DESIGN AND DEVELOPMENT OF LIQUID IMPEDANCE ANALYZER IN dsPIC MICROCONTROLLER

[1]Vikash Mishra, [2]Harish Kumar Maheshwari, [3]Ashish Jaiswal
[1]Department of Electronics and Communication Engineering,
[1]Jaipur Engineering College and Research Center, Jaipur, India
[2, 3]Department of Electrical and Electronics Engineering
[2, 3]Rajasthan Institute of Engineering and Technology, Jaipur

Abstract- *Liquid impedance measurement is one of the most important parameter for detecting the diseases in the blood or fuel impurity. The Impedance of the liquid is measure with the help of IC AD5934. The AD5934 is a high precision impedance converter IC. This chip can be configured and controlled by a dsPIC microcontroller 30F6014. The Real and Imaginary values are processed by microcontroller and results are sent to computer using UART. User is able to set various frequencies using computer. This Liquid Impedance Analyzer instrument can also be used for various impedance analysingapplications.*

Keyword: LIA, dsPIC, UART, DFT.

I. INTRODUCTION

Electrical Liquid Impedance Analyzer (LIA) technology measures electrical properties of Liquid by means of applying electrical current or voltage to the whole Liquid or regions of interest, sensing corresponding voltage or current and manipulative the impedance by using Ohm's law. The main aim of the system is to provide the complete spectrum of liquid impedance from frequency range of 10Hz to 100 KHz. It is commonly used in biomedical applications, Liquid property analysis, impedance spectrographic and many more to count. It has proved to be very likely in detecting diseases in blood and impurities in milk that has great social effect. Each liquid has some impedance and by measuring the change in impedance, we come to know about the impurities as they cause the change in the liquid.

II. METHODOLOGY

This Development is all about spectral analysis of liquids that uses impedance measurement tool. The AD5934 IC is used to measure the impedance of the liquid. The frequency generator allows an external complex impedance to be excited with a known frequency. The red dot electrodes are connected among the input and output ports. The current in response to the impedance is Converting into voltage by an impedance amplifier. The response signal from the impedance is sampled through the on-board ADC and a discrete Fourier transform (DFT) is managed by an on-board DSP engine. The DFT algorithm returns a real (R) and imaginary (I) data-word on each output frequency. These values are compared with the obtained results from a recognized precise resistance using the similar configuration on the signal path. The genuine impedance value can be calculated from the recognized resistance together with the above measured results. This system is based on a microcontroller, high precision and low power device. Due to the simple assembly, it can be made equally a portable impedance measurement device, which is used in Liquid impedance analysis. The AD5934 produces a small current 800 µA at a fixed frequency 100 KHz which is passed among two electrodes dip into the Liquid and the voltage drop between two electrodes provides the measurement of impedance. Impedance signals from liquid are acquired by AD5934 and those signals are analysed using dsPIC. This Result is shown on the computer using the UART Port.

MEASURING THE IMPEDANCE

The AD5934 is capable of measuring Liquid impedance values through providing the real and imaginary values. The magnitude of the real and imaginary data contents is set by the equation number1:

$$Magnitude = \sqrt{R^2 + I^2} \quad (1)$$

To determine the genuine impedance value, the microcontroller multiplies magnitude with Gain Factor GF. The Gain Factor is the ratio of the output voltage to Input voltage measured using known external impedance connected between output voltage and Input voltage. The Impedance of the Liquid analyzer is given by following Equation

$$Impedance = \frac{1}{Magnitute * GainFactor} \quad (2)$$

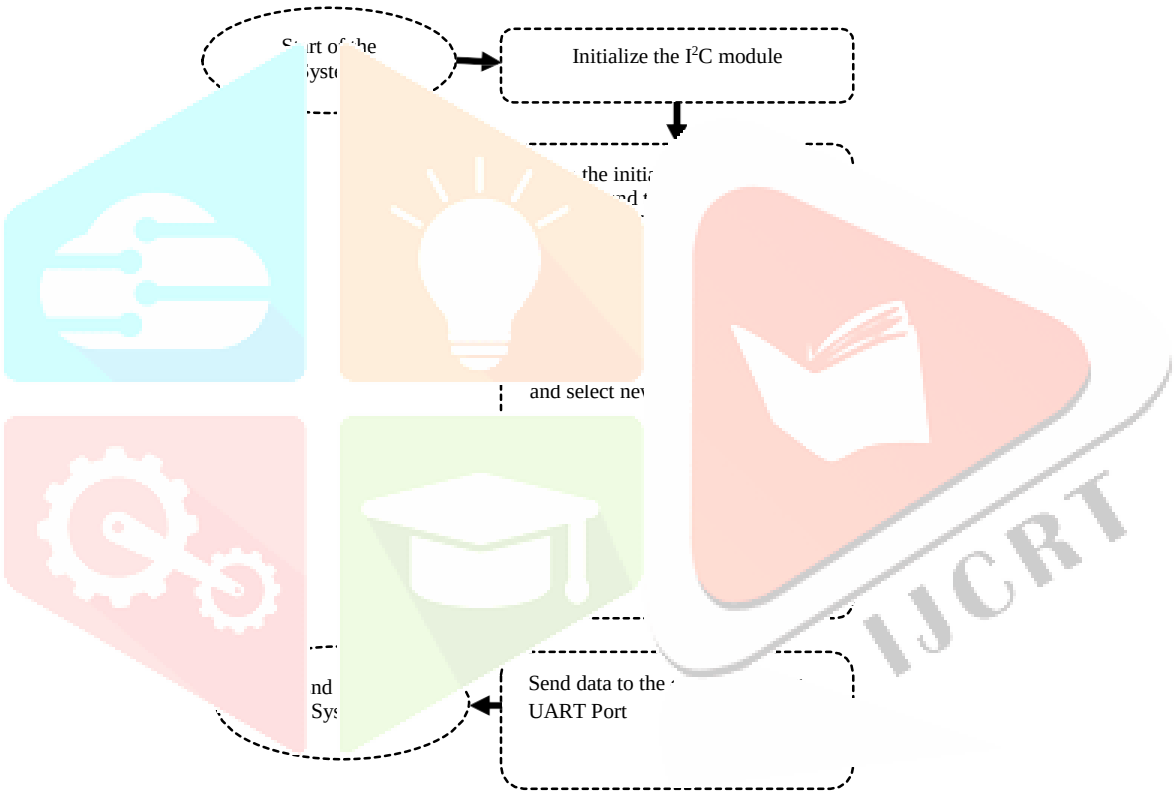

Figure: 1 Flow Chart of the System

III HARDWARE

A. dsPIC 30F6014Microcontroller

The dsPIC30F devices comprise extensive Digital Signal Processor (DSP) functionality inside a high performance 16-bit microcontroller, Modified Harvard and C compiler optimized instruction set architecture. It takes Up to 144 Kbytes on-chip Flash program space, 8 Kbytes of on-chip data RAM and 4 Kbytes of non-volatile data EEPROM. It has 12-bit Analog-to-Digital Converter (A/D) with 100 Ksps conversion rate

B. AD5934Chip

The AD5934 is a high precision impedance converter system which combines a frequency generator by a 12-bit, 250 kSPS, and Analog-to-Digital converter (ADC). The frequency generator permits an external complex impedance to be excited by a well-known frequency. The signal in response from the impedance is sampled by the on-board Analog-to-Digital converter (ADC) and a discrete Fourier transform (DFT) is complete by an on-board DSP engine. The DFT algorithm returns a real (R) and imaginary (I) values at each frequency.

A. MikroProgSuite

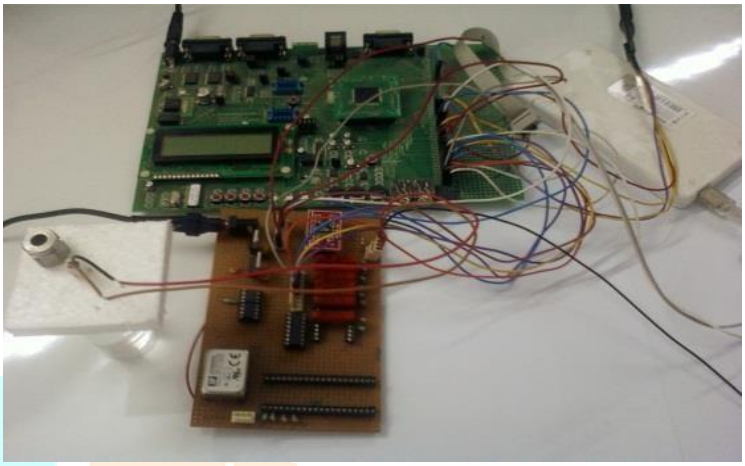

Figure 2: Hardware Connection of the System

IV SOFTWARE

Program mikroProg Suite for PIC is proposed for programming PIC, dsPIC and PIC32 microcontrollers from Microchip. The graphic interface of the program is clear and easy-to-use, that makes the use of this program faster. This program's main window contains basic options for programming microcontrollers. Additionally, there are innovative programming options that enable skilled users to set configuration bits on their own. This displays important information about microcontroller for example: Flash Memory, EEPROM Data Memory, RAM, I/O Pins and many more.

B. Mikro Ccompiler

The mikro C compiler is an authoritative, feature-rich advance tool for dsPIC30/33 and PIC24 microcontrollers. This is designed to provide the programmer through the easiest possible solution to emerging applications for embedded systems, without compromising performance or control.

C. MATLab

MATLAB is built up around vectors and matrices. This is a great tool for solving algebraic and differential equations for numerical integration. MATLAB has influential graphic tools and produces good pictures in both 2D and 3D.This is also a programming language, and one of the easiest programming languages for writing mathematical programs.

V RESULTS

All values of Magnitude and Phase are sent to the computer using UART port. These values are used for plotting frequency vs. Magnitude and frequency vs. phase graph. These are some graphs shown below for different ranges of impedances:

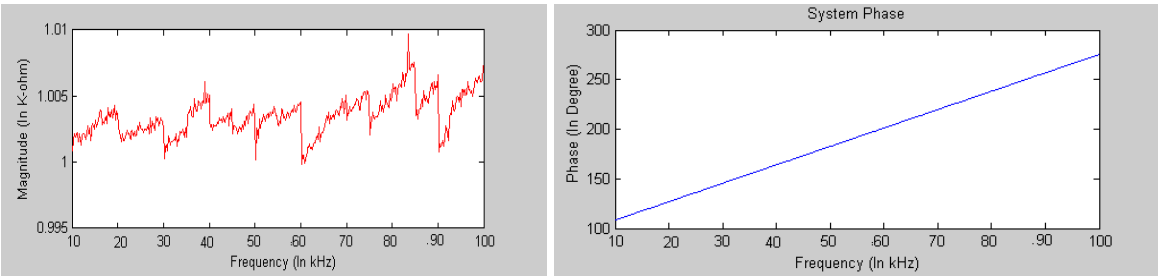

Figure: 3 Magnitude and System Phase plot for 1kΩ

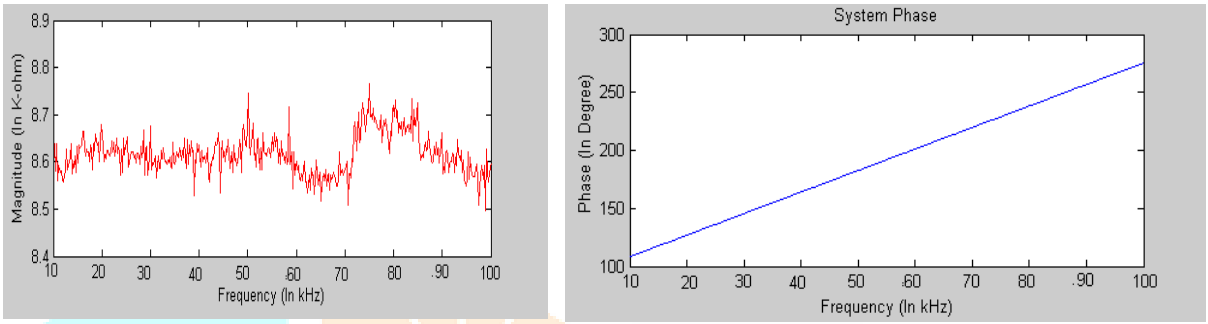

Figure: 4 Magnitude and System Phase plot for 10kΩ

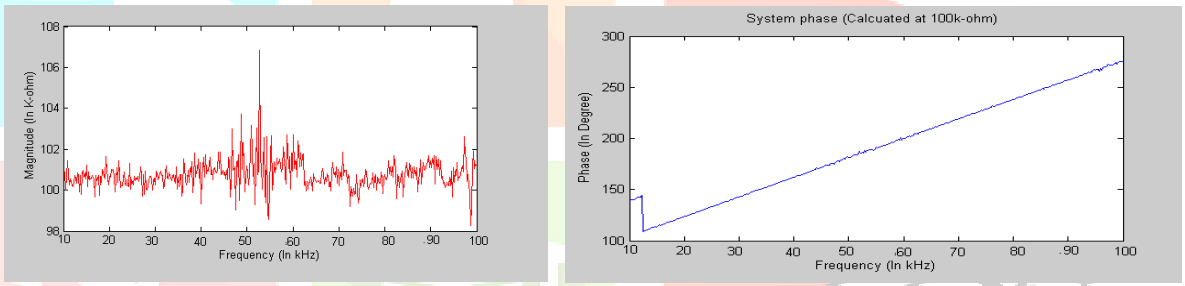

Figure: 5 Magnitude and System Phase plot for 100kΩ

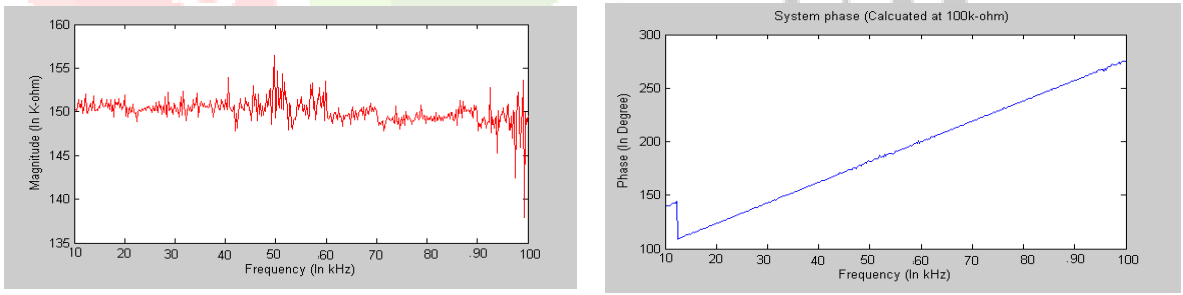

Figure: 6 Magnitude and System Phase plot for 149kΩ

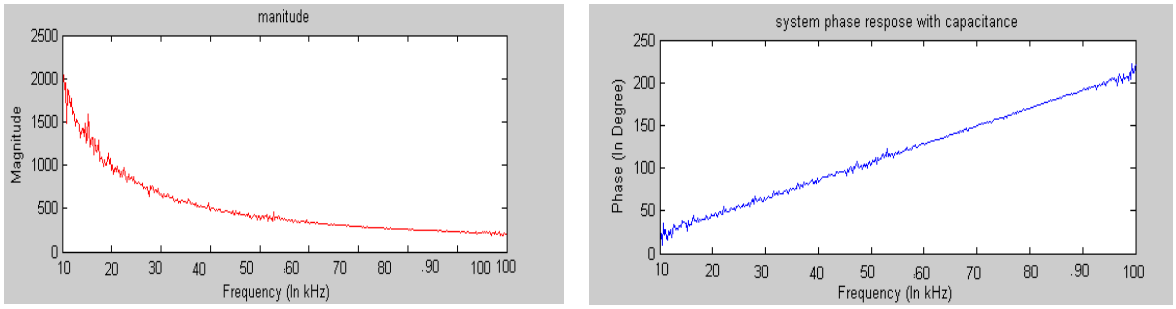

Figure: 7 Magnitude and Phase response for 22pF capacitor

VI CONCLUSION

Here we plotted frequency vs. Magnitude and frequency vs. phase graph on Different Frequency (10 KHz-149 KHz) and Capacitance in MAT Lab. These results are compared with standard values. Satisfactory results have been observed.

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