Daffodil International University (DIU)
Department of Electrical and Electronic Engineering

EEE 422: Measurement and Instrumentation Lab

EXPERIMENT NO: 04

NAME OF THE EXPERIMENT: CAPACITANCE MEASUREMENT USING 555 TIMERS.

Objective:
To measure an unknown capacitance using mono-stable timer.

Theory:
A mono-stable timer produces a pulse at the output whose width is dependent on the timing resistance and capacitance. For a 555 timer connected in mono-stable mode, the pulse width is given by

$$t_w = 1.1RC \text{ seconds} \text{ --------------------- (1)}$$

To measure capacitance, trigger the mono-stable timer at a constant frequency, f. The average dc voltage of the mono-stable timer will be,

$$V_{out} = V_{cc}\, t_w\, f = 1.1\, V_{cc}\, f\, R\, C \text{ ------------------ (2)}$$

Measure the voltage V_{out} for a standard capacitance, C_s. Connect the capacitance to be measured across C_s.

$$V_1 = 1.1\, V_{cc}\, f\, R\, C_s \text{ ------------------(3)}$$

$$V_2 = 1.1\, V_{cc}\, f\, R\, (C_s + C) \text{ ------------------(4)}$$

Combining (3) and (4) one gets,

$$\frac{V_1}{V_2} = \frac{C_s}{C_s + C} \text{ --------------------(5)}$$

$$\text{or, } C = \frac{C_s(V_2 - V_1)}{V_1} = C_s\left(\frac{V_2}{V_1} - 1\right) \text{ ------------------(6)}$$
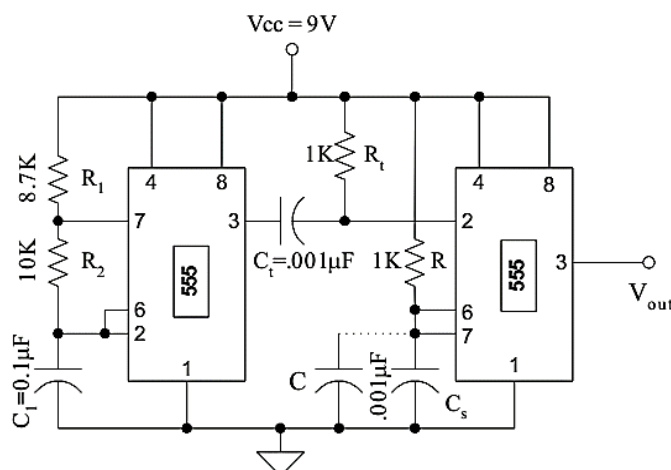
Circuit Diagram:

Figure-1: Capacitance measurement by mono-stable timer.

Apparatus:

1. IC 555 (2 pcs.)
2. Resistor: 1K(2 pcs.), 10K, 8.7K
3. Capacitor: 0.001μF (2 pcs.), 0.1μF (2 pcs.), 0.22μF, 0.47μF, 1.0μF
4. Trainer board
5. Oscilloscope
6. DMM

Procedure:

In this experiment two 555 timers are used. One 555 timer is operating in astable mode and the other one is in mono-stable mode as shown in figure-1. For the 555 astable timer the output frequency is given by,

$$f = \frac{1.44}{(R_1 + 2R_2)C_1} \quad \text{--------------(7)}$$

Proceed according to the following steps.

1. Connect the circuit as shown in figure-1 and run the circuit.
2. Record the voltmeter reading and the waveform pattern at pin 3 of both the timers with an oscilloscope.
3. Add the capacitance to be measured $C = 0.1\mu F$. Repeat step-2.
4. Repeat step-3 for $C = 0.22\mu F$, $0.47\mu F$, and $1.0\mu F$.
5. Tabulate the recorded readings for steps 2, 3 and 4. Determine the unknown capacitance using equation (6).

Report:

1. Explain the operation of a 555 timer as monostable and astable multivibrator.
2. Is it possible to measure capacitance using only one 555 timer? Explain your answer.
3. List other methods of measuring capacitance.
4. What is the purpose of R_t and C_t?
5. What is the maximum range of C_s?