



**HIGH ISOLATION OF SINGLE POLE DOUBLE THROW SWITCH
WITH SWITCHABLE RESONATOR
FOR WIRELESS COMMUNICATIONS**



DOCTOR OF PHILOSOPHY

2015



Faculty of Electronic and Computer Engineering



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اونيورسيتي تیکنیکل ملیسیا ملاک

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

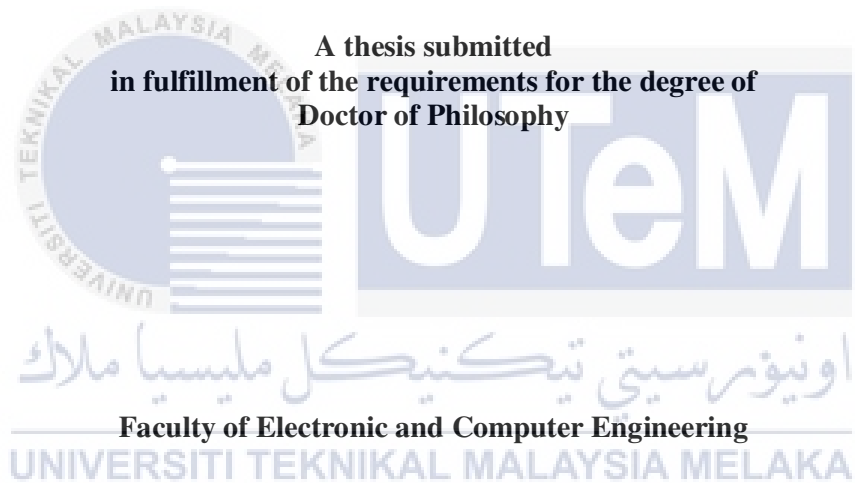
Noor Azwan Bin Shairi

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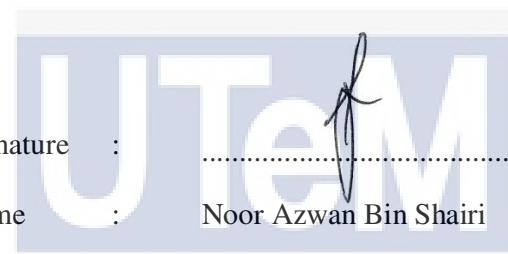


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DECLARATION

I declare that this thesis entitled “High Isolation Of Single Pole Double Throw Switch With Switchable Resonator For Wireless Communications” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Name : Noor Azwan Bin Shairi
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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

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Supervisor Name : Prof. Madya Dr. Badrul Hisham Bin Ahmad

Date : 28 Sept. 2015

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DEDICATION

*The sake of Allah, my Creator and my Master,
My great messenger, Mohammad S.A.W who taught us the purpose of life,
My beloved wife Sakinah,
My beloved sons Ahmad Syafiq, Ahmad Syariq, and Ahmad Syarif,
All the people in my life who touch my heart,
I dedicate this research.*



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ABSTRACT

In wireless communication systems, Single Pole Double Throw (SPDT) switches are widely used in radio frequency (RF) front-end system to support transmit and receive modes switching for Time Division Duplex (TDD) communication. High isolation between transmitter and receiver in the RF front-end is one of the key parameters in SPDT switch design, especially for high power applications such as a base station and wireless infrastructure. Therefore, this research work introduced a new high isolation of SPDT discrete switch design using switchable resonator that includes minimum number of PIN diodes or produce absorptive feature. The microstrip resonators such as a transmission line stub, radial stub, parallel coupled line and ring were selected in this research work. By analyzing a mathematical model of simplified SPDT switch with resonator, a high isolation could be achieved due to a bandstop response of the resonators. These resonators were able to reconfigure between bandstop and allpass or bandstop and bandpass responses to support transmit and receive modes switching. The proposed SPDT switches with switchable resonator were demonstrated for the applications of Time Division Synchronous Code Division Multiple Access (TD-SCDMA) in 2 GHz band and Worldwide Interoperability for Microwave Access (WiMAX) and Long Term Evolution (LTE) in 3.5 GHz band. Results showed that isolation of more than -25 dB was achieved in the SPDT discrete switch design using these four types of switchable resonators and suitable for high power application with 1 Watt and 10 Watt transmit output power. Despite high isolation performance, the proposed SPDT switches (with transmission line stub and radial stub resonators) used a minimum number of PIN diodes compared to conventional multiple cascaded switches technique. Meanwhile, the proposed SPDT switches (with parallel coupled line and ring resonators) produced high isolation with absorptive feature without additional circuit components.

ABSTRAK

Suis Satu Kutub Dua Lontar (SPDT) banyak digunakan dalam sistem frekuensi radio (RF) untuk sistem komunikasi wayarles yang digunakan untuk pensuisan mod hantar dan terima dalam komunikasi dupleks pembahagian masa (TDD). Isolasi tinggi antara penghantar dan penerima dalam sistem RF adalah salah satu parameter penting dalam merekabentuk suis SPDT terutama untuk aplikasi kuasa tinggi seperti stesen pencawang dan struktur wayarles. Oleh itu, penyelidikan ini telah memperkenalkan satu isolasi tinggi yang baharu terhadap suis SPDT terurai dengan menggunakan resonator boleh-suis termasuk penggunaan bilangan diod PIN yang minimum atau menghasilkan ciri serapan. Resonator-resonator jalur-mikro seperti puntung talian penghantaran, puntung jejarian, talian gandingan selari dan cincin telah dipilih dalam penyelidikan ini. Satu model matematik suis SPDT termudah bersama resonator telah dianalisa yang mana satu isolasi tinggi boleh dicapai disebabkan sambutan jalur-henti resonator tersebut. Resonator-resonator ini boleh dikonfigurasi-semula antara sambutan jalur-henti dan semua-lepas atau jalur-henti dan jalur-lepas untuk menyediakan pensuisan mod hantar dan terima. Suis-suis SPDT dengan menggunakan resonator boleh-suis ini telah didemonstrasi untuk aplikasi Pembahagian Masa - Capaian Pelbagai Pembahagian Kod Segerak (TD-SCDMA) dalam spektrum frekuensi jalur 2 GHz, dan Kebolehkendalian Serantau untuk Capaian Gelombang Mikro (WiMAX) dan Evolusi Jangka Panjang (LTE) dalam spektrum frekuensi jalur 3.5 GHz. Keputusan ujian telah menunjukkan isolasi lebih daripada -25 dB telah dicapai dalam rekabentuk suis SPDT terurai menggunakan keempat-empat jenis resonator ini. Rekabentuk ini sesuai untuk aplikasi kuasa tinggi dengan 1 Watt dan 10 Watt kuasa keluaran penghantar. Selain itu, suis-suis SPDT bersama resonator puntung talian penghantaran dan jejarian telah menggunakan diod PIN yang minimum berbanding dengan teknik konvensional. Manakala, suis-suis SPDT bersama resonator talian gandingan selari dan cincin telah menghasilkan isolasi tinggi dengan ciri serapan tanpa sebarang penambahan komponen-komponen litar.

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