American International University-Bangladesh
Department of Electrical and Electronic Engineering
EEE3120: Digital Logic &Circuits Laboratory

Title: Design and implementation of multivibrators using Timer IC

Introduction:

The name of the timer comes from the three 5 kΩ resistors which are embedded in it [1]. This IC gives precise time at the output which is must in the time related circuits. One of its basic operations is to produce clock pulses with predefined frequency as an astable mutivibrator. Another operation is to work like a stop watch which is done in monostable mode. We will see these two operations in this experiment. The following figure is the layout of the 555 Timer IC as which allows us to focus on the functions of the circuit.

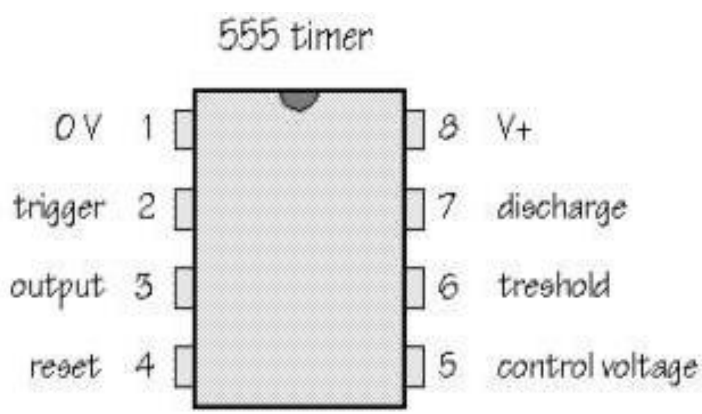

Figure 1: Pin configuration of the 555 timer IC.

Theory and Methodology:

Astable Multivibrator: It is also called free running sinusoidal oscillator. An astable multivibrator is simply and oscillator. The astable multivibrator generates a continuous stream of rectangular off-on pulses that switch between two voltage levels. The frequency of the pulses and their duty cycle are dependent upon the RC network values.

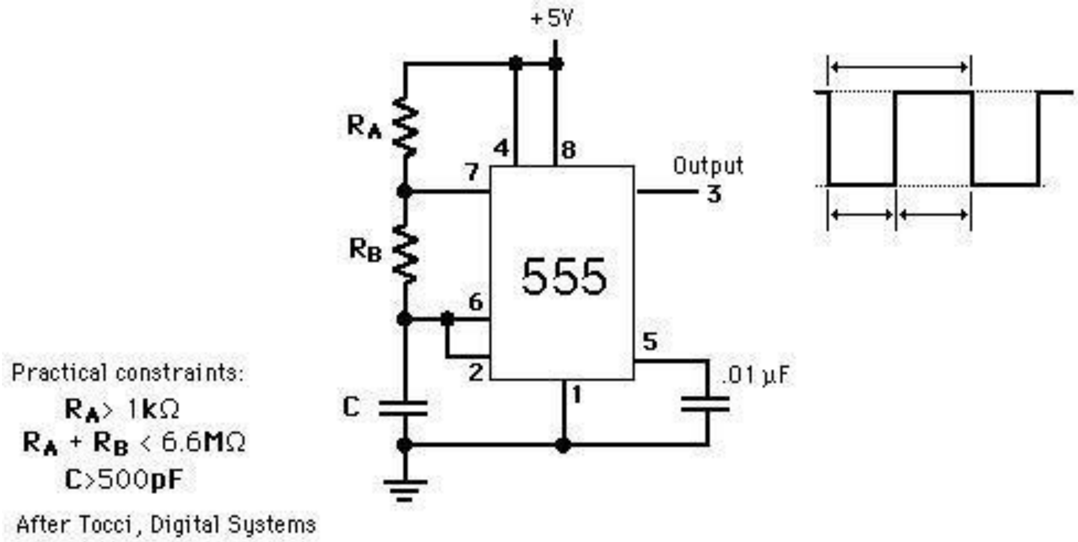

Figure 2: 555 timer connected as an astable multivibrator

The time that the output is high, TL is how long it takes C to discharge from 1/3 of Vcc to 2/3 of Vcc. It is expressed as

TH = 0.7(RA + RB) C

The time that the output is low, TH is how long it takes C to charge from 2/3 of Vcc to 1/3 of Vcc. It is expressed as

TL =0.7RBC

The time period, T = TH + TL = 0.7(RA + 2RB) C

Frequency of Oscillation, f = 1/T = 1.44 / (RA + 2RB) C

Duty cycle, D = TH/ T = (RA + RB)/ (RA + 2RB) x

100%.

One shot multivibrator: In the one-shot mode, the 555 acts like a monostable multivibrator. A monostable is said to have a single stable state--that is the off state. Whenever it is triggered by an input pulse, the monostable switches to its temporary state. It remains in that state for a period of time determined by an RC network. It then returns to its stable state. In other words, the monostable circuit generates a single pulse of fixed time duration each time it receives and input trigger pulse. Thus the name becomes one-shot. One-shot multivibrators are used for turning some circuit or external component on or off for a specific length of time. It is also used to generate delays. When multiple one-shots are cascaded, a variety of sequential timing pulses can be generated. Those pulses will allow you to time and sequence a number of related operations.

Pulse width of the output is given by T= 1.1 RC (in seconds)

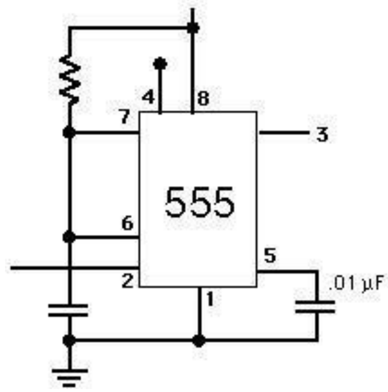

Figure 3: 555 timer connected as a one shot multivibrator

<u>Pre-Lab Homework:</u>

Astable Multivibrator:

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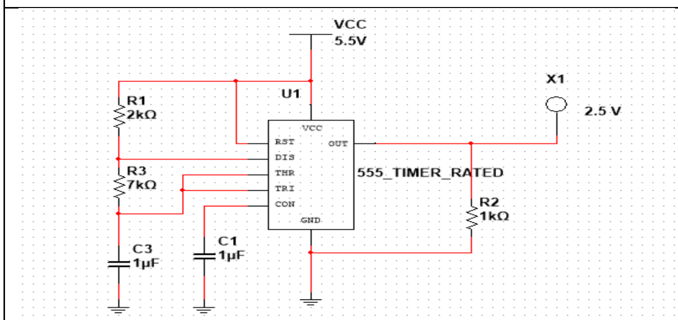
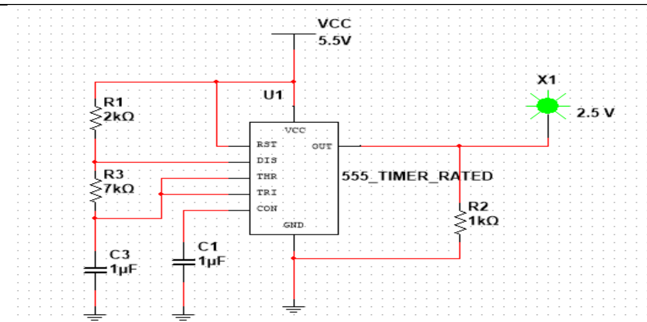
<tr><th>SIMULATED DATA</th><th>SIMULATED DATA</th></tr>
<tr><td>
Fig.1.1: Astable Multivibrator (Output =0)</td><td>
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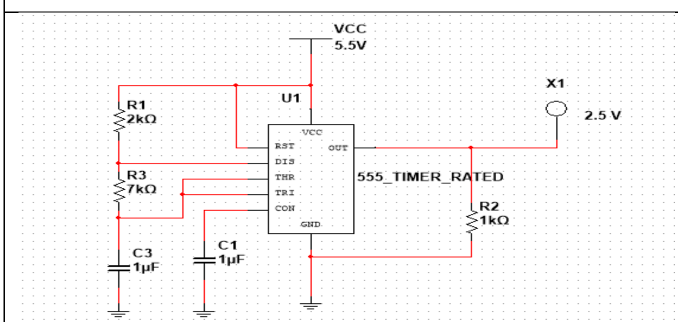
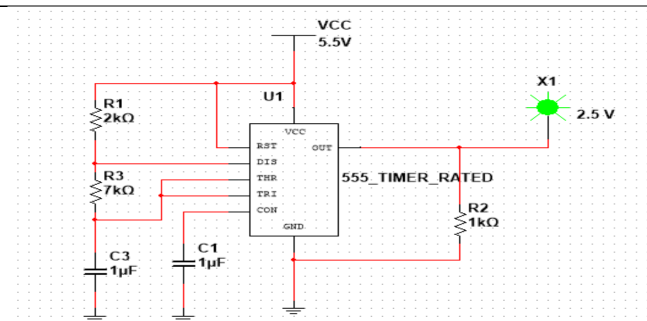
<tr><td>
Fig.1.2: Astable Multivibrator (Output =0)</td><td>
Fig.1.2: Astable Multivibrator (Output =0)</td></tr>
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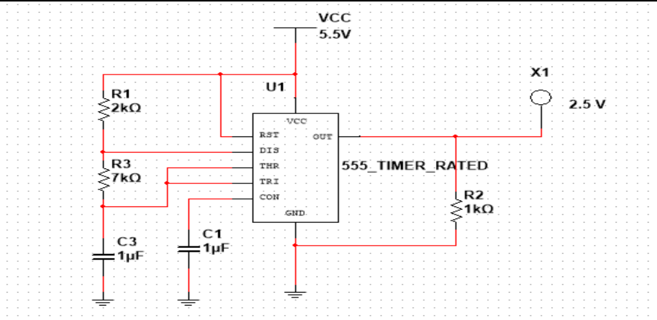

Fig.1.3: Astable Multivibrator (Output =0)

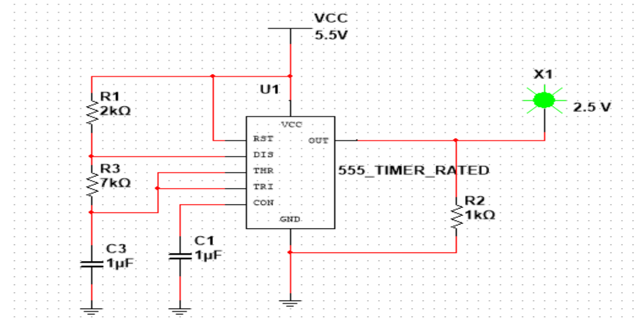

Fig.1.3: Astable Multivibrator (Output =0)

Monostable Multivibrator:

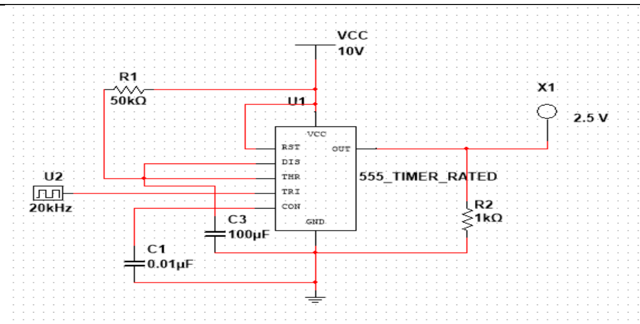

Fig.2: Monostable Multivibrator (Output=0)

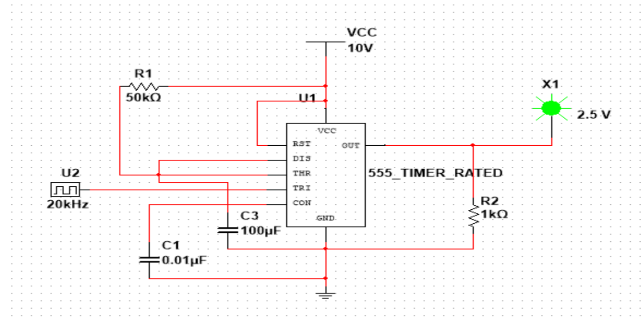

Fig.2: Monostable Multivibrator (Output=1)

Calculation:

Astable Multivibrator:

Realtime Calculation:

$T_H = (2.06+3.13+1.81)/3 = 2.33$

$T_L = (2.6+1.58+1.63)/3$

$= 1.94$

$T = T_H + T_L$

$= 2.33+1.94$

$= 4.27$

$f = 1/T$

$= 1/4.27$

$= 0.23$

$D = T_H/T$

$= 2.33/4.27$

$= 0.55$

$= 55\%$

Mathematical Calculations:

$C = 100uF$
$= 100 \times 10^{-6}$ F
$R_A = 10K\Omega$
$= 10 \times 10^{3}\ \Omega$
$R_B = 22K\Omega$
$= 22 \times 10^{3}\ \Omega$
$T_H = 0.7(R_A+R_B)C$

$=0.7(10x10^{3}+22x10^{3})100x10^{-6}$
$= 2.24s$
$T_L = 0.7(R_B)C$
$= 0.7x22x10^{3}$
$= 1.54s$
$T = T_H + T_L$
$= 2.24s+1.54s$
$= 3.78s$
$f = 1/T$
$= 1/3.78$
$= 0.264$

$D = T_H / T$
$= 2.24/3.78$
$= 0.592$
$= 59.2\%$

Monostable Multivibrator:

$T_H = 12.61s$

Mathematical Calculations:

$T_H = 1.1 \times R \times C$
$= 1.1 \times (100 \times 10^{3}) \times (100 \times 10^{-6})$
$=11$

Apparatus:

Resistors 1k	1[pcs]
Resistors 2.2k	1[pcs]
Resistors 4.7k	1[pcs]
Resistor 50k	1[pcs]
Capacitor 0.01u	1[pcs]
Capacitor 0.022u	1[pcs]
Capacitor 100u	1[pcs]
555 Timer IC	1[pcs]

Precautions:

Never turn on the DC source before the circuit is placed correctly and checked carefully. Check for short circuits in the circuit.

Experimental Procedure:

The setups for the astable multivibrator and monostable multivibrator are given in the following figures.

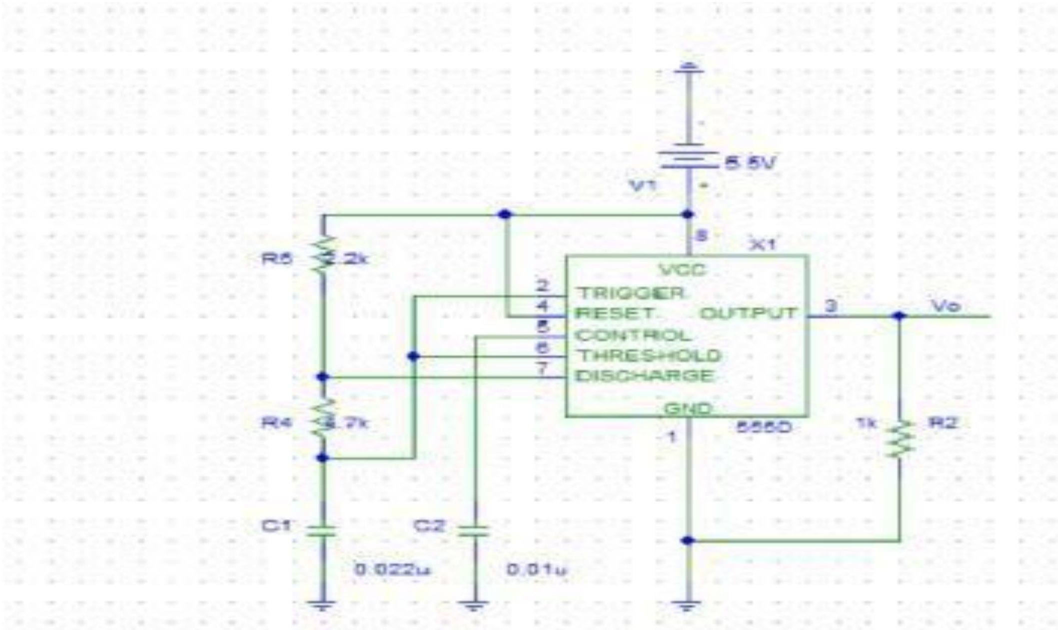

Figure 4: Experimental setup for astable multivibrator.

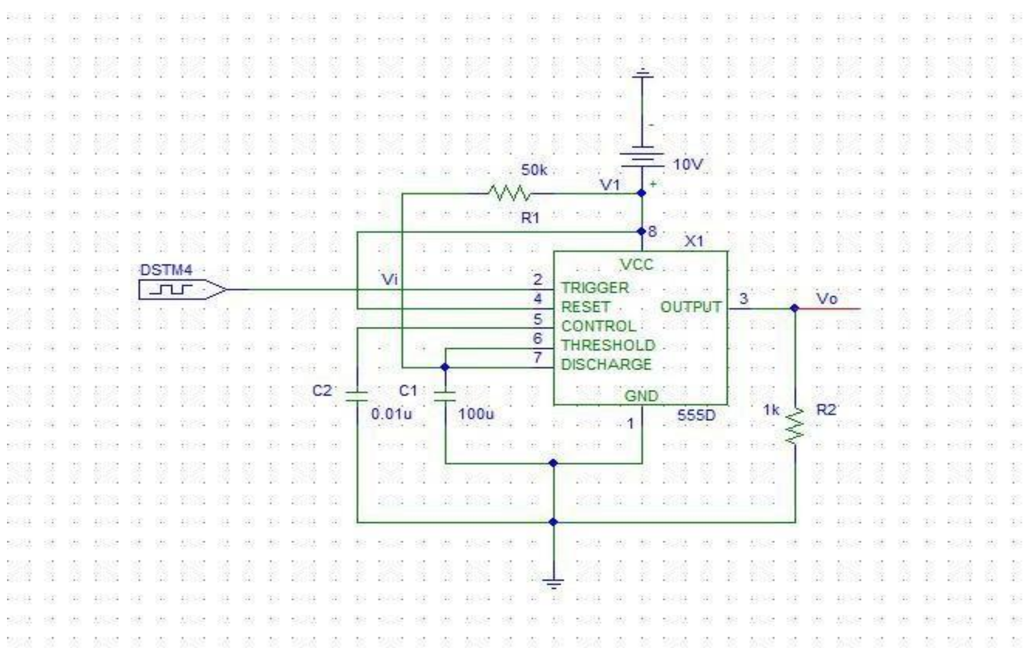

Figure 5: Experimental setup of the monostable multivibrator.

Simulation and Measurement:

Astable multivibrator:

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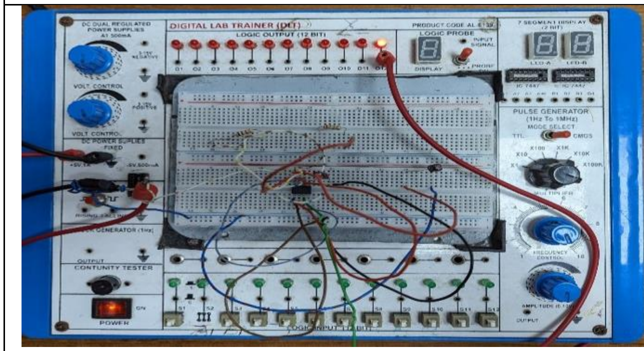
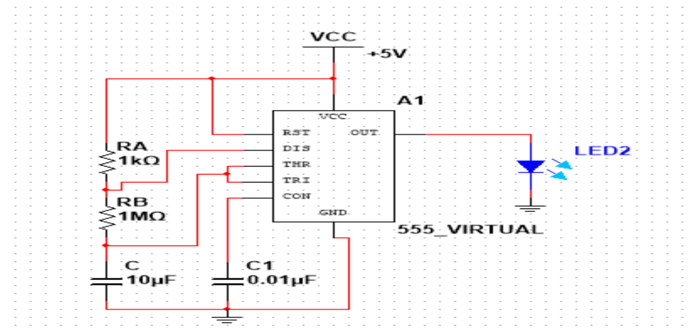
<tr><th>EXPERIMENTAL DATA</th><th>SIMULATED DATA</th></tr>
<tr><td>
Fig.1: 555 timer connected as an astable multivibrator (T_h output=1)</td><td>

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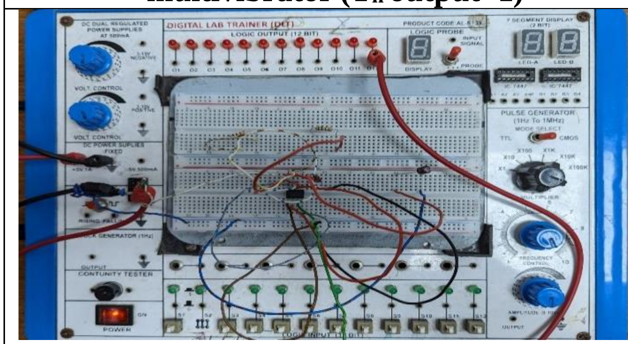
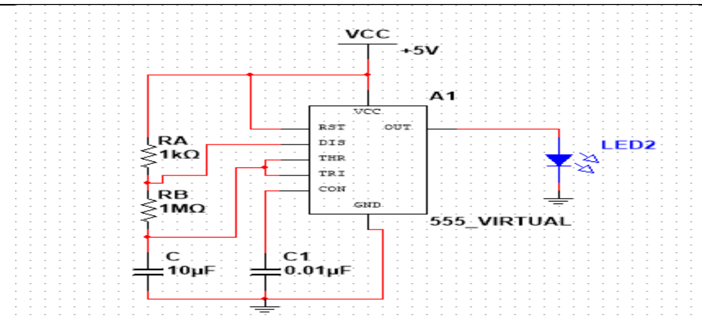
<tr><td>
Fig.1: 555 timer connected as an astable multivibrator (T_l output=0)</td><td>

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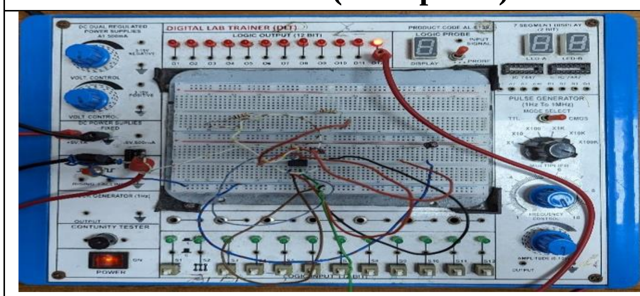
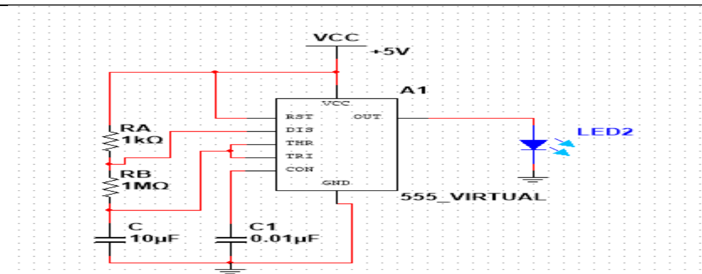
<tr><td>
Fig.2: 555 timer connected as an astable multivibrator (T_h output=1)</td><td>

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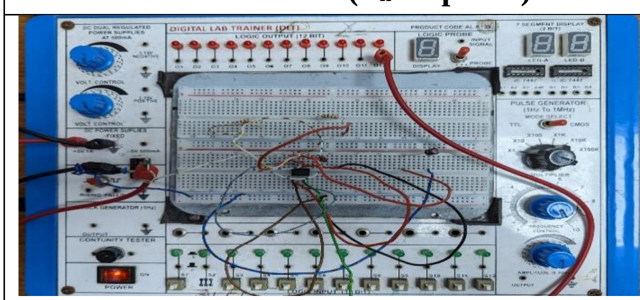
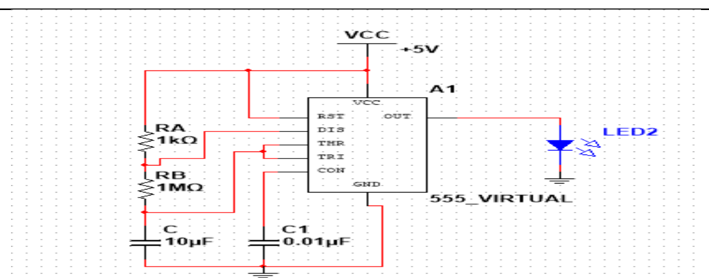
<tr><td>
Fig.2: 555 timer connected as an astable multivibrator (T_l output=0)</td><td>

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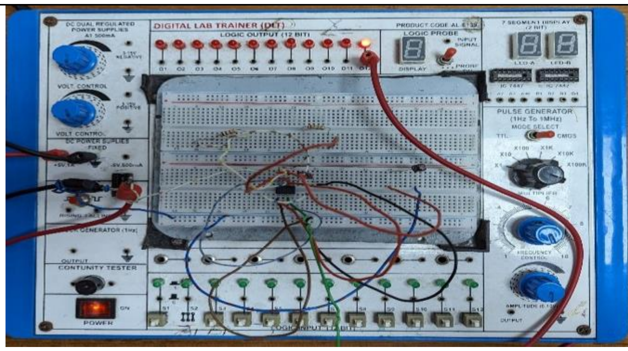

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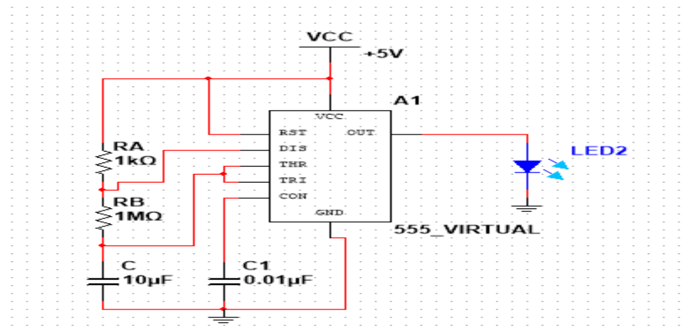

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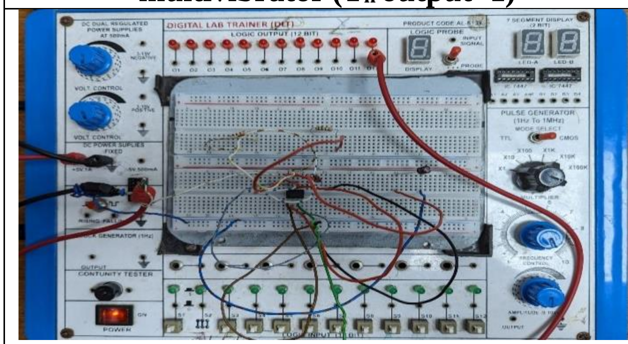

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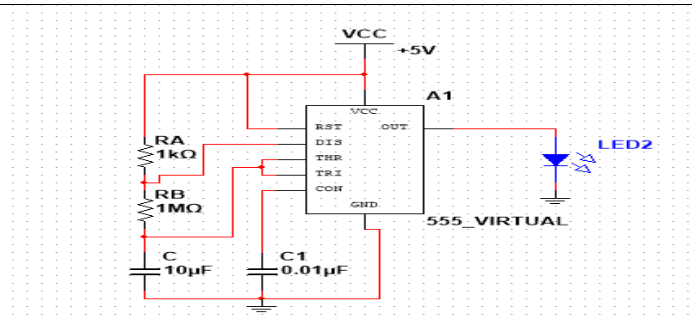

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One shot multivibrator:

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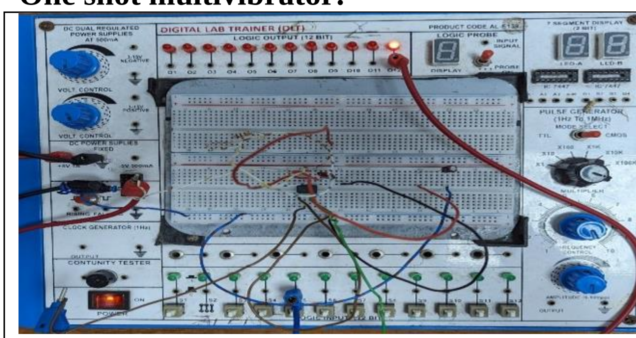

Fig.4: 555 timer connected as a one shot multivibrator (T_h output=1)
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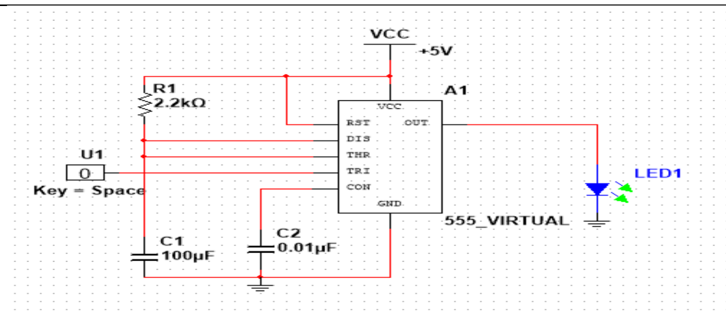

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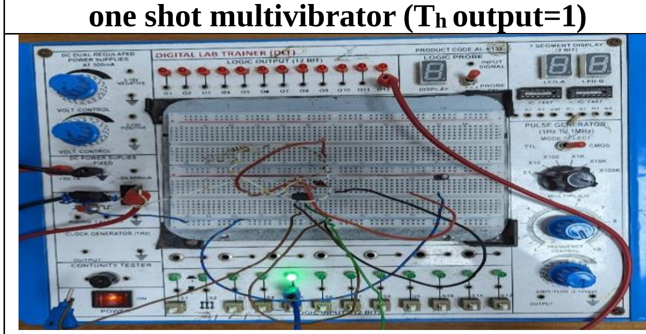

Fig.4: 555 timer connected as a one shot multivibrator (T_l output=0)
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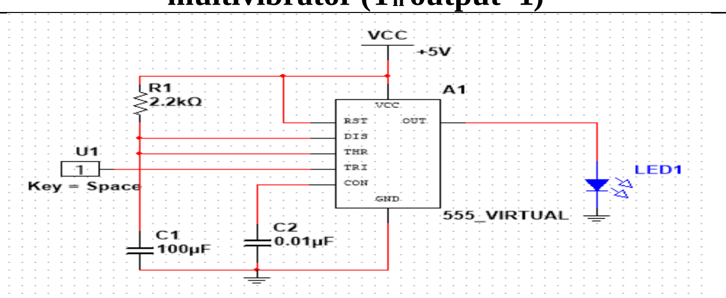

Fig.4: 555 timer connected as a one shot multivibrator (T_l output=0)
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Result:

555 timer connected as an astable multivibrator(Hardware calculation)

Group-03

Exp-09: Design and Implementation of multivibreators using Timer IC

R_A - 1K
R_B - 1M
c - 10 uF

Ex-9

	TH	TL	T	F = 1/T	Duty cy
	11.98	7.98	19.96	0.05	
	8.46	8.15	16.61	0.06	$\frac{9.43}{17.63} \times 100$
	7.85	8.46	16.31	0.06	= 53.48%
Avg	9.43	8.197	17.63	0.056	

Calculation.

$T_H = 0.7 \times (R_A + R_B)\, C$
$= 7.007$ s

$T_L = 0.7 \times R_B \times C$
$= 7$ s

$T = T_H + T_L = 14.007$

$F = 1/T = 0.07$

Duty cycle $= T_H/T \times 100\%$
$= 50.02\%$

$$\text{error} = \frac{17.63 - 14.007}{17.63} \times 100\%$$
$= 20.55\%$

Para	physical	calculated	% of diff
T_H	9.43	7.007	25.69%
T_L	8.197	7	14.60%
T	17.63	14.007	20.55%
f	0.056	0.07	20%
D	53.48%	50.02%	6.47%

Discussion:

As seen in the results and simulation section, both the astable and monostable multivibrator had been implemented correctly with the help of 555 timers. The hardware implementation is matching with the desired output. There were some difficulties while doing the experiment. One was, it was hard to find the pin names as the IC did not has proper labeling in it. As a result, the initial connection was wrong and after that it was corrected. The monostable multivibrator needed an extra IC to be put in the pulse generator port which was unknown at first. Other than these, the experiment was completed without any problem.

Conclusion:

The 555 timer is used the system has low power consumption. Furthermore, with 555 timer, the system is very stable. In addition, another important boon is that the system can be used for timing from microseconds to hours. Generating time delays from microseconds to ours is useful in many applications.

Reference(s):

1. Boylestad, Robert L., and Louis Nashelsky. *Electronic Devices And Circuit Theory*, 2006, Pearson Prentice Hall.

2. Thomas L. Floyd, *Digital Fundamentals*, 9th Edition, 2006, Prentice Halluy.