شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

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التوثيق الالكتروني والميكروفيلم

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics and Communications Engineering Department

Low Frequency Meander Dipole Antenna for Ground Penetrating Radar (GPR)

A Thesis

Submitted in partial fulfillment of the requirements for the degree of

Master of Science in Electronics and Communications Engineering

Submitted By

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Bachelor of Science in Electrical Engineering
Electronics Engineering and Electrical Communications
Faculty of Engineering, Ain Shams University, 2021

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STATEMENT

This Thesis is submitted to Ain Shams University for the degree of Master of Science in Electronics and Communications Engineering.

The work included in this thesis was carried out by the author at the Electronics and Communication Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt

No part of this thesis was submitted for a degree or a qualification at any other university or other scientific entity.

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ACKNOWLEDGEMENT

Thanks God for a lot of merits that led to successful completion of this work.

I would like to express my most sincere gratitude to my supervisors

Dr. Angie Reda Eldamak and Prof. Dr. Hani Amin Ghali for their guidance, support and encouragement. Their vast experience and deep understanding of the subject proved to be immense help to me, and also their profound view – points and extraordinary motivation enlightened me in many ways. I just hope my thinking and working attitudes have been shaped according to such outstanding qualities.

I would like to thank my family, mother, father and wife, I would like to present this work for you, without your support I would not have accomplished.

Last but not least, I want to thank all my friends and colleagues for their support and sharing the wonderful times during the past years.

ABSTRACT

Mohammed Saber Ismail Gomaa

Low Frequency Meander Dipole Antenna for Ground Penetrating Radar (GPR),

Master of Science, Ain Shams University, 2021

In this thesis, low frequency antennas for Ground Penetrating Radar (GPR) systems operating at frequency below 200 MHz are developed. The thesis presents design, analysis, fabrication and measurements of all proposed designs. Measurements include reflection coefficient (S_{11}), input impedance (Z) as well as radiation patterns using a homemade setup in the VHF band.

First, printed Meander dipole antenna operating at 73 MHz and 145.75 MHz is presented. The dual band dipole antenna is composed of meander line terminated with a stub. The proposed antenna is implemented on FR4 substrate with an overall size of 61.3 X6.45 cm^2 ($0.15\lambda_o$ x $0.015\lambda_o$). A 70% reduction in length is realized with the proposed antenna design compared to a regular dipole operating at the lower band (73 MHz). The reflection coefficient for the measured antenna is -15 dB and -18.5 dB at 73 MHz and 145.75 MHz with bandwidth of 2 MHz and 6.6 MHz, respectively. The antenna exhibits omnidirectional radiation characteristics at both bands with simulated radiation efficiency up to 87%.

Second, the printed meander dipole antenna acquires enhanced -10 dB bandwidth of 20 MHz (13%) compared 6.6 MHz (4.5 %) in the VHF band. Bandwidth enhancement is realized through two techniques; 1) resistive loading to the meander line, and 2) metal strips at the back side acting as capacitive loading. A parametric study is implemented for the position, values of the resistors and the dimensions of the metal strips to realize maximum bandwidth. Using resistive loading, the bandwidth is increased from 6.6 MHz to 12 MHz with efficiency 42 %. On the other hand, adding two metal strips further increases the bandwidth to 20 MHz with efficiency up to 56%. The antenna exhibits omnidirectional radiation characteristics over the operating frequency 140-160 MHz.

Finally, all proposed structures are fabricated, measured and compared to simulated results Measurements are in good agreement with simulation results. Moreover, measurements and simulations for the proposed antennas in proximity to soil as well as with buried objects are also presented

Key words: Ground Penetrating Radar (GPR) – Meander antenna- Low frequency- VHF band

SUMMARY

Ground Penetrating Radar (GPR) systems are commonly used as methods for the detection of underground objects. GPR is used in a range of applications such as borehole inspection, archaeological investigations, building condition evaluation, bridge deck examination, landmine detection (anti-personnel and anti-tank) and reinforced concrete assessment, geophysical investigations, pipes and cable detection.

GPR's core configuration is the transmitter, receiver and signal processing The transmitter decides the types of targets that can be detected; depends on the resolution and depth of penetration, lower or higher bands are required.: (0.01–2 GHz) in architecture and archaeology, (0.5–3 GHz) in military, (1–10 GHz) in medicine. In a GPR system, antennas (transmitting or receiving antennas) are one of the most critical components of this system. In order to achieve a fine resolution and a reasonable penetration depth for a portable GPR, the antenna must have wide bandwidth, good impedance matching, and high gain in addition to small or compact size.

In this thesis, a Low frequency meander dipole antennas for Ground Penetrating Radar (GPR) system with reduced size and wide band are presented. The structure is constructed on a 613 x64.5 mm^2 FR4 dielectric substrate. The antenna's bandwidth is enhanced by using loading resistance method and two metal strip while the size is decreased by using meander tecqunique. The operational bandwidth of this antenna extends from 6 MHz to 20 MHz. The minimum return loss -14 dB. The average Radiation efficiency is between 26%-54%. The antenna performance was simulated and fabricated. The performance was measured. Good agreement was found between simulation and experimental results.

Table of Contents

List of FIGURES