

**DESIGN OF COMPLEMENTARY FREQUENCY SELECTIVE SURFACE  
ON GLASS DESIGN FOR WIRELESS COMMUNICATION APPLICATION**

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**THIS REPORT IS SUBMITTED IN PARTIAL FULFILMENT OF  
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BORANG PENGESAHAN STATUS LAPORAN  
PROJEK SARJANA MUDA II

**Tajuk Projek** : DESIGN OF COMPLEMENTARY FREQUENCY SELECTIVE SURFACE ON GLASS DESIGN FOR WIRELESS COMMUNICATION APPLICATION

**Sesi Pengajian** : 

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Dedicate with love to my family members especially my beloved parents, Mr.  
Dahlan Bin Kasman and Madame Sanisah Binti Salleh

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## ABSTRACT

Modern houses use energy efficient building materials like metal shielding and energy saving windows to improve the thermal efficiency. Such energy efficient building materials creates the barrier for outdoor-to-indoor RF signals propagation which is one of the challenging problems in the field of cellular communication. One of the newer passive techniques which is operator independent and does not have additional network burden, is the use of complementary frequency selective windows.

Frequency selective windows consist of Frequency Selective Surface (FSS) etched on the metal coating of the energy saving windows, allowing cellular frequencies to pass through them while blocking the thermal radiation. FSS possess frequency selective behavior based on the element geometry. In order to improve the performance of FSS, Complementary approach has been used which it produce strong fields in the separation region. As a result, good angular and polarisation stability can be achieved

This thesis presents the modelling, simulation, fabrication and test measurements of the FSS that is transparent to GSM and UMTS frequency band. CFSS with a double circular ring patch and slot for front and back surface of glass as a unit cell is selected for the analysis. The modelling and simulation of the FSS are carried out in the Computer Simulation Technology (CST) microwave studio, 2012 version. CFSS prototype is fabricated using the commercial available aluminium tape. The objective of this project is to have transparency frequency for GSM and UMTS which have 900 MHz, 1800 MHz and 2100 MHz frequency.

## ABSTRAK

Rumah dan bangunan moden pada masa kini menggunakan bahan yang berkesan untuk membina bangunan seperti logam dan tingkap penjimat tenaga untuk meningkatkan kecekapan pengawalan haba. Tetapi bangunan yang menggunakan bahan yang bekesan dalam pengawalan haba akan menyebabkan gangguan kepada singal radio frekuensi dimana menjadi masalah untuk kepada komunikasi tanpa wayar untuk beroperasi. Satu teknik terbaharu yang mampu beroperasi secara sendiri dan tidak mendatangkan masalah sampingan yang di namakan tingkap dengan permukaan yang mampu menapis frekusni tertentu (FSS).

Tingkap dengan permukaan yang mamou menapis frekuensi tertentu ini di ukir pada permukaan tingkap yang mempunya salutan logam diatasnya, membenarkan frekuensi untuk perhubungan tanpa wayar untuk melalui tingkap tersebut di samping mampu menahan radiasi haba dari berlaku. Teknik ini mampu berfungsi untuk memilih frekuensi tertentu bedasarkan bentuk geometrinya. Bagi meningkatkan prestasi teknik ini, satu penambahbaikan telah dilakukan dengan menggunakan teknik permukaan yang mampu menapis frekuensi tertentu dengan permukaan yang lengkap (CFSS). Teknik ini mampu menghasilkan keputusan yang baik walaupun berada di medan yang berasingan. Hasilnya, kestabilan sudut yang baik dan polarisasi boleh dicapai

Projek ini membentangkan model, simulasi, fabrikasi dan ujian pengukuran FSS yang telus kepada jalur frekuensi untuk GSM dan UMTS. CFSS dengan dua patch dan slot yang berbentuk cincin untuk permukaan depan dan belakang kaca sebagai dipilih untuk analisis. Pemodelan dan simulasi FSS dijalankan di studio microwave Computer Simulation Technology (CST), 2012 versi. Pototaip CFSS direka menggunakan pita aluminium yang. Objektif projek ini adalah untuk mempunyai kekerapan ketelusan frekuensi untuk GSM dan UTMS yang mempunyai 900 MHz, 1800 MHz dan 2100 MHz frekuensi.



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**LIST ABBREVIATION**

2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
AuC	Authentication Centre
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BPL	Building Penetration Loss
BSC	Base Station Controller
BSS	Base Station Subsystem
BTS	Base Transceiver Station
CCH	Control Channel
CN	Core Network
CPCH	Common Packet Channel
CS	Circuit Switched
CST	Computer Simulation Technology

CFSS	Complementary Frequency Selective Surface
DAS	Distributed Antenna System
dB	Decibel
DCH	Dedicated Channel
DSSS	Direct Sequence Spread Spectrum
EGSM	Extended GSM
EIR	Equipment Identity Register
EM	Electromagnetic
ETSI	European Telecommunications Standards Institute
EU	European Union
FDD	Frequency Division Duplexing
FSS	Frequency Selective Surfaces
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile Switching Centre
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HLR	Home Location Register
HS-DSCH	High Speed Downlink Shared Channel
IMEI	International Mobile Equipment Identity
IPCC	International Panel on Climate Change
ISDN	Integrated Services Digital Network
LTE	Long Term Evolution
Mcps	Megachips per second
ME	Mobile Equipment