SINGLE-SUPPLY READOUT INTERFACING CIRCUIT FOR EXTENDED-GATE FIELD EFFECT TRANSISTOR pH SENSING SYSTEM WITH DATA LOGGER

MOHAMAD FAISAL BIN AZLAN

FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITI TEKNOLOGI MARA
MALAYSIA

ACKNOWLEDGEMENT

In the name of Allah,

The Most Gracious and the Most Merciful.

Praise to Allah, Lord of the Universe

Alhamdulillah, first and foremost, I would like to thank our Creator for giving us a still functioning body and mind in order to live, life and learn, and particularly to work on my Final Year Project.

I would like to express my deepest gratitude to my project supervisor, Miss Ili Shairah Abd Halim and also Dr. Sukreen Hana Herman and Dr. Wan Fazlida Hanim Abdullah as a project co-supervisors, for their excellent guidance, caring, patience, and providing me with an excellent atmosphere for doing this project. This project would not have been possible to complete without their support and guidance.

Deepest thanks and appreciation to my parents, family and others for their cooperation, encouragement, constructive suggestion and full of support for the project completion, from the beginning till the end.

Besides, I would like to thank the authority of UiTM and Faculty of Electrical Engineering for providing us with a good environment and facilities to complete this project. Last but not least, to those who indirectly contributed in this assignment, your kindness means a lot to me. Thank you very much.

ABSTRACT

A single supply readout interfacing circuit (ROIC) for an extended gate field effect transistor (EGFET) pH sensor has been developed. The ROIC is used to capture the changes in the potential between a reference electrode and an extended-gate coated with sensing membrane. The potential changes are due to the differences in the ionic activities in different pH buffer solutions. The extended gate is connected to the gate of a commercialized MOSFET. Due to the small current and instability of reading produced by the sensing membrane, the ROIC is needed to obtain and stabilize the generated voltage. A constant voltage constant current (CVCC) circuit was applied in the ROIC with a drain-source voltage of 0.50 V and operates in the linear region at 330 μA drain current, using a single supply. The output of the ROIC is fed to a microcontroller to display the pH level and data logger to allow drift measurement for the sensor characterization. Based on the previous ROIC design and system, a dual supply operational amplifier is used and will produce negative output which is not compatible with microcontroller interfacing thus need extra hardware to be interfaced with microcontroller. Also, the previously proposed system can only do limited sensor characterizations and there is a need to have a system that can support in-depth sensor characterizations. Therefore, the aim of this research is to design a single supply ROIC for Extended-Gate Field Effect Transistor and to equip the system with data logger and design a graphical user interface (GUI) application using Visual Basic software for in-depth sensor characterizations. The developed circuit and system proved that it was able to capture the voltage changes and was able to be applied in measuring pH buffer solutions for pH 4, 7, and 10. The data from the data logger was controlled by a GUI developed using Visual Basic and drift and hysteresis measurements were successfully carried out.

Index Terms— Single source, ROIC, CVCC, data logger, EGFET pH sensor

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In this chapter, the general overview of the project will be explained and described. The appropriate techniques and methods used in the project and the expected overall performance will be explained. Besides that, the problem statements and several objectives will be stated. Moreover, the scope of the project work and the organization of the project report are also included in this chapter.

1.2 PROJECT BACKGROUND

Generally, sensor is a device which can detects the changes of some type of input from physical environment. The specific input could be pressure, heat, moisture, heat, motion, concentration, or anything that vary and can be measured. The output of the sensor normally is in electrical or optical signal. Sensors can be divided into a many types of sensor which are used in many kinds of application. For example, oxygen sensor in a car, motion sensor in home security system, biosensor in food industries and many more. Some sensors need to be interfaced with interfacing circuit to produce and output response and some are not. Usually, a sensor that produced a very small current and not stable needs an interfacing circuit in order to capture the response produced by the sensor.

Extended gate field effect transistor is an electrochemical sensor which detects the hydrogen ion concentration in a solution (pH) and gives the output response in electrical signal. Unfortunately, this sensor need an interfacing circuit to detects the output of this sensor since it only produced a small current and unstable. Apart from that, the sensor itself need to be characterize. For example the sensitivity, reliability and stability of the sensor need to be achieved before it can be labelled as a good sensor. In order to do that, the sensor has to be tested in a certain period of time to test its reliability and stability.