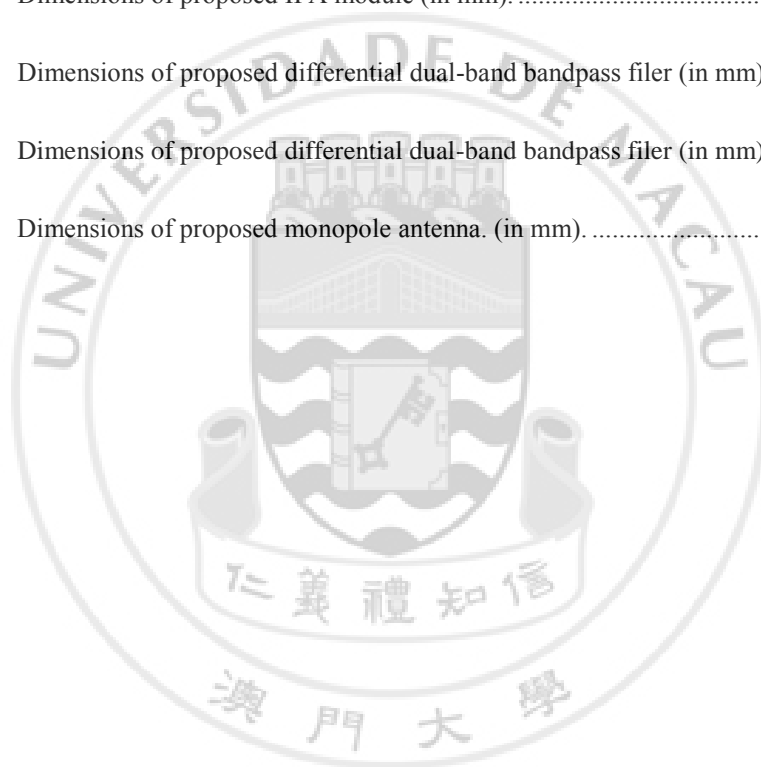
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LIST OF ABBREVIATIONS

DECT	Digital European Cordless Telephone
DGS	Defected Ground Structure
GSM	Global System for Mobile Communications
IFA	Integrated Filter-Antenna
IDFA	Integrated Differential Filter-Antenna
LNA	Low Noise Amplifier
LTCC	Low-Temperature Cofired Ceramic
PCL	Parallel Coupled-Line
PCN	Personal Communication Network
PCS	Personal Communication Systems
RF	Radio Frequency
RFID	Radio Frequency Identification
SiP	System in Package
SoC	System on Chip

CHAPTER 1 – INTRODUCTION

1.1 Single-/Multi-band Banpass Filter – Antenna Modules

In the past decades, the RF circuits with high quality performance, compact size and low cost have been intensively investigated in low frequency regime, some components of concern are antenna and filter as the physical size is proportional to the electrical wavelength. For example, low cost passive and active antennas for different system applications and compact filters were designed with various structures such as quarter- and half- wavelength resonator, dual-mode resonator, low temperature cofired ceramic (LTCC) structure and defected ground structure (DGS) and so forth [1.1]-[1.7]. The antenna and filter are the essential components for the RF transceivers in a variety of communication systems, such as GSM, DECT, PCN, PCS and RFID. Although the system on chip (SoC) is already developed, it is still difficult to integrate low-loss passive filters and antennas in SoCs due to the size limitations in distributed circuitry. Therefore, the system in package (SiP) technique is widely utilized to realize the integration of the antenna and filter circuits [1.8], [1.9].

Against this background, the researches on RF front-end circuits with multi-standard functionality are considered and the multifunctional guided-/radiated components concept has been proposed and attracted great attention. Recently, a filtering antenna component is presented based on the design of a bandpass filter as the antenna feeding line [1.10]. In [1.11], the concept of filter-antenna (filtenna) is proposed with integrating a horn antenna and waveguide cavity frequency-selective surface on one substrate. Besides, Lim *et al.* [1.12] have studied two three-port integrated-antenna-filter modules. The modules demonstrate the integration of a single band bandpass filter and patch antenna on one substrate, it has been