Capacitance meter circuit

MTE Project Report

Submitted by

Illu(2K20/EE/129)

Muskan(2K20/EE/173)

Muskan(2K20/EE/174)

Pradyumn Tiwari (2K20/EE/187*)*

Pragati Sattavan(2K20/EE/188)

Under the supervision of

Dr.Ram Bhagat

Department of Electrical Engineering

Delhi Technological University
Bawana Road. Delhi -110042
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CANDIDATE'S DECLARATION

We are **Illu, Muskan, Muskan,Pradyumn Tiwari and Pragati Sattavan(2K20/EE/129,2K20/EE/173,2K20/EE/174, 2K20/EE/187,2K20/EE/188)** students of B. Tech. **(Electrical Engineering)** hereby declare that the project Dissertation titled **"Capacitance meter circuit"** which is submitted by us to the Department Electrical Engineering, Delhi Technological University, Delhi in partial fulfillment of the MTE Project is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship, or other similar title or recognition.

Place: Delhi

Date:May 2022

CERTIFICATE

I hereby certify that the project Dissertation titled **" Capacitance meter circuit"** which is submitted by **Illu, Muskan, Muskan,Pradyumn Tiwari and Pragati Sattavan(2K20/EE/129,2K20/EE/173,2K20/EE/174, 2K20/EE/187,2K20/EE/188) [Electrical Engineering]**, Delhi Technological University, Delhi in complete fulfillment of the requirement for the award of the degree of the Bachelor of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi
Date: May 2022

Subject Teacher
Dr. Ram Bhagat

(Associate Professor)

ACKNOWLEDGEMENT

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INTRODUCTION

Capacitance is a measure of the ability of "something" to store electrical charge. Arduino capacitance meter relies on the same basic property of capacitors- the time constant. **The time constant** of a capacitor is defined as the time it takes for the voltage across the capacitor to reach **63.2%** of its voltage when fully charged. Larger capacitors take longer to charge, and therefore have larger time constants. An Arduino can measure capacitance because the time a capacitor takes to charge is directly related to its capacitance by the next equation:

TC = R x C

TC is the time constant of the capacitor (in seconds).

R is the resistance of the circuit (in Ohms).

C is the capacitance of the capacitor (in Farads).

So what we are going to do is charge the capacitor through a resistor using one of the Arduino pins. We have to know the resistence value of that resistor. Using the ADC of the arduino we can measure the voltage that the capacitor reached. We start counting the sime and when the voltage reach 63.2% of the full charge we stop the charge and calculate te capacitance. We can obtain the capacitance value because we know the resistance of the circuit, the measured voltage and the time that it took to reach 63.2% of the full charge. From the equation above we obtain C as:

C = TC / R

The Arduino measures the capacitance of the unknown capacitor by recording the time it takes for the capacitor to reach 63.2% of its voltage when fully charged, then dividing that value by the known resistance of the circuit. Now we should be ready to set up the capacitance meters and start measuring some capacitors.

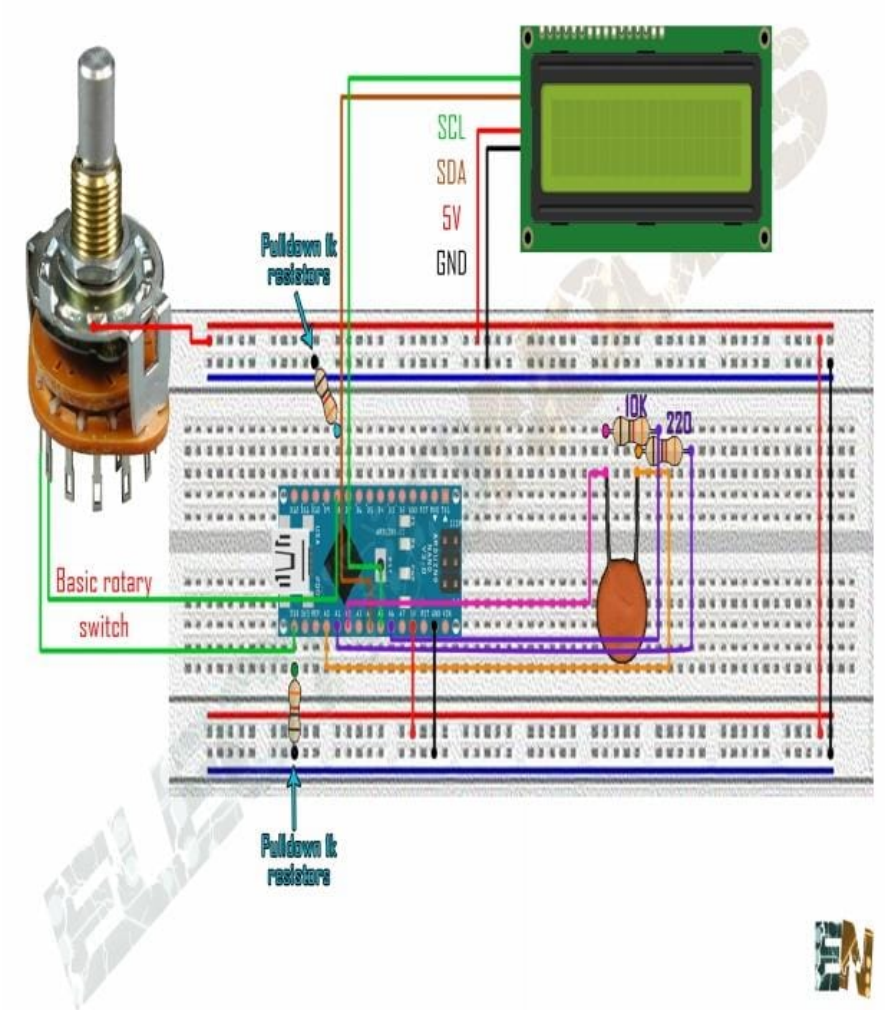
Range 0.1 µF to 3900 µF

The main problem of this setup is the values range that we can measure. It's almost impossible to be able to measure capacitors from 1pF to 100F using one simple circuit and the Arduino. That's why we are going to mount two circuits. One for ranges from 0.1uF to 3.9F and the other one from 10pF to 4.7nF. With this two setups we could measure capacitors from 10pF to almos 4F.

Se we will use pin 13 to charge the capacitor through the 10K ohm resistor. Once the charge starts we also start a time counter in microseaconds. We measure the voltage with the analog input A0. The Arduino ADC has 10 bits so 0 volts would be 0 and 5 volts would be 1024. So 63.2% of 1024 is 648. When the analog read reaches that values we stop charging the capacitor and the time counter as well. We obtain the C value dividing the elapsed time by the used resistor value. We connect the LCD i2c pins as shown in the schematic above and upload the next code.

All in one capacitance meter

What we will do now is combine the two schematics above in just one. We will have to switch between scales and for that wt will use a rotary switch conected to 5 volts and tow f the switch pins to digitals pins D13 and D8 as we can see in the schematic below. We use this pins because in the future I whant to combine this capacitance meter with the resistance meter that we've created before.



So for the high values range we will use pins A1 (violet) and A6(violet) to charge and discharge the capacitor and analog pin A0(orange) to measure the voltage. For the low values we will use A1(violet) and A0(orange) to charge and discharge the small capacitor. In the code when we switch the scale we will have to define as inputs the pins that we won't use in order to give them infinit impedance to be sure that no curent will flow through those pins.

Programming

We have done the programming part of our hardware project in Arduino IDE in Arduino Programming language.
The code is:

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x3f,20,4);

#define analogPin      0

#define chargePin      13

#define dischargePin   8

#define resistorValue  10000.0F


unsigned long startTime;

unsigned long elapsedTime;

float microFarads;
```

```
    lcd.setCursor(0,0);
    lcd.print("SCALE:  0.1uF-4F");
    lcd.setCursor(0,1);
    lcd.print(microFarads);
    lcd.setCursor(14,1);
    lcd.print("uF");
    delay(500);
}

else{
    nanoFarads = microFarads * 1000.0;
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("SCALE:  0.1uF-4F");
    lcd.setCursor(0,1);
    lcd.print(nanoFarads);
    lcd.setCursor(14,1);
    lcd.print("nF");
    delay(500);
}


digitalWrite(chargePin, LOW);
```

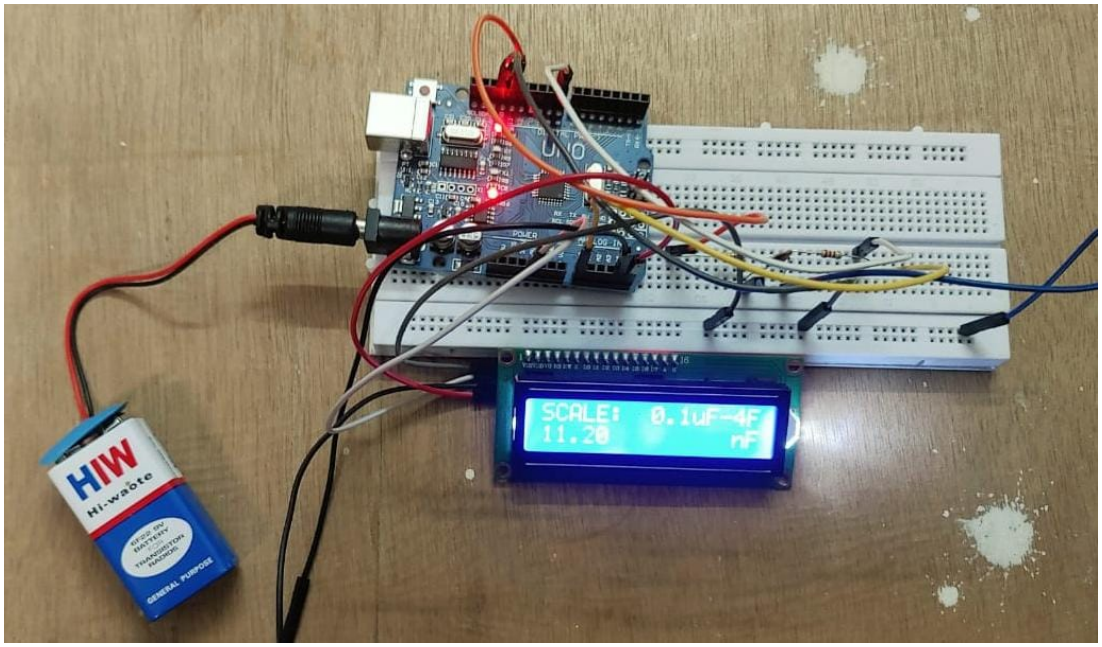
```
  pinMode(dischargePin, OUTPUT);
  digitalWrite(dischargePin, LOW);
  while(analogRead(analogPin) > 0){
  }

  pinMode(dischargePin, INPUT);

  lcd.setCursor(0,0);
  lcd.print("DISCHARGING.....");
  lcd.setCursor(0,1);


}
```

Hardware Implementation Of Capacitance Meter Circuit



CONCLUSION

So we have made this capacitance meter that can measure the specific range of values of 0.1 microfarad to 3900 microfarad.Capacitance Meter can be used to measure capacitance of unknown capacitors. Using Arduino for Capacitance Meter makes it easy to implement the project and with slight modifications, the circuit can be made for a wide range of capacitors.