MICROCONTROLLER BASED LCR METER

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Abstract - *LCR meter is basically inductance 'L', capacitance 'C' and resistance 'R' measuring device. Capacitors, resistors and inductors are the most common passive electrical components that are extensively used in all kinds of electronic circuits. During experiments we have to go through different components with unknown quantities, so simple and portable device is required to measure unknown quantities to make the experiment success. In this project, we discuss a technique of building a compact and economical digital LCR meter using a microcontroller.*

Key Words: LCR meter, ATmega 32, LM399 comparator, Voltage divider.

1. INTRODUCTION

Every electrical engineer and lab technician has been in a situation where it would be very helpful to have a meter to conveniently measure resistance, capacitance, and inductance. Capacitors, resistors and inductors lack a universal marking scheme to label the value of the components, and therefore it is often very difficult to know the value of these components. Commercial LCR meters are available, but are often very expensive and rarely very portable. This LCR meter is aimed to solve this problem. Its small packaging and auto ranging allow it to be used as a small LCR meter which fits nicely on the corner of the lab bench or as a portable meter to use out in the field. Wide variety of components can be tested without changing the settings on the meter.

1.1 Block Diagram

Block diagram shown in fig-1 of LCR meter consist of three measuring circuits which are resistance measuring, capacitance measuring and inductance measuring circuits. Output from these circuits are taken to the analog to digital converter inside the microcontroller. For better user interfacing a 16x2 alphanumeric LCD is used. Microcontroller works at 5 volt power supply there for a power regulator circuit is provided. To improve the processing speed of microcontroller an external crystal oscillator of frequency 16MHz is used. A rotary switch is included in order to change between the different measuring circuits.

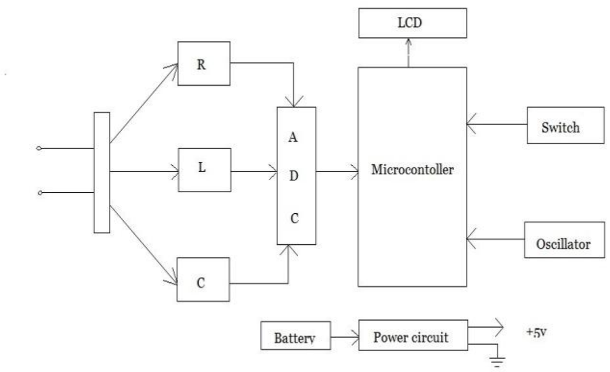

Fig -1: Block diagram

1.2 Inductance Measurement

An inductor in parallel with a capacitor is called an LC circuit, and it will electronically ring like a bell. Well regardless of the frequency or how hard a bell is struck, it will ring at its resonating frequency. The frequency of oscillation depends on both capacitor and inductor. Since the value of capacitor is known we can calculate the value of inductor using the equation.

$$Frequency = \frac{1}{2\pi\sqrt{LC}}$$

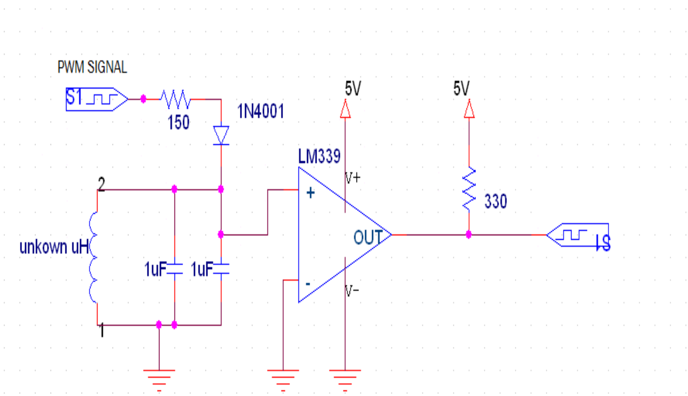

Fig -2: Inductance measurement circuit

1.3 Capacitance Measurement

Capacitance is measured based on the principle of charging a capacitor through a series resistor. The voltage across the capacitor increases exponentially as it charges. Let's assume that initially the capacitor was fully discharged. When Vin is applied across the RC circuit, the capacitor starts charging and consequently, the voltage (Vc) across it increases from 0 towards Vin in an exponential way. The equation provided in the figure describes how the voltage across the capacitor changes with time. After finding out the time that is required for the capacitor to charge up to a known voltage unknown capacitance can be determined by solving the equation (1a) knowing the value of R.

$$v_c = v_{in}(1 - e^{\frac{-t}{RC}}$$

$$v_c = \frac{v_{in}}{2}$$

$$\frac{1}{2} = 1 - e^{\frac{-t}{RC}}$$

$$.5 = e^{\frac{-t}{RC}}$$

$$\frac{-t}{RC} = -0.693147$$

$$C = \frac{t}{0.693147} \qquad \text{eq. (1a)}$$

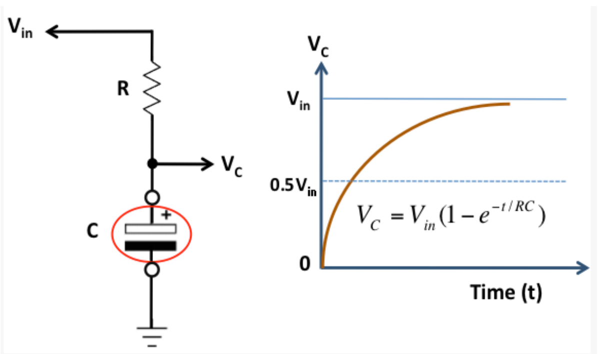

Fig -3: Capacitor charging characteristics

1.4 Resistance Measurement

Voltage divider fig -4 concept is used to measure resistance value. A known resistance (R1) and unknown resistance (R2) in series. Resistance R1 is pulled with 5 volt source and resistance whose value we want to measure is connect with ground and other terminal of resistance R1.Voltage across unknown resistance is measured with the help of ATmega 32 microcontroller. Value of Vcc and resistance R1 is known which is Vcc = 5 volt and R1 = 10K ohm. Using the given equations microcontroller calculate the unknown resistance.

$$Measured\ resistance = R_1 * \frac{V_{out}}{5 - V_{out}}$$

$$Measured\ resistance = 10000 * \frac{V_{out}}{5 - V_{out}}$$

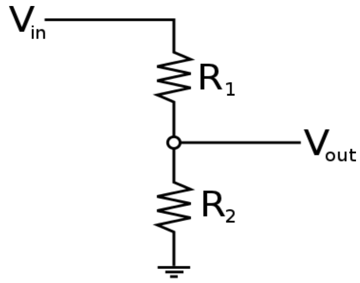

Fig-4: Voltage divider

2. FLOW CHART

According to the flowchart shown in fig-5 initialize the variables which are used in this program. Then determine whether the unknown component is R, L or C. If it is resistance that is to be measured, read ADC value and perform arithmetic operations inside microcontroller and finally display the result in the LCD display. For capacitance measurement first discharge capacitor, then start charging and find out the time required for charging to half of its maximum input (5 volt) with the help of a counter. After necessary calculations, display the capacitance value in LCD. If the unknown device is an inductor, send a pulse to tank circuit, then count frequency produced in the tank circuit. Using this frequency solve the resonance frequency equation, and display the result.

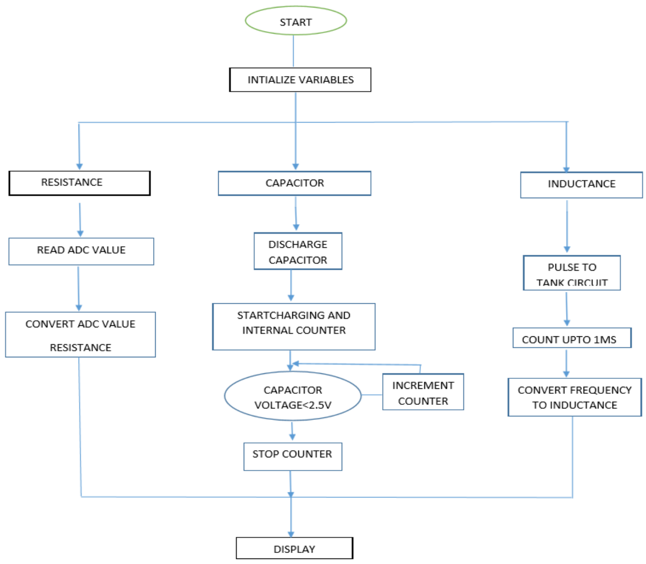

Fig-5: Flow chart

2.1 Result

With this LCR meter inductance of values starting from 80uH to 30000uH can be determined. It has an error rate of 1%. Capacitance values starting from 1 microfarad to 1000 microfarad can be measured using this LCR meter, with an observed error rate of approximately 0.5%. It can be seen that the processing time increases with the increased value of capacitance, so it is a slightly time consuming process. Using LCR meter we are able to measure resistance ranging from 1 ohm to 10 M Ohm with an approximate error of 0.8%. Since voltage divider method is used the processing time is less and result can be obtained immediately.

3. CONCLUSIONS

The hardware and software features of a low cost microcontroller based LCR meter for the measurement of inductance, capacitance, and resistance is described. The necessary software is developed in AVR studio compiler. The system is quite successful for the measurement of inductance, capacitance, and resistance with an accuracy of ± 1 percentage. The readings are observed for the time duration of 2 minutes; there is no change in the reading. The measurement in a wide range is a special feature of the present study. Strong software support is provided, to make the system user friendly, and it is very compact and can be used as a handheld meter. This meter can be made possible with less expense. The system was particularly designed for an industrial environment, in a developing country like India.

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