Faculty of Electronics and Computer Engineering

DEFECTED WAVEGUIDE STRUCTURE WITH CIRCULAR MONOPOLE ANTENNA FOR ULTRAWIDEBAND APPLICATIONS

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A thesis submitted in fulfillment of the requirements for the degree of Master of Science in Electronic Engineering

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DECLARATION

I declare that this thesis entitled “Defected Waveguide Structure with Circular Monopole Antenna for Ultrawideband Applications” 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.

Signature	:	………………………………………….
Name	:	CHIN SHU JIA
Date	:	……………..……………………………

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 Master of Science in Electronic Engineering.

Signature : ………………………………………….

Supervisor Name : ASSOC. PROF. DR. MOHAMAD ZOINOL ABIDIN BIN ABD AZIZ

Date : ………………………………………….

DEDICATION

To my beloved family

ABSTRACT

The next generation wireless communication demands for high resolution and high data rate which lead toward the highest level of exploring to the operating bandwidth. To overcome this demand, researches have been concerned on the wideband antenna to be assembled in one system to support all the possible frequency range. Monopole antenna appeared to be the often-considered candidate due to low cost and low profile for the portable devices. Yet, it performed poor gain. Furthermore, the defected structure was noticed to design on ground plane and microstrip feed line as Defected Ground Structure (DGS) and Defected Microstrip Structure (DMS), respectively but not yet in waveguide as Defected Waveguide Structure (DWS). Thus, the project aimed to design, simulate and fabricate monopole antenna with DWS. The antenna design was constructed in CST Microwave Studio. The effects of DWS toward monopole antenna were investigated through antenna parameters such as reflection coefficient, gain, directivity, efficiency and radiation pattern. Besides on antenna parameters, transmission coefficient of the DWS was also simulated and measured. The simulated results for example reflection coefficient, gain and radiation pattern were verified by measured results. The simulated S-Parameters results of DWS were also modelled. The equivalent circuit was used to model the stop band and pass band characteristics of simulated S-Parameters based on filter concepts in the Advanced Design System (ADS) software. Initially, both monopole antennas achieved wide bandwidth more than 8 GHz with two resonance frequencies around 3 GHz and 9 GHz. With the FR4 waveguide, the performances of monopole antenna were remained with slightly higher gain and directivity. Meanwhile, the monopole antenna with waveguide showed multiband in narrower bandwidth less than 5 GHz and significant high directivity more than 8 dB. DWS has been designed in single element, connected element and hybrid element. Generally, almost all the monopole antenna with DWS showed improvement on the gain and directivity with maximum enhancement achieved up to 4 dB. In the meantime, the wideband characteristics more than 8 GHz and efficiency more than –3 dB were presented. Both the resonance frequencies of monopole antennas were shifted slightly. The second resonance frequency shifted around 0.5 GHz when DWS was added on externally. Meanwhile, the performance of monopole antenna with DWS in connected element was slightly different compared to the others monopole antenna with DWS. Fluctuated reflection coefficient with higher gain more than 5 dB and directivity more than 7 dB was observed around 2 – 5 GHz. DWS designs improved the overall gain and directivity at the same time maintained the wideband characteristics and high efficiency of monopole antenna. The DWS could be used as a platform for the future communication system based on smart system technology.

ABSTRAK

Keperluan sistem komunikasi wayarles akan datang terhadap resolusi yang tinggi serta kadar data yang tinggi telah membuka ruang kepada penerokaan lebar jalur operasi ke tahap yang lebih tinggi. Untuk memenuhi permintaan ini, para penyelidik telah menitikberatkan kepada penggunaan antena jalur lebar untuk dipasangkan ke dalam satu sistem supaya dapat menyokong kesemua julat frekuensi yang dikehendaki. Antena ekakutub sering dianggap sebagai pilihan yang boleh dipertimbangkan kerana kos dan profil yang rendah bagi peranti mudah alih. Walau bagaimanapun, antena ini mempunyai gandaan yang lemah. Selain itu, struktur tidak sempurna telah direkabentuk pada satah bumi dan mikrojalur suapan sebagai struktur satah bumi tidak sempurna (DGS) dan struktur mikrojalur tidak sempurna (DMS). Namun, rekabentuk struktur tidak sempurna ini belum lagi direka pada pandu gelombang sebagai pandu gelombang tidak sempurna (DWS). Oleh itu, projek ini dilaksanakan atas tujuan untuk merekabentuk, mensimulasi dan membina antena ekakutub dengan DWS. Rekabentuk antena direka dengan menggunakan perisian CST Microwave Studio. Kesan DWS terhadap antena ekakutub dinilai melalui parameter antena seperti pekali pantulan, gandaan, kearahan, kecekapan dan corak sinaran. Selain daripada parameter antena, pekali penghantaran untuk DWS juga disimulasi dan diukur. Hasil simulasi seperti pekali pantulan, gandaan dan corak sinar disahkan dengan melalui proses pengukuran. Hasil simulasi bagi S-parameter DWS juga telah dimodelkan. Litar setara digunakan untuk memodelkan ciri-ciri jalur batas dan jalur lulus bagi hasil simulari S-Parameter berdasarkan konsep penapis melalui perisian Advanced Design System (ADS). Pada mulanya, kedua-dua antena ekakutub mencapai lebar jalur melebihi 8 GHz dengan dua frekuensi salun sekitar 3 GHz dan 9 GHz. Dengan pandu gelombang FR4, prestasi antena ekakutub masih dikekalkan dengan nilai gandaan dan kearahan yang lebih sedikit tinggi. Sementara itu, antena ekakutub dengan pandu gelombang menghasilkan berbilang lebar jalur dengan lebar jalur sempit yang kurang daripada 5 GHz dan kearahan yang tinggi melebihi 8 dB. DWS telah direkabentuk dalam bentuk unsur tunggal, bersambung dan hibrid. Secara umumnya, hampir semua antena ekakutub dengan DWS menunjukkan peningkatan gandaan dan kearahan dengan peningkatan maksimum dicapai sehingga 4 dB. Pada masa yang sama, ciri-ciri jalur lebar yang luas melebihi 8 GHz dan kecekapan melebihi –3 dB telah dihasilkan. Kedua-dua frekuensi salun antena ekakutub telah beranjak sedikit. Frekuensi salun kedua telah beranjak kira-kira 0.5 GHz apabila DWS disambung di bahagian luar. Sementara itu, prestasi antena ekakutub dengan DWS unsur bersambung adalah berbeza sedikit berbanding dengan rekabentuk yang lain. Pekali pantulan yang berubah-ubah dengan gandaan dan kearahan yang tinggi melebihi 5 dB dan 7 dB dapat diperhatikan sekitar 2 – 5 GHz. Rekabentuk DWS telah meningkatkan gandaan dan kearahan secara keseluruhan dan pada masa yang sama mengekalkan ciri-ciri jalur lebar dan kecekapan yang tinggi yang ada pada antena ekakutub. DWS boleh dijadikan sebagai asas bagi sistem komunikasi masa hadapan berdasarkan teknologi sistem pintar.

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