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PC based Dielectric Constant Measurement System for Solid Polymer Films

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ABSTRACT: the present paper deals with Personal computer based for the measurement of dielectric constant for polymer films it has been designed and developed. It is based on the principle that the change in frequency of an XR–2206 function generator, when the polymer film sample forms the dielectric medium of the dielectric cell, is measured with a PC with the help of sensing unit and decoding unit. Software is developed in C using Keil and turbo C-cross compiler. The instrument system covers a wide range of dielectric constants for various samples at various concentrations .The system is quite successful in the measurement of dielectric constant for polymer films.

KEYWORDS: PC based data acquisition system, Dielectric constant, XR-2206 Function generator, Frequency measurement, and 'C' C-cross compiler.

I. INTRODUCTION

Personal computer is an amazing device and there is hardly any field without computers. It is an intelligent machine, which can be programmed to serve as a human being in many applications. It finds innumerable applications such as Medical, Scientific, Communication, Business, Banking and education etc. The dielectric constant is a property of major concern in understanding it behavior in various films. A "dielectric" is a substance that can sustain an electric field and acts as an insulator. Some solids and liquids conserve as good dielectric materials, having a special property of storing and dissipating electrical energy when subjected to electromagnetic fields. Dry air is an excellent dielectric. Dielectric measurements are useful for detecting explosives, plastic and metal weapons, drugs, chemical agents, and biological agents. The dielectric cell consists of two parallel metallic plates which act as electrodes. The cell acts as a capacitor, while the solids sample acts as a dielectric medium. Dielectrics find extensive use in electrical and electronic industries. They are used for insulation purposes [1].In the present study, the technique utilizes frequency measurement for determination of capacitance using PC as a tool, while most of the conventional techniques measure the capacitance using bridge methods. It is very important to evaluate their electrical and physical characteristics such as molecular structure and density [2]. The interest in the study of dielectric properties of materials, spring from both the practical need for dielectrics in technical devices[3] and the interest of physicists and physical chemists in the molecular structure and dynamics of condensed matter[4].

II. PRINCIPLE AND INSTRUMENTATION

The IC XR–2206 is a function generator chip. It acts as an RC oscillator. The frequency of oscillations depends on the values of timing resistor R and timing capacitor C. The value of R is kept constant. The dielectric cell acts as a capacitor C that varies with the dielectric medium. Consequently, the frequency of the oscillator also changes. The measurement of the frequency of the oscillator enables one to measure the value of the capacitance of the cell and, thus, the dielectric constant of the medium. In the present study, with suitable interface of the oscillator circuit with a PC, the frequency of the oscillator is measured. The dielectric constant of the medium is computed using following Eq. 1 & 2 and is displayed [5].The dielectric constant ε of a solid is defined as the ratio of the electrical capacitance of a cell when the sample

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forms the dielectric medium (Cs) to the capacitance of the cell when air forms the dielectric medium (C_0) at a given temperature, which is represented by the following equation

$$\varepsilon = (C\ s) / (C_0) \qquad \text{------ (1)}$$

The dielectric cell consists of two parallel metallic plates which act as electrodes. The cell acts as a capacitor while the solid acts as a dielectric medium.

The dielectric constant ε of the sample is given by

$$\varepsilon = (C_X - C_L) / (C_A - C_L) \qquad \text{------- (2)}$$

where C_X = actual capacitance of the cell with the sample

C_L = Lead capacitance

C_A = Actual capacitance of the cell with air

III. EXPERIMENTAL

3.1Hardware Design

The block diagram of the system designed and constructed in the present study is shown in Fig.1. The dielectric cell which acts as a capacitor C is connected toXR-2206. The XR-2206 network is generated the oscillator. The output of the RC oscillator is square wave it is TTL compatible is given to decoder circuit. In the present study we use decoding circuit because PC can't directly measure the frequency. So that the decoder circuit used, it can measure the frequency accurately up to nearly one megahertz frequency. The role of the Personal computer is that it measures the frequency data and computing the dielectric constant. And also stores the data for further analysis through plotting using origin6.0 software.

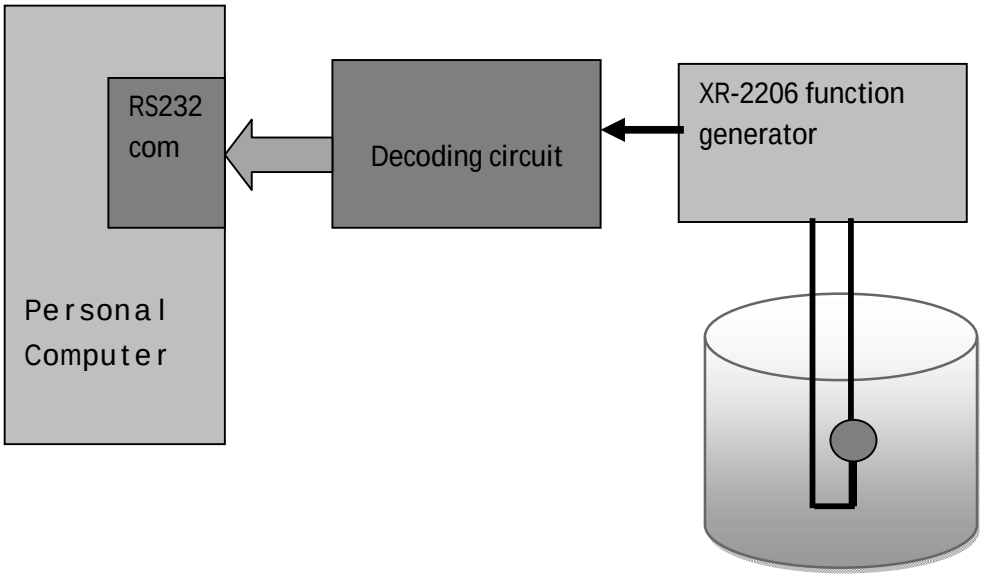

Figure 1: PC based dielectric constant measurement system

IV. SOFTWARE DEVELOPMENT

The software for the development of PC based system for the measurement of dielectric constant for solids is developed using keil and turbo C – cross Complier. The main role of the software in the present study is to test the following hardware modules activities.

1. To measure the frequency of the Oscillator.
2. To measure the capacitance and dielectric constant.
3. To display the measured data.

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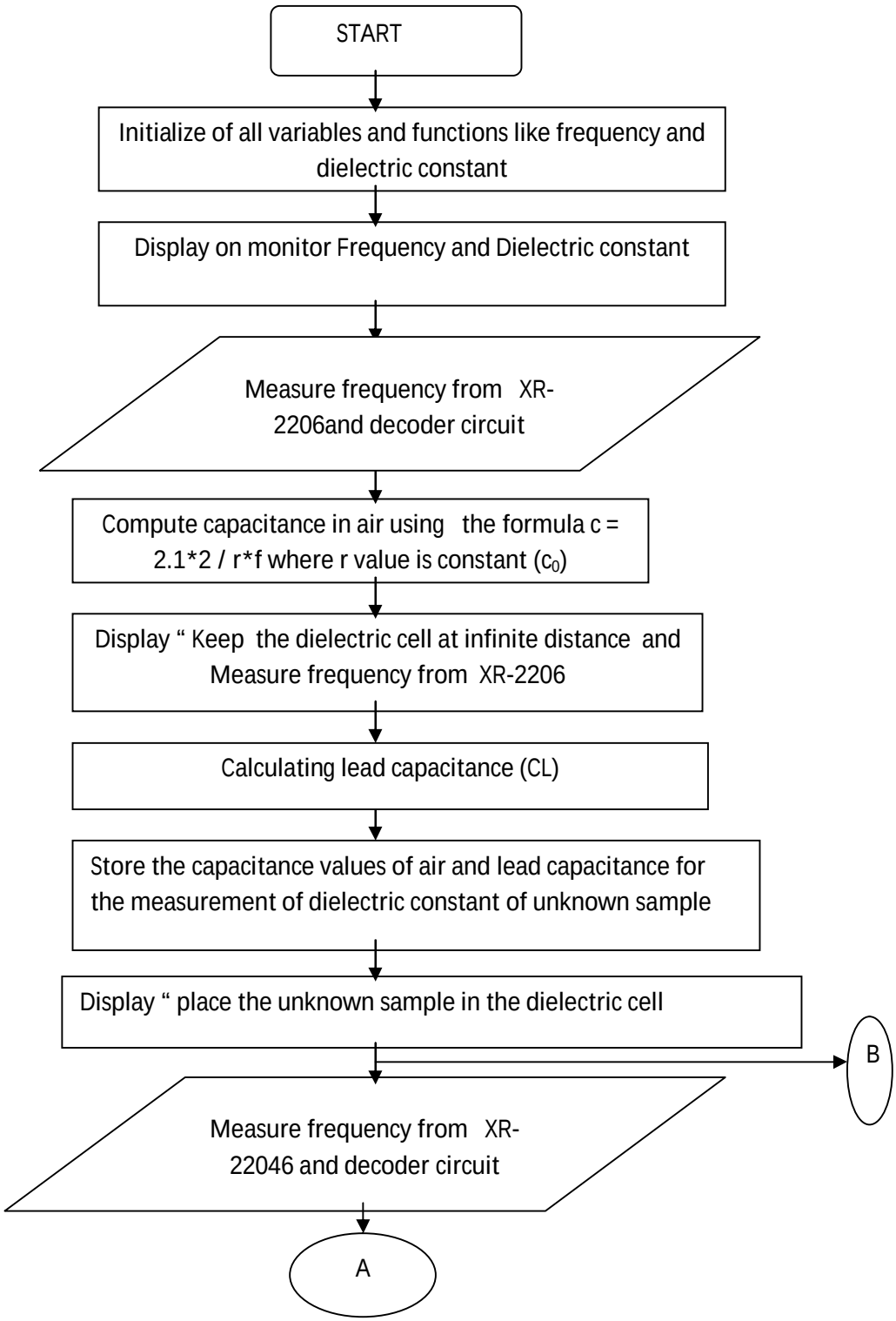
4.1Flowchart Of The Dielectric Constant In Solids

The flowchart is so drawn that it is self-explanatory and gives the complete idea of how designed system sequentially does the different steps involved in measurement of solids.



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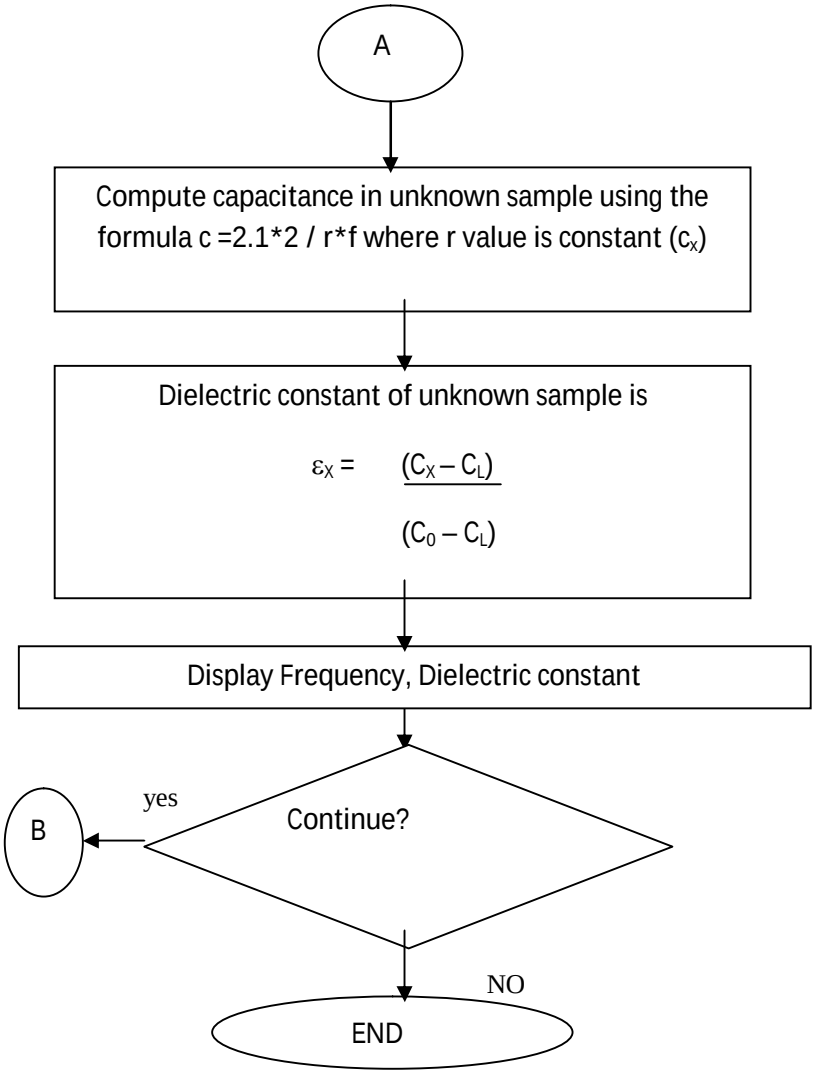

Fig.2 Flow chart of the PC based dielectric constant measurement system for solids

V. EXPERIMENTAL PROCEDURE

The experimental procedure involves the following major steps

1. Design of the system as shown in the block diagram
2. Developing software
3. Measuring the frequency
4. Storing the frequency data and calculating dielectric constant
5. Observing the procedure for different samples

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VI. CALIBRATION

The instrument is calibrated and measured following the procedure mentioned below.

1. The dielectric cell keeps it in air.
2. Connect the cell to the circuit as shown block diagram in Figs.1
3. Switch on the system and activate the software.
4. The system measures and displays the frequency and in turns the capacitance of the cell. Note down the values.
5. Keep the cell at infinite distance to measure the lead capacitance.
6. Repeat the steps from (2) to (4).
7. Keep the unknown sample in the cell.
8. Repeat the steps from (2) to (4).
9. Then calculate the dielectric constant of unknown sample using the equation (2).
10. Stored the readings of the dielectric constant of unknown samples.

VII. RESULTS AND DISCUSSION

The personal computer based dielectric constant measuring system is designed and constructed. The software for the systems is written in 'C' language. The performance of the system is studied and tested for different samples of polymers. The function of the systems is found satisfactory.

The attempt is made here is a fundament approach towards measuring merely discussing well about sampling, storage and calculating dielectric constants. Further this can be extended to process and change the characteristics of samples. This operation on the dielectric involved are cell designing, decoding, measuring frequency, calculating. Hence this sample design would give an idea on measuring the conductivity and dielectric constant, resistivity etc.

VIII. CONCLUSION

The hardware and software features of a PC based system for the measurement of dielectric constant for solids are described. The necessary software is developed in C, using Turbo C-cross compiler. The system is quite successful for the measurement of dielectric constants for solids. The measurement of dielectric constant, over a wide range, is a special feature of the present study.

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