PASSIVE, ACTIVE AND ABSORBING FREQUENCY SELECTIVE SURFACES FOR WIRELESS COMMUNICATION APPLICATIONS

by

Ghaffer Iqbal Kiani

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MACQUARIE
UNIVERSITY

Department of Physics & Engineering

Faculty of Science

Macquarie University

Sydney, Australia

In the Name of Allah The Most Beneficent The Most Merciful

Dedicated to Almighty Allah and My Loving and Caring Parents

ABSTRACT

This thesis presents three topics related to frequency selective surfaces (FSSs), namely absorb/transmit FSSs, active FSSs and passive bandpass FSSs for energy-saving glass used in modern buildings. These three FSSs are unique in their design and functionalities. The absorb/transmit FSS is a novel dual-layer frequency selective surface for 5 GHz WLAN applications. This FSS can stop propagation of specific bands by absorbing as opposed to reflecting, while passing other useful signals. This is in contrast to the conventional Salisbury and Jaumann absorbers, which provide good absorption in the desired band while the out-of-band frequencies are attenuated. The second topic is a single-layer bandpass active FSS that can be switched between ON and OFF states to control the transmission in 2.45 GHz WLAN applications. Previously, researchers have focused on the bandstop and dual-layer versions of the active FSS. This is in contrast to the design presented in this thesis which is single-layer and provides extra advantage in a practical WLAN environment. Also the dc biasing techniques that were used for the active FSS design are easier to implement and provide good frequency stability for different angles of incidence and polarisations in both ON and OFF states. The last topic is on the use of a bandpass FSS in energy-saving glass panels used in building design. The manufacturers of these glass panels apply a very thin metal-oxide coating on one side of the glass panels to provide extra infrared (heat) attenuation. However, due to the presence of the coating, these energy-saving glass pan-

els also attenuate communication signals such as GSM 900, GSM 1800/1900, UMTS and 3G mobile signals etc. This creates a major communication problem when buildings are constructed with windows of this glass. In this thesis, a solution to this problem is presented by designing and etching a cross-dipole bandpass FSS on the coated side of the glass to pass the useful signals while keeping infrared attenuation at an acceptable level. One of the advantages of this FSS design is that measured material values of the metal-oxide coating are used for simulations, which have not been done previously.

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STATEMENT OF ORIGINALITY

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Signature:

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List of Abbreviations

AUD Australian Dollar

CST Computer System Technology

FSS Frequency Selective Surface

GPS Global Positioning System

GSM Global System for Mobile Communication

HFSS High Frequency Simulation Software

IR Infrared

PCB Printed Circuit Board

PEC Perfect Electric Conductor

RCS Radar Cross Section

TE Transverse Electric

TM Transverse Magnetic

VNA Vector Network Analyser

VSWR Voltage Standing Wave Ratio

WLAN Wireless Local Area Network

List of Symbols

Z_s = Surface Impedance

$\overrightarrow{E}^{inc}$ = Incident Electric Field

$\overrightarrow{E}^{scat}$ = Scattered Electric Field

$\overrightarrow{J_s}$ = Current Density

ϵ_r = Relative Permittivity

μ_r = Relative Permeability

ϵ_o = Permittivity in air

μ_o = Permeability in air

σ = Conductivity

λ_g = Guided Wavelength

λ_o = Free Space Wavelength

dB = Decibels

ω = Angular Frequency