Sudan University of Science and Technology

College of Engineering

School of Electronics Engineering

Design and Implementation of Measurement Instrument Using Microcontroller

A Research Submitted In Partial fulfillment for the Requirements of the Degree of B.Sc. (Honors) in Electronics Engineering

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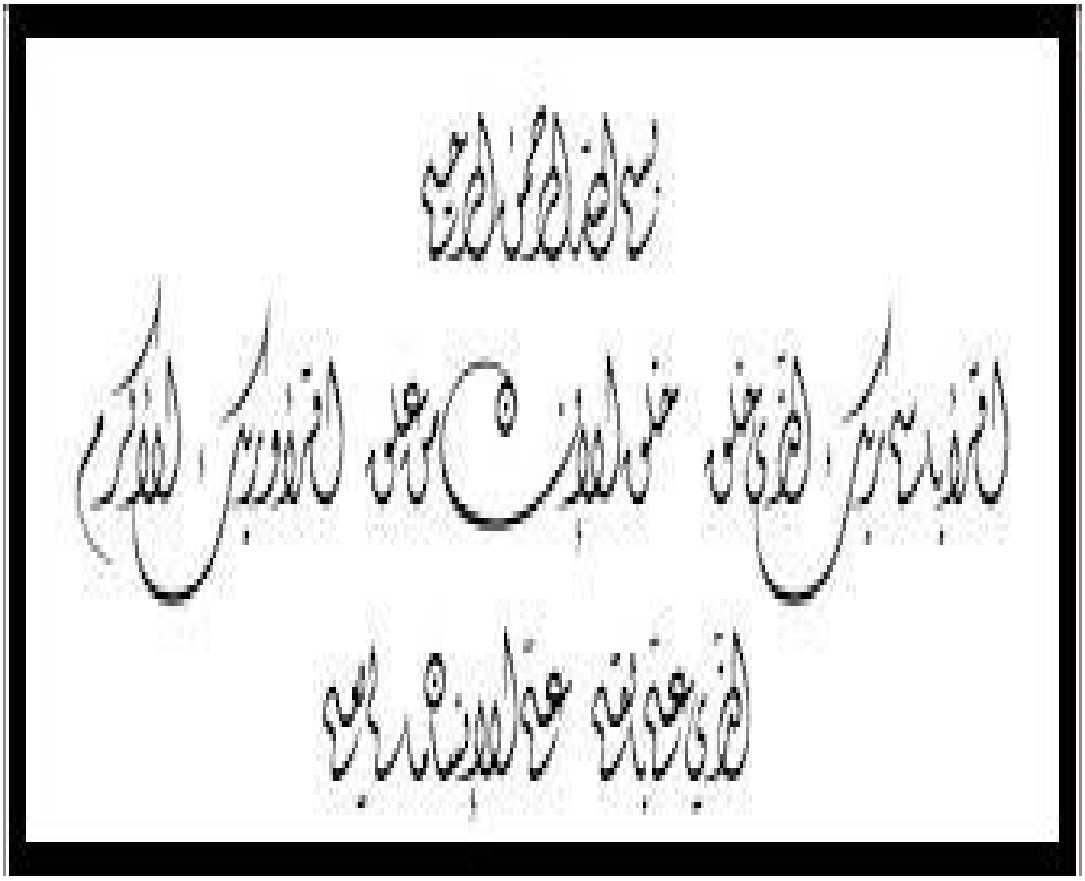
الآيه الكريمة



Dedication

To our beloved families, caring friends, and devoted teachers.

We thank you dearly for all that you have done for our education and well being. All of our successes hereafter we attribute to you.

ACKNOLWLEDGEMENT

Foremost, we would like to express our sincere gratitude to our supervisor Mr. Musaab Mohammed Salah Elhassan for the continuous support of our study and research. We are deeply indebted to Ms. Mayada Abdelgadir Mohammed for her invaluably constructive criticism and advice during the project work.

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ABSTRACT

In this research, the designed system is implemented to measuring voltage, current, resistance, frequency, and temperature measurement, based on a PIC microcontroller. The main theories for designing this system revolve around using rearrangements of Ohm's law for measuring the three basic electric properties: voltage, current, and resistance, along with voltage dividers for extending measurement range.

Temperature sensing is achieved by connecting an LM35 sensor to an ADC pin and measuring its voltage output. Frequency measurement is achieved by using the built-in counter directly to count signal pulses that occur in a unit time with no need for additional conversion circuitry. All measurement results are displayed on an alphanumeric LCD.

Microcontroller program coding was done by using MikroC compiler, and then Proteus simulation environment was used to simulate the system prior to physical programming on hardware.

المستخلص

في هذا البحث، تم تصميم وتطبيق نظام لقياس الجهد، التيار، المقاومة، التردد، ودرجة الحرارة اعتمادا على متحكم دقيق.

النظريات الأساسية لتصميم هذا النظام تدور حول إعادة ترتيب قانون أوم لقياس ثلاثة خصائص كهربائية أساسية: الجهد، التيار والمقاومة، مع مقسم جهد لتوسيع نطاق القياس.

ويتم تحسس درجة الحرارة من خلال ربط جهاز تحسس LM35 إلى الطرف المحول من تماثلي إلى رقمي وقياس خرج الجهد لها. ويتحقق قياس التردد مباشرة بإستخدام العداد المدمج لحساب نبضات الإشاره التي تحدث في وحدة الزمن، دون استخدام دوائر التحويل إضافية. يتم عرض كافة نتائج القياس على أبجدية شاشة العرض.

تم كتابة برنامج المتحكم باستخدام المترجم mikroC ، واستخدمت بعد ذلك بيئة المحاكاة (Proteus) لمحاكاة النظام قبل البرمجه الفعلية على الأجهزة.

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INTRODUCTION

1.1 Preface

Measurement is the assignment of numbers to objects or events. A measurement has two major criteria values: magnitude and uncertainty. These values enable comparisons to be done between different measurements and reduce confusion. [1]

A multimeter is an electric device that can measure various properties of physical quantities of electric components and current. They are basically digital voltmeters that contain several conversion circuits that allowing different measurement such as voltage, current and resistance within one instrument.

Traditionally, electric measurement devices were built on electro-mechanical and analog circuits that were generally imprecise, and required regular calibration to insure acceptable level of accuracy. Moreover, these analog devices had high cost and were generally heavy in weight, making portability difficult.

With the advent of integrated circuits, digital electronic measurement devices replaced analog ones due to their numerous advantages. Additionally, they provide ease of integration of multiple functions within one relatively small device. Digital multimeters have been developed to satisfy the need for higher measurement accuracy and a faster speed of response to voltage changes than that which can be achieved with analog instruments.

The aim of this project is to build a versatile, low cost, high precision digital multimeter using microcontrollers.

1.2 Problem Statement:

There is a need for versatile measurement instruments for electric components and signals that can provide accuracy and flexibility in choice of measurement functions.

1.3 Proposed solution:

To develop a measurement system based on microcontroller technology, taking advantage of microcontroller's ability to connect with various chips and components that aid in the measurement process, its precision of calculation, rapid response and ease of implementation.

1.4 Objectives:

- To identify physical principles to be used for measurements and related equations for each type of measurement.
- To design simulation code for each measurement function, and test it in software.
- To build the physical circuit according to the simulation circuit, while minimizing component cost.
- To test and calibrate the hardware implementation for measurement accuracy.

1.5 Methodology:

The design principles are based on the natural laws of physics regarding electrical circuits, namely, Ohm's law and various rearrangements thereof, in order to measure the different electrical

quantities. The proposed design coded and compiled with MikroC and is then simulated in Proteus simulation environment, to insure that it conforms to the microcontroller's specification. After wards, the design is implemented in hardware, while being calibrated in software to account for errors.

1.6 Research Outlines:

- Chapter 2: General overview of microcontrollers and discusses their typical structure.
- Chapter 3: Principles and basic theory regarding the design of the system.
- Chapter 4: Details the simulation circuit and describes hardware implementation
- Chapter 5: Conclusion and recommendations