

**CHARACTERIZATION OF FRINGING ELECTRIC FIELD SOIL  
MOISTURE SENSOR TO MEASURE VOLUMETRIC WATER  
CONTENT (VWC)**

This project is presented in partial fulfillment for award of the  
**Bachelor of Electrical Engineering (Hons) in Electronic Engineering**  
**UNIVERSITI TEKNOLOGI MARA (UiTM)**  
**SHAH ALAM, MALAYSIA**



MUHAMMAD ZAID B. MA'RIFFIN  
FACULTY OF ELECTRICAL ENGINEERING  
UNIVERSITI TEKNOLOGI MARA  
40450 SHAH ALAM,  
MALAYSIA  
JULY 2012

## ACKNOWLEDGEMENT

“In the name of Allah, the Most Gracious and the Most Merciful”

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. This dissertation would not have been possible without the guidance and the help of several individuals who in one way or another contributed and extended their valuable assistance in the preparation and completion of this research.

First and foremost I would like to express my sincerest gratitude to my supervisor, En Azrif Manut, who has supported me throughout my thesis with his knowledge and his excellent guidance. His invaluable help of numerous comments, criticisms and suggestion during the preparation of this project are gratefully praised. Mostly for his patience on any problem that occurred during the thesis is invaluable and appreciated. I attribute the level of my Bachelor degree to his encouragement and effort and without him this thesis, too would not have been completed or written.

I also would like to thank to all my friends that gives supports and helping me for finishing the thesis. Their support and help always give motivation and energy for me to finish the thesis. My appreciation also goes to all academic and non-academic member included the technician of the Faculty of Electrical Engineering for their co-operation during my stay in Universiti Teknologi Mara.

Last but not least, my deepest gratitude goes to my beloved parents; Mr. Ma'riffin B. Samsudin and \_\_\_\_\_ for their endless love, prayers and encouragement. They were always supporting me and encouraging me with their best wishes. Without them guidance, support, encouragement and advises, I may never have overcome this long journey in my studies.

Finally, to those who indirectly contributed in this research, your kindness means a lot to me. For any errors or inadequacies that may remain in this work, of course, the responsibility is entirely my own. Thank you very much.

## **ABSTRACT**

This project aims to research and analyze design of fringing electric field (FEF) soil moisture sensor. Fringing electric field (FEF) sensors are usually used to detect the presence of a material or estimate the concentration of a material. Regarding to their principle, fringing electric field (FEF) sensors can be used as a tool in agriculture field to monitor volumetric water content (VWC) of soil. There are no standard analytical models for FEF sensors. The design parameters such as sensor geometry affect the performance of fringing electric field (FEF) sensors. This research concentrate to the effect of the electrode width, number of electrode and whether there have or no ground. The FEF sensors are simulated using Finite Element Method Magnetic (FEMM). Based from the simulation results, selected design of the FEF soil moisture sensors have been fabricated using printed circuit board, PCB technology. The actual test is done by measure the capacitance value using LCR meter. Test results obtained are then compared with FEMM simulations. The comparison proves that the addition of shielding electrodes and ground electrode at the backplane can improve the penetration depth of FEF sensors. The increasing number electrode, small gaps between electrodes and small electrode width make the sensor more sensitive to presence moisture.

# TABLE OF CONTENTS

CHAPTER	LIST OF TITLE	PAGE
	APPROVAL	I
	DECLARATION	II
	ACKNOWLEDGEMENT	III
	ABSTRACT	IV
	TABLE OF CONTENTS	V
	LIST OF FIGURES	VIII
	LIST OF TABLES	X
	ABBREVIATIONS	XI
	INTRODUCTION	
1.0	1.1 Introduction (Background of Study)	1
	1.2 Problem statement	3
	1.3 Project Objective	4
	1.4 Scope of Work	4
	1.5 Thesis Organization	5
	LITERATURE REVIEWS	
	2.1 Introduction	6
	2.2 Volumetric Water Content	6
	2.3 Direct Method	7
	2.3.1 Volumetric Method	7
2.0	2.3.2 Gravimetric Method	8
	2.4 Indirect Method	9
	2.4.1 Tensiometer	10
	2.4.2 Gypsum Block Resistance	11
	2.4.3 Neutron Meter	12
	2.4.4 Pressure Membrane	13
	2.4.5 Others Method	14

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 BACKGROUND OF STUDY**

Agriculture is the industry or practice of humans purposefully growing crops or raising livestock for the production of foodstuffs that they can consume directly, they can consume after some process, or they can feed to other livestock/organisms that can themselves be consumed directly or through some process. The real meaning of agriculture is the growing of crops and rearing of animals that are useful to man. The history of agriculture field start a long time ago which at that time all work is done manually. The works include all steps of the crop production and ranging process, including planting, fertilizing, harvesting, and herding. Nowadays technological improvements have sharply increased yields from cultivation. The machine help human in all process including planting, fertilizing, harvesting and also improves in irrigation system. In agriculture field, management of irrigation system is important to ensure plant growth is health and free from diseases. Irrigation is the non-natural application of water to the land or soil [18]. It is used to assist in the growing of agricultural crops. Irrigation water management requires timely application of the right amount of water. Managing irrigation water needs to combine a method of measuring soil moisture with some method of irrigation scheduling.

In order to monitor soil moisture, it is important to know soil type and soil texture to better understand available water capacity for the plant or crop and field capacity. Measurement of soil moisture is to detect whether there is a water shortage that can reduce yields or if there is excessive water application that can effect in water logging or leaching of nitrates below the root zone [8].