PH-211

Electronics Lab.

Experiment 7: Multivibrators.

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Experiment Name: Multivibrators

Experiment No.: 7

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Experiment - 07: Multivibrators

Aim: To construct a (a) astable and a (b) monostable multivibrator using IC 555.

Apparatus:
1) IC 555
2) Bread board
3) Resistors & Capacitors
4) Connecting Wires
(5) Digital CRO
(6) Pulse generator for monostable
(7) Multipower supply.

Astable:

(a) Resistors (1KΩ, 3.3KΩ, 10KΩ, 18KΩ)

(b) Capacitors (0.001 μF, 0.01 μF, 0.1μF, 1μF)

Monostable:

(a) Resistors (900 KΩ)

(b) Capacitors (0.01 μF, 1μF)

Formulae's

1) Astable Multivibrator

$\Rightarrow t_{High} = 0.693(R_1+R_2)C$ $\Rightarrow t_{low} = 0.693 R_2 C$

where,

R_1, R_2 = Resistance

C = Capacitance

t_{high} = Charging phase of Capacitor / Logic high phase

t_{low} = Discharging phase of Capacitor / Logic low phase.

$$T_{total} = t_{high} + t_{low} = 0.693(R_1+R_2)C + 0.693 R_2 C = 0.693(R_1+2R_2)C$$

$$f_{osc} = \frac{1}{T_{total}} = \frac{1.44}{\cancel{R+2R}(R_1+2R_2)C}$$ f = frequency of oscillator

$$\text{Duty Cycle } \% = \frac{t_{high}}{T} \times 100 = \frac{R_1+R_2}{R_1+2R_2} \times 100$$

$$-V_C(t) = V_F + (V_I - V_F)e^{-t/R'C}.$$

$$V_I = \frac{V_{CC}}{3}$$

V_F : V_{CC} (final voltage)
V_{CC} (bias voltage)
V_C (charging voltage)

$$-V_C'(t) = V_F + (V_I - V_F)e^{-t/R_2C}$$

$V_I = \frac{2V_{CC}}{3}$ (initial voltage)
$V_F = 0$ (final voltage)
$V_C'(t) \Rightarrow$ (Discharging voltage)

b) Monostable Multivibrator

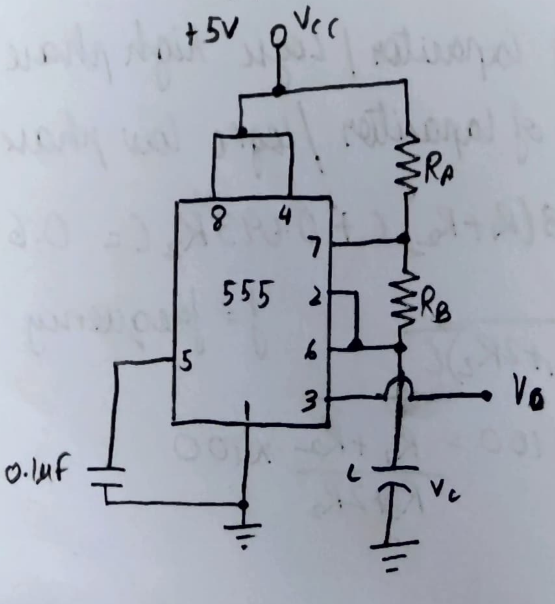
$T = 1.1\,RC$

Duty Cycle = $T_{OFF} / (T_{OFF} + T_{ON})$

$T \Rightarrow$ Time period of pulse
$T_{OFF} \Rightarrow$ time in astable state
$T_{ON} \Rightarrow$ time in stable state

Pulse width,
$W = 1.1\,RC$

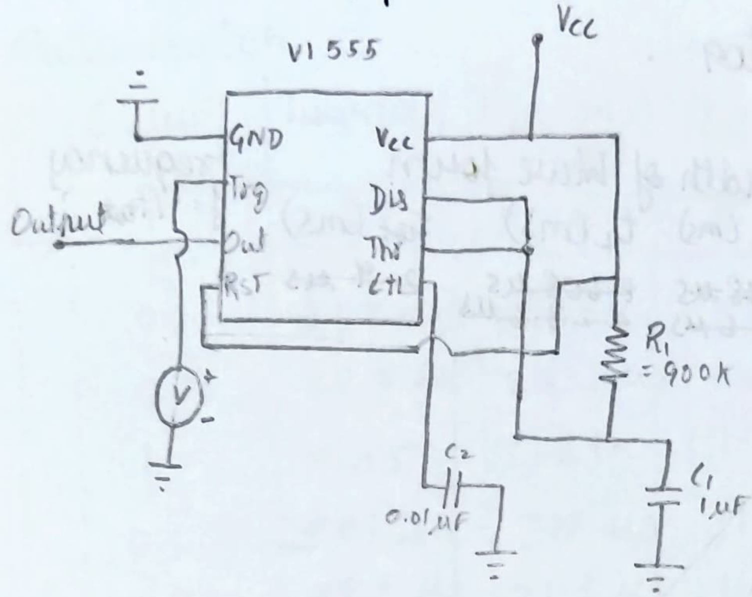
• Equivalent Circuits
a) Astable Multivibrator



$R_A = 1\,k\Omega$
$R_B = 3.3\,k\Omega$
$10\,k\Omega$
$18\,k\Omega$

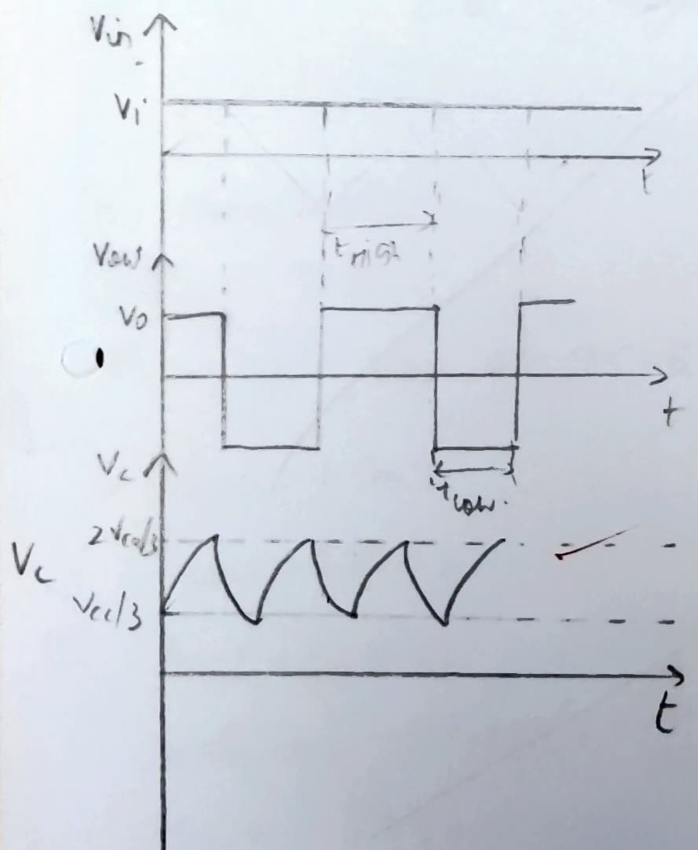
$C = 1\,\mu F$
$0.1\,\mu F$
$0.01\,\mu F$

b) Monostable Multivibrator

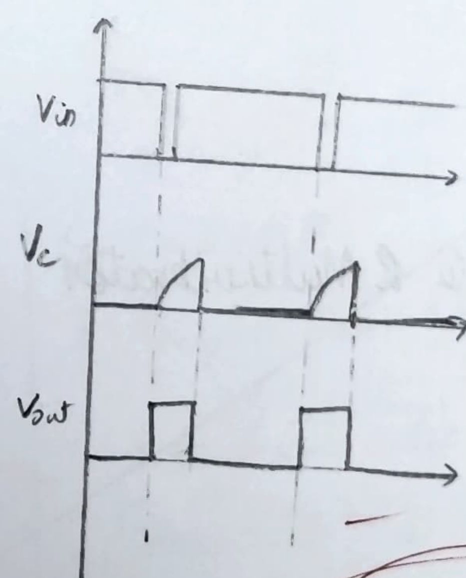


- Expected Waveform as a function of input

a) Astable Multivibrator



(b) Monostable Multivibrator



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Observation

(a) Astable Multivibrator

Sr No	R_B (kΩ)	C (μF)	T_{high} (ms)	T_{low} (ms)	T_{tot} (ms)	f_{osc} (exp) $f = 1/T_{tot}$	f_{osc} (theo)
1	3.3	1	2.87	2.24	5.11	195.69 Hz	189.47 Hz
2	3.3	0.1	287 μs	224 μs	511 μs	1.95 KHz	1.89 KHz
3	3.3	0.01	28.5 μs	22.7 μs	51.2 μs	19.57 KHz	18.95 KHz
4	10	1	9.05	2.21	11.26	88.81 Hz	68.57 Hz
5	10	0.1	897 μs	218 μs	1115 μs	896.9 Hz	685.7 Hz
6	10	0.01	88.2 μs	21.9 μs	110.1 μs	9.08 KHz	6.85 KHz
7	18	1	14.6 ~~ms~~	2.2	16.8	59.5 Hz	38.9 Hz
8	18	0.1	1.44 ms	219 μs	1.65	606 Hz	389. Hz
9	18	0.01	142 μs	22 μs	164 μs	6.09 kHz	3891 Hz

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(b) Monostable

For R = 1 kΩ

Duty cycle was at 75.8%

t_{high} = 1.5 ms

t_{low} = 500 μs

For R = 560 Ω

Duty cycle = 59.17%

t_{high} = 593 μs

t_{low} = 409.5 μs

For R = 560 Ω

$T = t_{high} + t_{low} = 593.4 + 409.5$

$= 1002.9$ μs.

$1.1\ RC = 1.1 \times 560 \times 1\,\mu F$

$T_{theoritical} = 616$ μs.

$\text{Duty cycle} = \frac{t_{high}}{T} = \frac{593.4\,\mu s}{1002.9\,\mu s}$

$= 59.17\%$

Duty cycle (obs) = 59.17%

Result

(1) ~~As you increase the light~~

Calculation

(a) Astable Multivibrator.

Duty cycle % = $\frac{R_A + R_B}{(R_A + 2R_B)} \times 100\%$

(a) For $R = 3.3\ k\Omega$

Duty cycle ⇒ $\frac{1+3.3}{1+6.6} \times 100 = 56.57\%$

(b) For $R_B = 10\ k\Omega$

Duty cycle = $\left(\frac{1+10}{1+20}\right) \times 100 = 52.30\%$

(c) For $R_B = 18\ k\Omega$

Duty cycle = $\frac{1+18}{1+36} \times 100 = 51.35\%$

(b) Monostable multivibrator:

For $R = 560\ \Omega$

$T = t_{high} + t_{low} = 593.4 + 409.5$
$= 1002.9\ \mu s$.

$w = 1.1RC = 1.1 \times 560 \times 1\mu F$

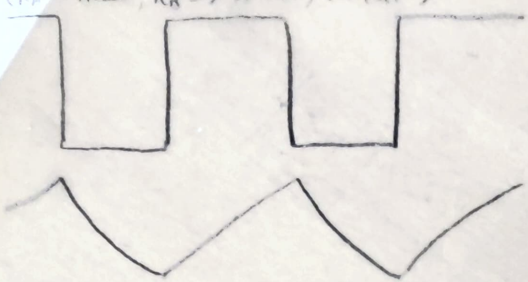
$T_{theo} = 6.16\ \mu s$.

Duty cycle = $\frac{t_{high}}{T}$ = ~~593~~ $\frac{593.4\ \mu s}{1002.9\ \mu s}$

$= 59.17\%$

Duty cycle (observed) = 59.27%

(1) ($R_A = 1k\Omega$, $R_B = 3.3k\Omega$, $C = 1uF$)



5 v/div
V_o v/s t

1 V/div
V_c v/s t

(2) ($R_A : 1k\Omega$, $R_B = 10k\Omega$, $C = 1uF$)

5 v/div
V_o v/s t

1 V/div
V_c v/s t

(3)

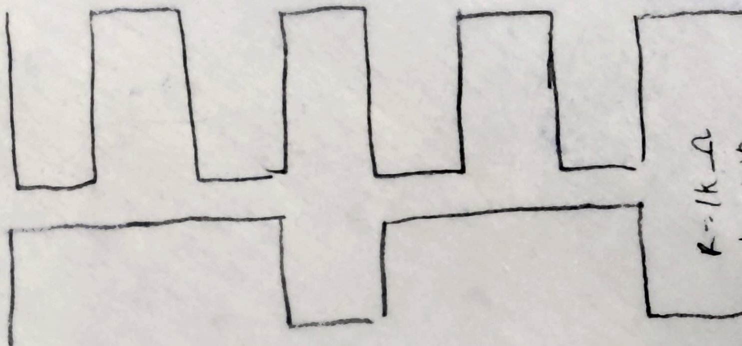
5 V/div

1 V/div
V_c v/s t

$R_A : 1k\Omega$, $R_B : 18k\Omega$, $C : 1uF$

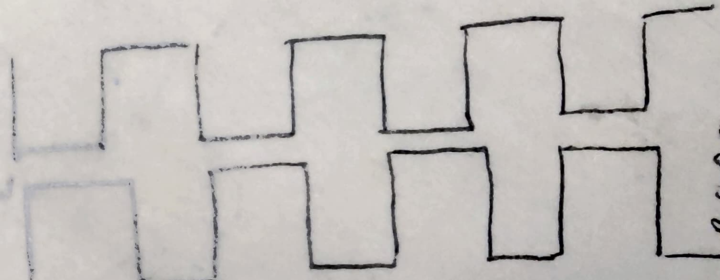
Astable Multivibrator

input
output



$R = 1k\Omega$
$f = 1kHz$

input
output



$R : 560\ \Omega$
$f = 1kHz$

Monostable Multivibrator

Result

- The $T_{high} \approx T_{low}$ for the output signal in a stable multivibrato when $R_B >> R_A$ for Astable Multivibrator.
- The Duty cycle ~~is~~ seen for Monostable Multivibrator is 59.27%

Discussion and precaution and Result

(a) Astable multivibratory worked as expected.

(b) As we increase the biasing voltage V_{cc} for astable multivibrator the frequency increases & pulses width decreases

(c) $T_{high} \approx T_{low}$ for output signal in astable multivibrator when $R_B >> R_A$.

(d) Operate using a V_{cc} that gives you output frequency as close to theoritical value.

(e) Connections must be tight.

(f) Don't pass high currents.

(g) Make sure the circuit is not shorted.

(h) 75% Duty cycle was observed for $R = 1K\Omega$ and 59.17% for 560Ω in monostable circuit.

(i) With decreasing capacitance, t_{high} & t_{low} increased.

(j) ~~Daily~~ Duty cycle for astable circuit for $R_B = 3.3K\Omega$ was found as 56.52%.