UNIVERSITI PUTRA MALAYSIA

MINIATURIZATION OF MICROSTRIP AND CPW-FED UWB PRINTED ANTENNAS WITH BAND REJECTION CHARACTERISTICS

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By

WESSAM ZAYD SHAREEF

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

September 2010

DEDICATION

This thesis is especially dedicated To

My ever loving parents,

My dearest siblings

And My homeland

IRAQ

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

MINIATURIZATION OF MICROSTRIP AND CPW- FED UWB PRINTED ANTENNAS WITH BAND REJECTION CHARACTERISTICS

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WESSAM ZAYD SHAREEF

September 2010

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The tremendous developments over the recent years in wireless communications applications led to the urgent need for the innovation of new technologies capable of vast data transfer rates at very low power consumption levels. Such technologies also require large portions of the frequency spectrum. Ultra wideband (UWB) technology is being considered as a solution to address these issues. This technology attracted high attention especially after the allocation of 7.5 GHz spectrum bandwidth between 3.1 GHz and 10.6 GHz for the UWB civil applications by the Federal communication Commission (FCC). As is the case in conventional wireless communication systems, an antenna plays a significant role in achieving successful transmission and reception of information in the form of data packets using UWB systems.

This thesis presents two new designs of notched band Ultra-Wideband printed antennas using microstrip and coplanar waveguide-fed configurations. Simple techniques of perforation the substrate and modifying the ground planes and radiator

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patches are used to achieve ultra wideband for the designed antennas with small structure. Narrow Arch-shaped slot was introduced to the patch of the proposed antennas to obtain the band rejection function around the 5.4 GHz frequency to avoid the interference with WLAN standards like IEEE 802.11a and HIPERLAN/2

Both UWB antennas were developed and analyzed by a 3D electromagnetic simulator. To confirm the simulation results, the two proposed antennas were fabricated on FR-4 substrate with dielectric constant of 4.4 and the experimental measurements were carried out using a network vector network analyzer (Anritsu 37347D). The analysis indicated a fairly good agreement between simulation and measurement.

The measured bandwidth of the proposed microstrip-fed UWB antenna is ranging from 2.62 GHz up to 12.7 GHz with a return loss no more than -10 dB excluding a notched frequency starting from 5.1 GHz to 6 GHz. The overall size of the antenna is $20 \times 21 \times 1.6$ mm^3

The measurement results of the proposed cpw-fed UWB antenna showed that this antenna has operational bandwidth starting from 2.45 GHz to 10.9 GHz with return loss better than -10 dB excluding the notched band from 4.83 GHz to 5.97 GHz. The antenna features the same compact size of the microstrip antenna ($20 \times 21 \times 1.6$ mm^3).

In the addition to the required UWB bandwidth, both designed antennas are exhibit high radiation efficiency, stable group delay and omni-directional pattern which

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makes them suitable for UWB portable wireless devices with their compact size feature.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGECILAN SAIZ JALUR MIKRO DAN SUAPAN CPW ANTENA TERCETAK DENGAN SIFAT-SIFAT JALUR PENOLAKAN

Oleh

WESSAM ZAYD SHAREEF

September 2010

Pengerusi: Alyani Binti Ismail, PhD

Fakulti: kejuruteraan

Pembangunan pesat dalam aplikasi tanpa wayar kebelakangan ini, memerlukan perubahan untuk menghasilkan teknologi baru dalam pemindahan kadar data yang laju menggunakan kuasa yang begitu kecil serta pecahan spektra frekuensi yang besar. Justeru, teknologi jalur teramat lebar, *Ultra Wideband* (UWB) sedang dipertimbangkan sebagai penyelesaian kepada permasalahan ini. Teknologi ini mula mendapat perhatian ramai terutamanya selepas berjaya memperuntukkan sebanyak 7.5 GHz lebar jalur spektrum, diantara 3.1 GHz sehingga 10.6 GHz untuk aplikasi awam UWB oleh Persatuan Suruhanjaya Komunikasi (FCC). Sistem komunikasi tanpa wayar yang sedia ada kini memerlukan antena yang berperanan penting untuk menghantar dan menerima data menerusi sistem UWB.

Dalam tesis ini, dua bentuk antena UWB tercetak yang menggunakan konfigurasi jalur mikro dan suapan satu satah pandu gelombang dipersembahkan. Bagi antena

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yang direka, teknik ringkas, iaitu dengan melubangkan permukaan material antena dan mengubah lapisan bawah antenna, serta tampalan pada pemancar digunakan bagi mendapatkan UWB pada saiz yang kecil. Slot berbentuk lengkuk kecil diperkenalkan bagi mendapatkan fungsi jalur penolakan di sekitar frekuensi 5.4 GHz, bertujuan untuk menghindari daripada gangguan piawaian WLAN, contohnya IEEE 802.11a dan HIPERLAN/2.

Kedua-dua antena UWB ini direka dan dianalisis menggunakan pensimulasi elektromagnetik. Bagi tujuan pengesahan keputusan simulasi, kedua-dua antena yang dicadangkan ini difabrikasikan di atas substrat FR-4 dengan tetapan nilai dielektriknya adalah 4.4 dan penganalisis rangkaian, Vector Network Analyzer, (VNA) model Anritsu 37347D digunakan bagi tujuan pengukuran hasil akhir eksperimen ini. Daripada analisis ini dapat dilihat, kedua-dua hasil simulasi dan ukuran akhir eksperimen ini memberikan keputusan yang memuaskan.

Bagi antena suapan jalur mikro UWB, lebar jalur yang diukur adalah dari 2.62 GHz sehingga 12.7 GHz dengan nilai kehilangan kembali tidak lebih daripada -10dB, tetapi tidak termasuk bagi antena yang dilubangkan, di mana frekuensinya bermula dari 5.1 GHz sehingga 6 GHz. Saiz keseluruhan antena ini ialah ($20 \times 21 \times 1.6$ mm^3).

Hasil keputusan bagi antena suapan cpw UWB yang dicadangkan ini menunjukkan bahawa antena ini mempunyai lebar jalur yang beroperasi bermula daripada 2.45 GHz sehingga 10.9 GHz dengan nilai kehilangan kembali lebih baik daripada -10dB, kecuali yang dilubangkan, dimana nilainya ialah 4.83 GHz sehingga 5.97 GHz. Saiz antena ini sama seperti saiz antena kompak jalur mikro ($20 \times 21 \times 1.6$ mm^3).

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Setiap rekaan antena menunjukkan kecekapan radiasi yang tinggi dan bentuk pemancaran ke seluruh arah yang stabil bagi jalur lebar UWB yang diperlukan, justeru menjadikan antena ini sesuai untuk peranti UWB mudah alih tanpa wayar dengan saiznya yang kecil.

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I certify that a Thesis Examination Committee has met on 29 September 2010 to conduct the final examination of **Wessam Zayd Shareef** on his master of science thesis entitled "Miniaturization of Macrostrip and Cpw- Fed UWB Printed Antennas with Band Rejection Characteristics" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P. U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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WESSAM ZAYD SHAREEF

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