Lab 7. Time and Frequency Measurements

Name-Surname : **Date :**

Student No. : **Group :**

ATTENTION! – You must bring your Digital Multimeter, LM555, 1kΩ resistor, 10kΩ potentiometer, 1uF and 10 nF capacitors, a breadboard and wires with you to the laboratory. Other equipment will be given during the experiment.

Tools

- **LM555:** The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits.

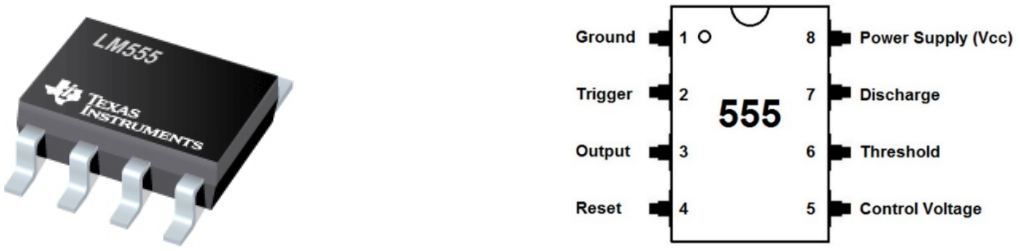
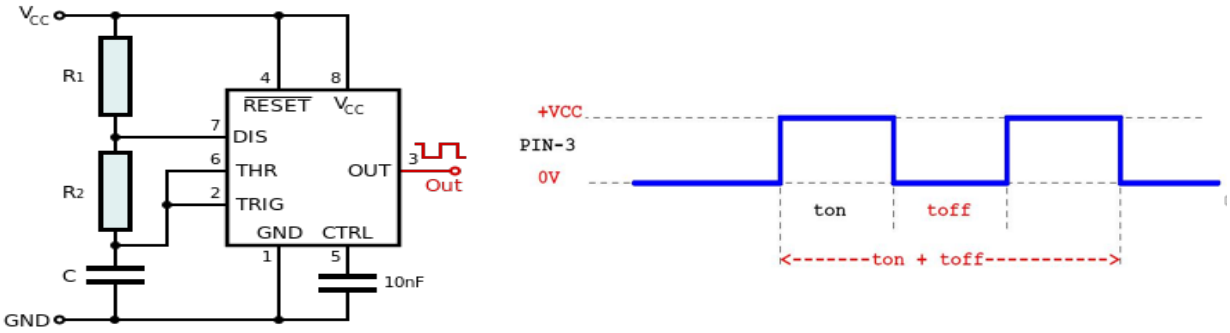


Figure 1. LM555 Timer and its pins.

Astable Operation Mode: The basic astable operation circuit diagram is shown below. C capacitor is responsible for HIGH and LOW states by charging and discharging. R_1 and R_2 resistors decide charging and discharging durations.



$$f = \frac{1.44}{\left[\left(R_1 + 2R_2\right)C\right]},\ t_{on} = 0.693\left(R_1 + R_2\right)C,\ t_{off} = 0.693R_2C,\ Duty\,Cycle = \frac{\left(R_1 + R_2\right)}{\left(R_1 + 2R_2\right)}$$

Figure 2. Astable Operation Mode of LM555.

- **Oscilloscope:** Oscilloscopes are used to observe the variation of an electrical signal over time, such that voltage and time describe a shape which is continuously graphed against a calibrated scale. The observed waveform can be analyzed for such properties as amplitude, frequency, rise time, time interval, distortion and others.

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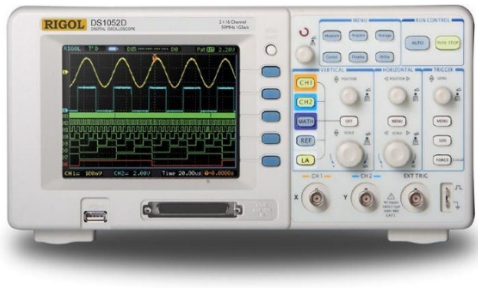


(a) (b)

Figure 3. a) Connection of probes, b) Configuration of ohmmeter.

- **DC Voltage Source:** The DC Voltage Source capable to supply 0-30 V DC Voltage. The voltage can be adjusted by using caps on the panel. It has a special module which provides constant 5V to the circuit. (Figure 1).

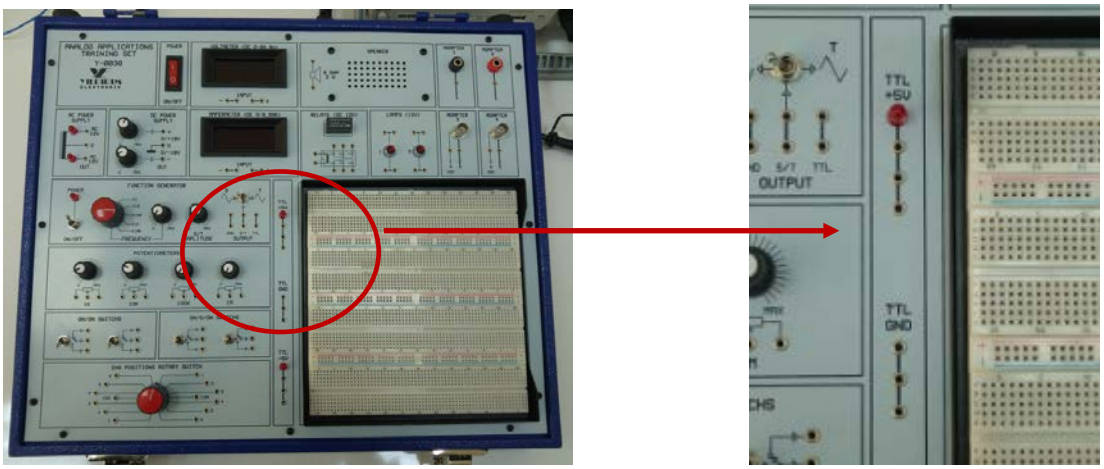
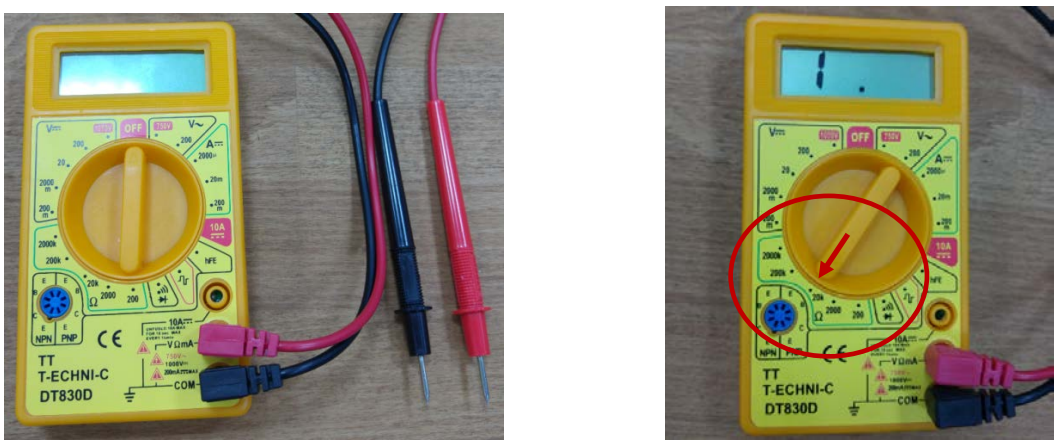


Figure 4. The DC Voltage Source.

- **Digital Multimeter:** Digital Multimeter is an electronic measuring instrument that can combine several measurement functions in a unit. Ohmmeter function will be used in the scope of this experiment. Red probe is connected to "V/Ω/mA" terminal and black probe is connected to "com" terminal as shown in Figure 5a. In order to measure resistance, switch is configured to ohmmeter section (marked with Ω) as shown in Figure 5b. Ohmmeter section includes a resistance value range. Before measurement, suitable resistance value is selected from value range in ohmmeter section.



(a) (b)

Figure 5. a) Connection of probes, b) Configuration of ohmmeter.

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- **Breadboard:** Breadboard is an equipment to be utilized for creating temporary and prototyping circuits and experimenting with circuit design. It is also called as solderless breadboard, since it does not require soldering, it is reusable. Figure 2 indicates a breadboard and its connections. The power rails give you lots of easy access to power. Usually they are labeled with a '+' and a '-' and have a red and blue stripe, to indicate the positive and negative side. As seen in Figure 2 power rails are connected vertically while the others are connected horizontally.

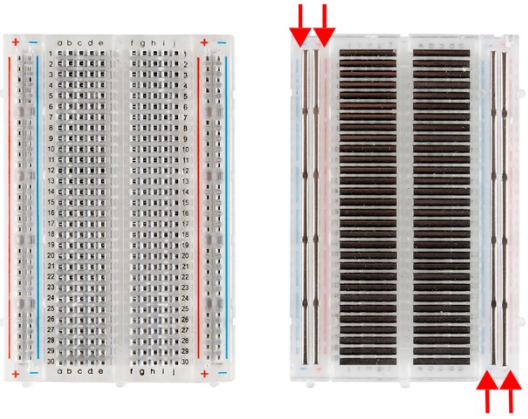
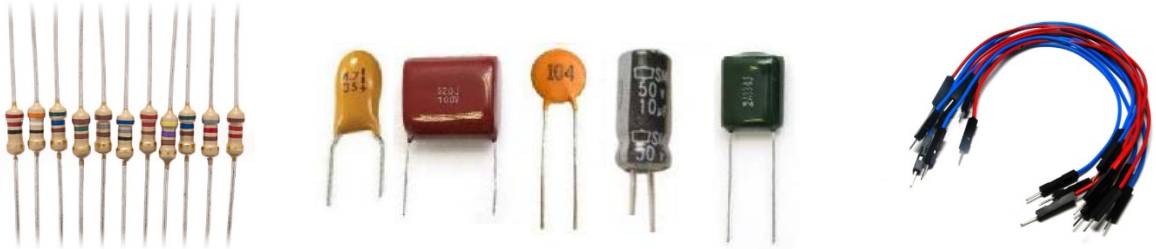


Figure 6. A breadboard and connections on it.

- **Resistors, Capacitors and Wires**



(a) (b) (c)

Figure 7. a) Resistors, b) Capasitors, c) Wires.

- **Potentiometer:** A potentiometer is a manually adjustable variable resistor with 3 terminals. Two terminals are connected to both ends of a resistive element, and the third terminal connects to a sliding contact, called a wiper, moving over the resistive element. The position of the wiper determines the output voltage of the potentiometer.

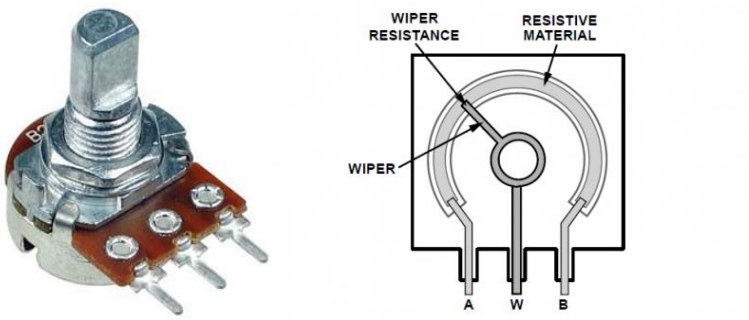


Figure 8. A Potentiometer.

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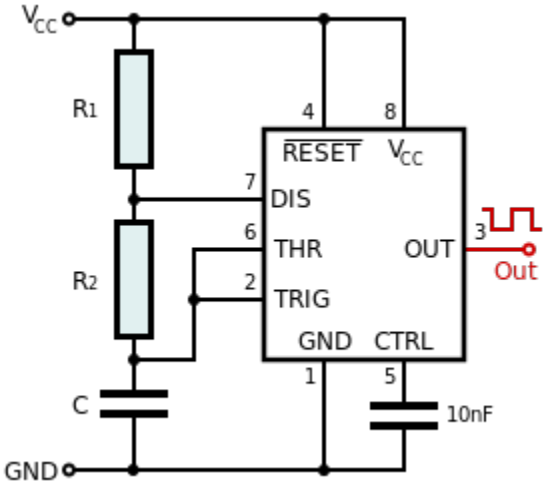
Instructions

1. Build the circuit below on your breadboard. Also, take its photo for the report. (V_{cc}=5V, R_1=10kΩ potentiometer, R2= 1kΩ, C=1uF.)



2. Measure the voltage output and determine frequency, duty cycle, t_{on}, t_{off} by using oscilloscope for given R_1 values. Also, take photos from oscilloscope screen for three cases.

R_1 (Ω)	f (Hz)	Duty Cycle	t_{on} (s)	t_{on} (s)
10k				
5k				
100				

3. Find R_1 value, so that duty cycle will be 50%. (by using oscilloscope)

R_1 (Ω)

Homeworks

1. In introduction section, briefly describe purpose of the experiment.
2. In method section, include all photos of your experiment and briefly describe the used materials and measurement procedures.
3. In results section, calculate the frequency, duty cycle, t_{on}, t_{off} for the values of R_1 given at Instruction 2.
4. In results section, compare the calculated and measured frequency, duty cycle, t_{on}, t_{off}.
5. In results section, calculate the R_1, so that duty cycle will be 50%.
6. In results section, compare the calculated and measured R_1 value.
7. In results section, plot three voltage-time graph by using measured values in Instruction 2.
8. In conclusion section, comment on the difference between calculated and measured values.
9. In conclusion section, when/where/why can LM555 timer with astable operation mode be used?

* *You can access report format from website lcetin.github.io*