

To Measure Dielectric Constant of Liquid By Using PIC Microcontroller

Prof.P.K.Ghuge¹, Prof.N.R.Kolhare²

¹Department of ETC, P.E.S.college of Engineering Aurangabad,Maharashtra,(India)

²Department of ETC, Government college of Engineering Aurangabad,Maharashtra ,(India)

ABSTRACT

A dielectric constant measurement setup has been developed to measure dielectric constant of liquids using PIC16F877A microcontroller. A modified operational amplifier based Wheatstone bridge network is used to compute resistance and hence calculate dielectric constant of liquids. This instrument system permits recording of dielectric constant of liquids at atmospheric temperature. Further, an LCD module is interfaced with the microcontroller to display temperature and dielectric constant. Software is developed in C using Ride's C-cross compiler. The dielectric constant is measured with the standard calibration unit and determines the percentage error in the measurement of prior to the actual measurement. The system is quite successful in the measurement of dielectric constant in liquids with an accuracy of +0.2%.

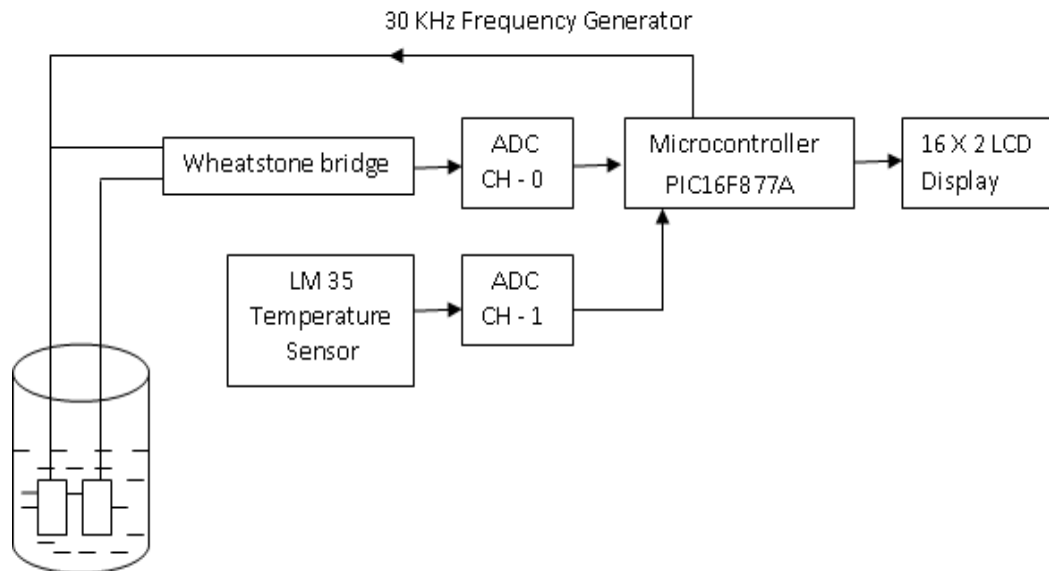
Keywords : *Dielectric constant, PIC16F877A microcontroller, Wheatstone bridge network, Wheatstone bridge network ,etc.*

I. INTRODUCTION

As every dielectric have its own property and its own design. These properties have helped them in getting valuable information which could help improve the quality of-an application or to design a manufacturing process. The response of a measurement at the electric, atomic, molecular and microscopic at the electric field constitutes its dielectric properties. According to the requirements of the electrical and electronics industries and the quality standard of their products, the new insulating materials are manufactured by petrochemical and polymer industries. But the current system available is not so convenient and is costly and difficult to implement. To present a prototype for measuring the dielectric constant of liquid, a protocol is designed using PIC16F877A microcontroller. The system proposed in this work measures dielectric constant of liquid using Wheatstone bridge network and is mainly a process of understanding the dielectric constant of liquid to meet in one hand goal of miniaturization, low cost and portability and which measure dielectric constant of liquid and temperature in air.

II. SYSTEM MODEL

1. Block Diagram



1. Parts of the System

Liquid sensor

Wheatstone bridge

Analog to digital converter

PIC16F877A microcontroller

Temperature Sensor

Liquid crystal Display (LCD)

2. Working

The block diagram contains PIC16F877A microcontroller which controls all components working on PCB we have interfaced LM 35 temperature and liquid sensor to the controller. 12 V battery is given for power supply and some component requires only 5V for working and some required 12 V. Copper plates are used as a liquid sensor, the size of that copper plates are 10 x 25 mm and distance between that plates is 5mm. By using Wheatstone bridge we find unknown resistance of liquid and then finding capacitance of liquid by using formula $C = 1 / R f c$ and then calculate the dielectric constant of liquid by using formula

$$\epsilon_r = C \times d / (\epsilon_0 \times A)$$

ϵ_0 = Permittivity of free space = 8.85×10^{-12}

C = Capacitance of liquid

d = Distance between two plates

A = Area of plate

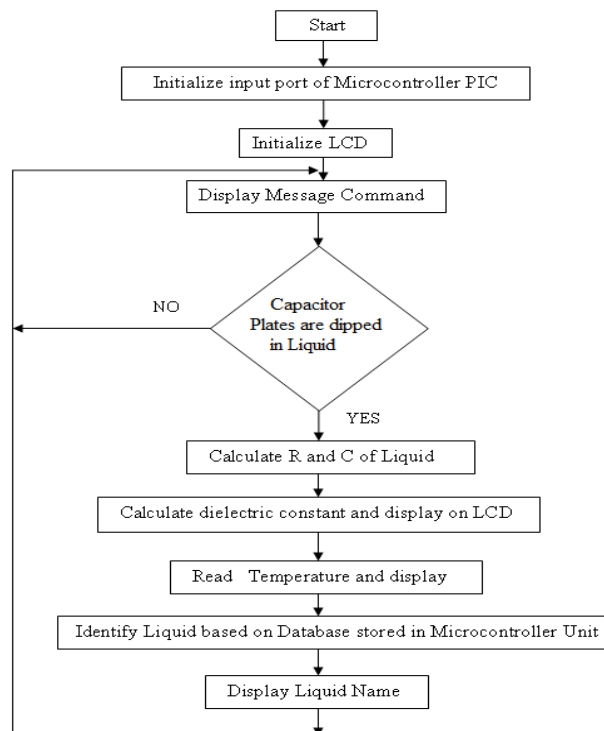
By using 16 * 2 LCD display dielectric constant and atmospheric temperature is displayed.

In the circuit microcontroller IC PIC16F877A (U1) is taken. A crystal of 4 MHz is connected to pin No.13 and 14 of U1. Capacitor C1 and C2 of 33pf each are connected to two pins of crystal(y) these capacitor are used to provide ground coupling of crystal terminal and to provide stable ground reference. A reset resistance R12 of 10KΩ is connected to reset pin No.1(MCLR) of micro controller. This resistance is pulled up to worth micro controller satisfactory since this pin is active low. Pin 11 and 32 are connected to Vcc = 5V and pin 12 and 33 are ground pin's .Whetstones bridge network with resistance 10KΩ are connected .Unknown resistance of bridge i.e. Resistance of Liquid dielectric need to be calculated, this unknown resistance terminals are connected to 2pin header P11 output of bridge is given by micro controller pin 5 i.e. RA3. Input of bridge is connected to pin RC) and RC1 of micro controller which gives supply with frequency to the bridge network.

16 X 2 LCD display P5 is connected to microcontroller U1. Data pins of LCD D0 - D7 are connected to B0 to B7 pin of U1. Control pins RS,RW,EN pins of LCD i.e. pin,4,5,6 are connected to microcontroller pin 28,29,30 i.e. RD5,RD6,RD7

Power input to PCB are given through header P9 diodes D1-D4 (1N4007) are connected to form bridge rectifier to rectify input signal. Filter capacitor C3 of μf 50 V is connected to filter noise signals and gives input to regulating for 7805 (U2) to provide fixed 5 V output remaining circuit .Capacitor (Ceramic) C4 and C5 of 0.1 μf each are connected to provide common ground reference to input and output .Resistance R13 of 14 is connected to led 25 for power indication P10 Header is connected to have Vcc and GND supply out from Board.

4. Design Implementation Flow Chart



III.HARDWARE DESCRIPTION

1. Power Supply

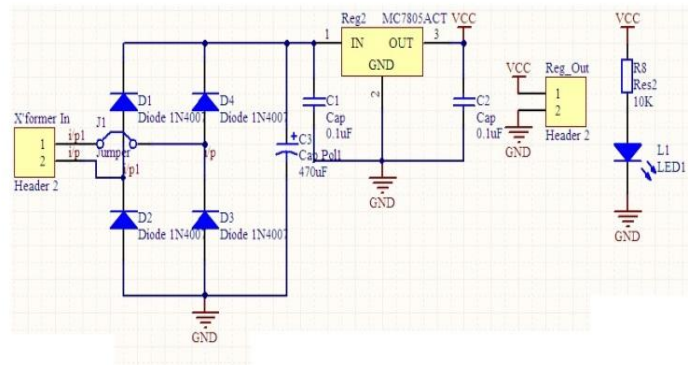


Figure 1 : Block diagram of a power supply

Figure1 shows the block diagram of a typical power supply. The DC mains are provided through battery to get the required voltage at the secondary .Then it is applied to the bridge rectifier, which converts the sinusoidal input into full wave rectified output.

2. PIC 16F877A Microcontroller

This is a CMOS FLASH based 8 bit, 40 pin microcontroller. It has five I/O ports. The PIC16F877A feature 256byte of EEPROM data memory,self-programming,2comparators,8 channels of 10 bit Analog to Digital (A/D) converter ,2 capture/comparator/PWM functions, the synchronous serial port can be configured as either 3 wire Serial Peripheral Interface or the 2 wire Inter –Integrated circuit bus and a Universal Asynchronous Receiver Transmitter(USART).

3. Liquid Crystal Display

A 16 X 2 alphanumeric LCD is used which displays the number of units of energy consumed. To display the information on LCD, the microcontroller has to sent its ASCII value to the data pins of the LCD.

4. Temperature Sensor

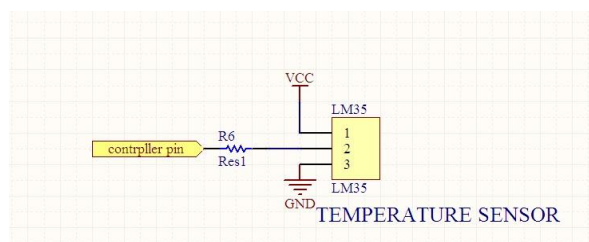
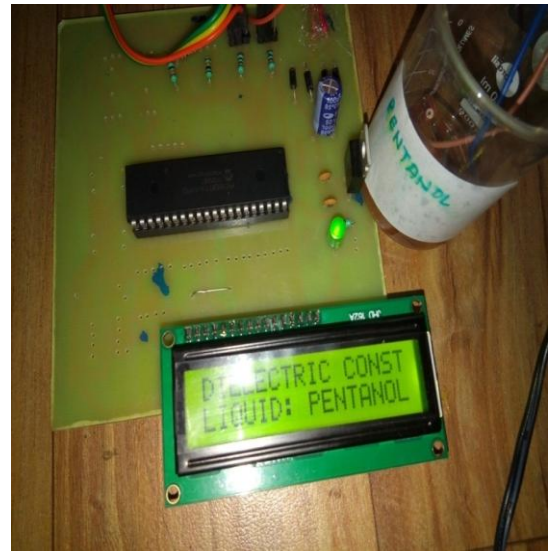


Figure2 : Block Diagram of a Temperature Sensor LM 35

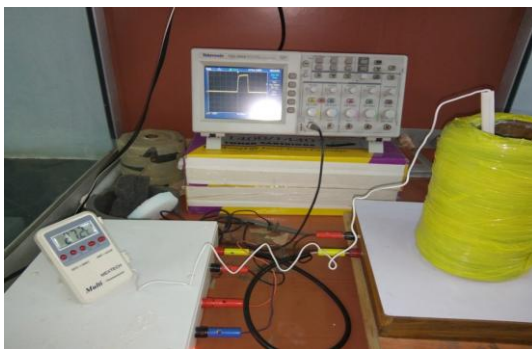
Temperature sensor LM 35 is to measure the atmospheric temperature. The 10 bit analog to digital converter in PIC16F877A microcontroller converts the analog output from the sensor to corresponding digital signal. The LM 35 series are precision integrated –circuit temperature sensors, whose output voltage is linearly preoperational to the Degree Celsius (Centigrade) temperature.

IV. TESTS AND RESULTS

1. System Photographs



2. Calibration System Unit



V. RESULT ANALYSIS

Liquid	Ideal Value	Calibratation Unit	Practical value
Propanol	20.33	22.576	23.72
Pentanol	14.8	15.08	15.15
Butanol	17.8	17.98	18.3
Ethanol	24.3	24.877	25.94
Chlorobenzen	5.62	6.39	6.87
Bromobenzen	5.17	5.97	7.24

Table 1: Evaluation Table of Dielectric Constant Measurement of Liquid

VI. ADVANTAGES

1. Recolonization of any liquid base becomes easier.
2. Different frequency can be generated for different application.

3. Designing a capacitor of determined value is possible. Determining the value of dielectric constant tells the breed of the liquid.

VII. CONCLUSION

The basic aim of project is to monitor dielectric constant of the unknown liquid for knowing its nature so in order to clarify the concentrating need required for polymers used in different industries and different frequency generation ability of the liquid by means of its dielectric constant. By knowing the value of dielectric constant it become easy to produce a specific value of capacitor.

The hardware and software feature of a PIC microcontroller based system for the measurement of dielectric constant in liquids are described software is developed in Embedded C. The system is quite successfully for the measurement of dielectric constants in liquids with an accuracy of ± 0.2 . The measurement of dielectric constant; over a wide range is a special feature of the present study.

VIII. ACKNOWLEDGEMENTS

Completion of my dissertation is a task which would have not accomplished without cooperation and help from guide. I am fortunate to have the opportunity to work under the guidance of **Prof.N.R.Kolhare**, Department of Electronics and Telecommunication Engineering. The work could not be completed without the extended cooperation of **Dr.P.W.Khirade**, Department of Physics, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad who allowed me to utilize standard calibration unit of their lab. The journey could not have been possible without the blessings of my family I express my sincere thanks to them. And at the last I would like to thank to those who I am not able to recall.

REFERENCE

- [1.] A. Rajendran, P. Neelamegam "Sensors & Transducers Magazine", ISSN 1726-5479-Vol.41, Issue 3, March 2004, pp.181 – 190.
- [2.] Ch. V. V. Ramana, K. Malakondaiah "Instrumentation Science & Technology" ISSN 1073-9149, vol- 35: 599–608, Oct 2007.
- [3.] Narayana K. V. L and Bhujanga Rao A. "Sensors & Transducers Journal" ISSN 1726-5479- Vol. 139, Issue 4, April 2012, pp. 141-151.
- [4.] S.C. Bera, S. Chattopadhyay and J.K.Roy, A Modified approach to the Measurement of capacitance of a capacitive transducer by an AC Bridge network, IE (I) journal-EL, 2002, Vol.82, pp 250-252.
- [5.] Wheatstone, Ch., An account of several new instruments and processes for determining the constants of a voltaic circuit. Phil. Trans. Roy. Soc. Bd. 133(1843), S. 303/327.
- [6.] XR-2206 function generator chip Datasheet, Exar; the Analog Plus Company, 1997.
- [7.] T. T. Grove, M. F. Masters, and R. E. Miers, Am. J. Phys., Vol. 73, No. 1, January 2005.
- [8.] D. V. S. Murthy, Transducer and Instrumentation, *Prentice-Hall*, New Delhi, India, 1995.