DESIGN, FABRICATION AND CHARACTERIZATION OF MICRO FLUIDIC AND CMOS-BASED PROCESS TECHNOLOGY RF TUNEABLE INDUCTOR

by

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Thesis submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy

November 2016

ACKNOWLEDGMENT

Each of the following individuals has provided me with support, advice, and encouragement throughout the process of developing this thesis. It is with sincere gratitude and appreciation that I thank you all for everything you have done to assist me in the most ambitious endeavor of my career thus far.

Firstly, I would like to express my sincere gratitude to my supervisor Associate Prof. Asrulnizam Abd Manaf for the continuous support of my Ph.D. study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. He always tried to give advice and help me as soon as needed. I would like to thank him for taking some time to read this thesis and give constructive feedback led to significant improvement, despite his busy schedule. I could not have imagined having a better advisor and mentor for my Ph.D. study.

Besides my supervisor, I would like to thank the rest of my thesis committee: Dr. Norlaili Mohd Noh and Dr. Mohd Tafir Mustaffa, who provided me an opportunity to join their team and for their insightful comments and encouragement, but also for the hard question which incited me to widen my research from various perspectives

My sincere thanks also go to Dr. Yufridin Wahab who gave access to the laboratory and research facilities in AMBIENCE, UNIMAP. Without his precious support, it would not be possible to conduct this research.

I am extremely thankful and indebted to Dr. Patrick Pons as my co-supervisor for helping me and sharing expertise MEMS process, and for his valuable guidance.

I can say it was a big honor for me to be working with Advanced Integrated System Device Group (AISDe) in the School of Electrical and Electronic Engineering.

I wish to express my sincere thanks to CEDEC, for providing me with all the necessary facilities and EDA tools for the research. I am also grateful to Mr. Mohd Kusairay Musa for supporting me with EDA tools, Mr. Mohd Hasnirol Baharom and Mr. Shukri for measurements and guidance in on-chip measurement that greatly assisted the research.

I place on record, my sincere thank you to SilTerra Fab which provided me free fabrication for my designs. I would like to thank Ms. Awatif Hashim for her great helps on MPW processes. I would like to thank Mr. Yusman and his modeling team in SilTerra for providing me the fabrication opportunity in SilTerra fab.

I would like to thank from NOR lab technicians Mr. Jamil and Mr. Anas. They helped me to use clean room facilities in school of Physics in Universiti Sains Malaysia.

I also would like to thank Ms. Zammira Khairuddin and Mr. Abdul Latip Hamid who provided me the access to measurement facilities in the communication laboratory in Universiti Sains Malaysia.

I take this opportunity to express gratitude to all the department staff for their help and support especially Mr. Rahmat for his great helps in handling all official jobs and Ms. Sharida for handling grant works.

This research was supported by Universiti Sains Malaysia research university (RU) grant No. 1001/PELECT/814107, postgraduate research grant scheme (PRGS) No. 1001/PELECT/8045003 and exploratory research grant scheme (ERGS) No. 203/PELECT/6730112. I thank our colleagues from school of electrical and electronic engineering who provided insight and expertise that greatly assisted the research.

I would also like to thank my parents, my sisters and brother. They were always supporting me and encouraging me with their best wishes.

And special thanks to my friends, Mr. Majid Rafiee and Mr. Hamidreza Ameri for all their help and support.

I wish to thank my unique friends Samiyeh Esmailee and Zeinab Javanshah who both have offered me unlimited encouragement and have been an enthusiastic sounding board regardless of the topic. Thank you for sharing this grad school journey with me.

Last, but never least, I must thank my unbelievably supportive husband Dr. Farshad Eshghabadi. He has demonstrated rare and amazing patience with unconditional love, and continual support of my academic endeavors over the past several years enabled me to complete this thesis

I also place on record, my sense of gratitude to one and all, who directly or indirectly, have let their hand in this venture.

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LIST OF ABBREVIATIONS

3D	Three dimensional
CMOS	Complementary Metal Oxide Semiconductor
DC	Direct current
EM	Electromagnetic
FM	ferromagnetic
LLG	Landau-Lifshitz-Gilbert
LNA	Low-Noise Amplifier
MEMS	Microelectronic Mechanical System
PDK	Process Design Kit
PCB	Printed Circuit Board
PDMS	Polydimethylsiloxane
PZT	Pizomagnetic
RF	Radio Frequency
Q factor	Quality factor
SMA	Sub Miniature Version A
SOS	silicon on sapphire
VCO	Voltage-Controlled Oscillator

REKABENTUK, FABRIKASI DAN PENCIRIAN PENGARUH BOLEH TALA RF BERDASARKAN PROSES TEKNOLOGI MIKRO BENDALIR DAN CMOS

ABSTRAK

Pemboleh aras RF induktor menjadi fokus penyelidikan bagi menghasilkan konfigurasi sistem RF di dalam cip yang bersaiz kecil. Pendekatan ini menjadi salah satu cabaran kerana bacaan bagi nilai aruhan yang tinggi bagi satu jarak penalaan perlu dihasikan serta factor kualiti yang tinggi. Pelbagai teknik penalaan yang telah digunakan sebelum ini seperti suis bergilir, suis aruhan saling, gandingan bimorph pada kesan yang berbeza-beza, dan suiz medan magnet. Tetapi jarak penalaan yanag diperolehi adalah kurang dari 60% bagi pemboleh aras induktor dan pada masa yang sama kualiti faktor berada pada paras yang rendah. Matlamat penyelidikan ini adalah untuk menghasilkan reka bentuk pemboleh aras induktor dengan jarak penalaan dan kualiti faktor yang tinggi bagi aplikasi RF dengan menggunakan teknik mikro bendalir serta pemboleh aras induktor berasaskan CMOS dengan nilai bacaan jarak penalaan yang berskala kecil serta kualiti faktor yang tinggi pada aplikasi gelombong mikro tanpa wayar. Analisis parametric berdasarkan persamaan untuk induktor satah dan 3-dimensi telah dikaji. Cadangan teknik penalaan yang baru telah ditentukan berdasarkan sumbangan parameter fizikal dan ciri ciri elektrik bagi keberkesanan variasi kearuhan yang telah dipilih. Cecair telap khususnya cecair-ferro digunakan untuk tujuan permerhatian. 3 jenis pemboleh aras induktor yang berasaskan cecair iaitu pemboleh aras bagi lingkaran satah induktor, pemboleh aras wayar-lilit solenoid induktor dan pemboleh aras wayar-terikat solenoid induktor dicadangkan bagi hasil kerja ini. Dengan menggunakan alat analisis simulasi HFSS full-3D EM, rekabentuk

induktor berasaskan cecair telah direkabentuk dan dianalisisi. Pemboleh aras induktor diukur dengan mengalirkan cecair-ferro ke dalam teras induktor. Teras induktor difabrikasi dengan menggunakan bahan berasaskan PDMS. Keputusan jarak penalaan serta resonan frekuensi berubah mengikut menggunakan kepekatan magnet nano-partikel yang terkandung di dalam cecair-ferro. Ukuran bagi nisbah penalaan untuk pemboleh aras wayar-lilit induktor ialah 90.6% serta Q faktor adalah 129. Manakala nisbah penalaan untuk wayar-terikat induktor adalah 81% serta kualti faktor 39.8. Selain itu, pemboleh aras induktor dengan menggunakan CMOS 0.11 um proses teknologi telah direkabentuk, disimulasi dan diukur untuk mengawal aliran magnet ke induktor satah. Induktor tersebut boleh dilaras dengan 9 nilai induktor berbeza dan julat laras adalah 6.5% untuk 1.7 GHz. Tambahan lagi, proses MEMS untuk menghasilkan mikro saiz 3D induktor solenoid juga dicadangkan. Faktor kualiti untuk rekabentuk induktor yang dicadangkan berada di dalam julat yang diterima untuk aplikasi frekuensi tinggi tanpa wayar. Induktor berdasarkan CMOS juga menunjukkan nilai faktor kualiti serta nisbah jarak penalaan yang berskala kecil.