**PIMPRI CHINCHWAD EDUCATION TRUSTS**
**PIMPRI CHINCHWAD COLLEGE OF ENGINERRING NIGDI,PUNE-44**

Department of Electronics and telecommunication

## IE2 ACTIVITY

Name of the course: Analog Integrated Circuits

Year and Branch:(S.Y) B.Tech(E&TC) 2023-24

Topic- "Design and implement Astable multivibrator for f=2KHZ and 60% duty cycle"

Presented by :

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# ASTABLE MULTIVIBRATOR

An astable multivibrator, also called a free-running multivibrator, is a circuit that continuously produces square waves or pulses without the use of an external trigger. The term “astable” refers to the absence of a stable state in this particular type of multivibrator.

- The circuit is built to alternate between two stable states, resulting in a steady oscillation.
- By changing the values of the resistors and capacitors in the circuit, the frequency and duty cycle of the output waveform can be altered.
- In digital circuits, the astable multivibrator is frequently employed as a clock source. The timing of data transfers between various components can be synchronized using the frequency of the output waveform

The output of an astable multivibrator does not have any stable state and it changes its state from high to low and low to high repeatedly.

## ADVANTAGES

- **Frequency Stability**: They can produce a stable frequency output once properly configured with appropriate components.
- **Square Wave Output**: The output waveform is a square wave, which is useful for digital applications and as a clock signal in digital systems.
- **Tunable Frequency**: By adjusting the values of resistors and capacitors, the frequency of the output waveform can be easily tuned to suit specific requirements.

## DISADVANTAGES

- **Temperature Sensitivity**: The frequency stability of the output waveform can be affected by temperature variations, which might require additional compensation circuits for precise applications.
- **Power Consumption**: Depending on the design and components used, astable multivibrators can consume a significant amount of power, especially if they're designed to operate at higher frequencies.
- **Component Tolerance Sensitivity**: Astable multivibrators can be sensitive to tolerances in component values, which might require careful selection of components for precise operation.

## APPLICATIONS

- Used in square wave frequency generators.
- Used as a timing oscillator in the computer system.
- Used in flashing lights

## CONCLUSION

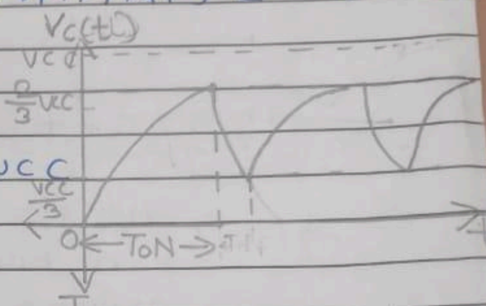
In summary, the astable state of a multivibrator is characterized by its ability to continuously oscillate between two unstable states, producing a square wave output. This state allows for a variety of applications due to its simplicity and versatility.

* Transient analysis of Astable multivibrator:

60%

for TON:

$$v(t) = v(\infty) - (v(\infty) - v_{initial})\, e^{-Ton/(RA+RB)C}$$




capacitor charging

$$v(\infty) = v_{final}$$

$$v_{initial} = \frac{1}{3} VCC$$

$$v(t) = \frac{2}{3} VCC$$

$$V(final) = VCC$$

$$\frac{2VCC}{3} = VCC - \left(VCC - \frac{VCC}{3}\right) e^{-TON/(RA+RB)C}$$

$$\frac{2VCC}{3} = VCC - \left(\frac{3VCC - VCC}{3}\right) e^{-TON/(RA+RB)C}$$

$$\frac{2VCC}{3} = VCC - \frac{2}{3} VCC\, e^{-TON/(RA+RB)C}$$

$$\frac{2VCC}{3} - VCC =$$

$$-\frac{1}{\cancel{3}} \cancel{VCC} = -\frac{2}{\cancel{3}} \cancel{VCC}\, e^{-TON/(RA+RB)C}$$

$$\frac{1}{2} = e^{-TON/(RA+RB)C}$$

$$\ln\left(\frac{1}{2}\right) = \ln\left(e^{-TON/(RA+RB)C}\right)$$

PCCOE

$\cancel{\ln\left(\frac{1}{2}\right)}$

$$-\ln 2 = \frac{T_{on}}{(R_A+R_B)C}$$

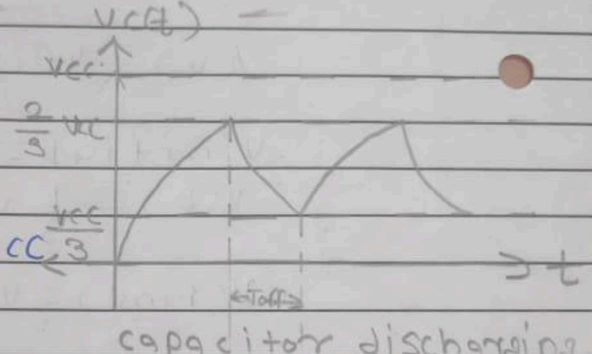
$$\therefore T_{ON} = 0.693(R_A+R_B)C$$

For off :

$v(t) = \frac{1}{3}V_{CC}$

$v_{initial} = \frac{2}{3}V_{CC}$

$v_{final} = 0$




$$v(t) = v_{final} - (v_{final} - v_{initial})e^{-T_{off}/R_BC}$$

$$\frac{1}{3} = 0 - (0 - \frac{2}{3}V_{CC}\, e^{-T_{off}/R_BC}$$

$$\frac{1}{\cancel{3}} = \frac{2}{\cancel{3}}\, e^{-T_{off}/R_BC}$$

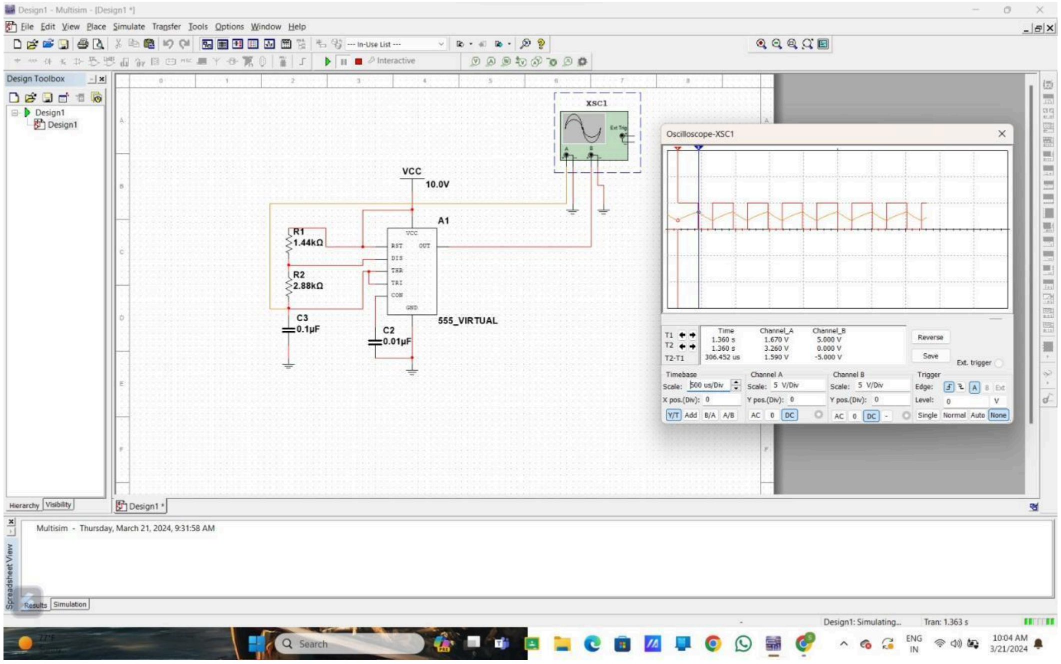
$$\frac{1}{2} = e^{-T_{off}/R_BC}$$

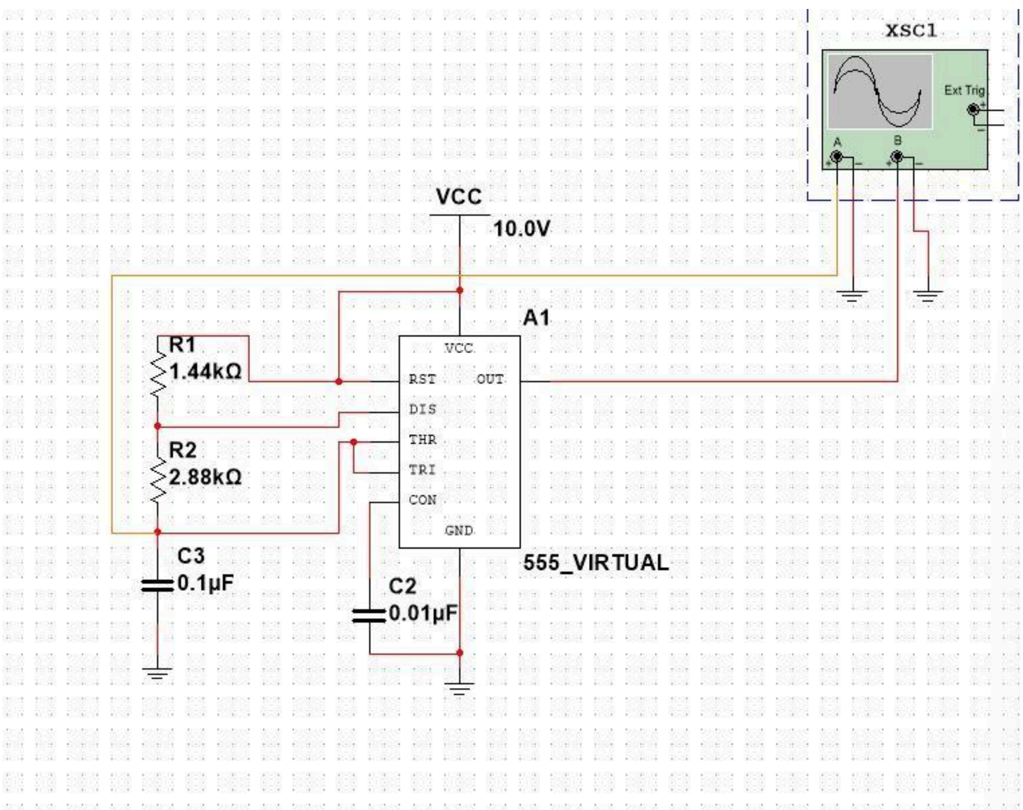
$$\ln\frac{1}{2} = \ln\left(e^{-T_{off}/R_BC}\right)$$

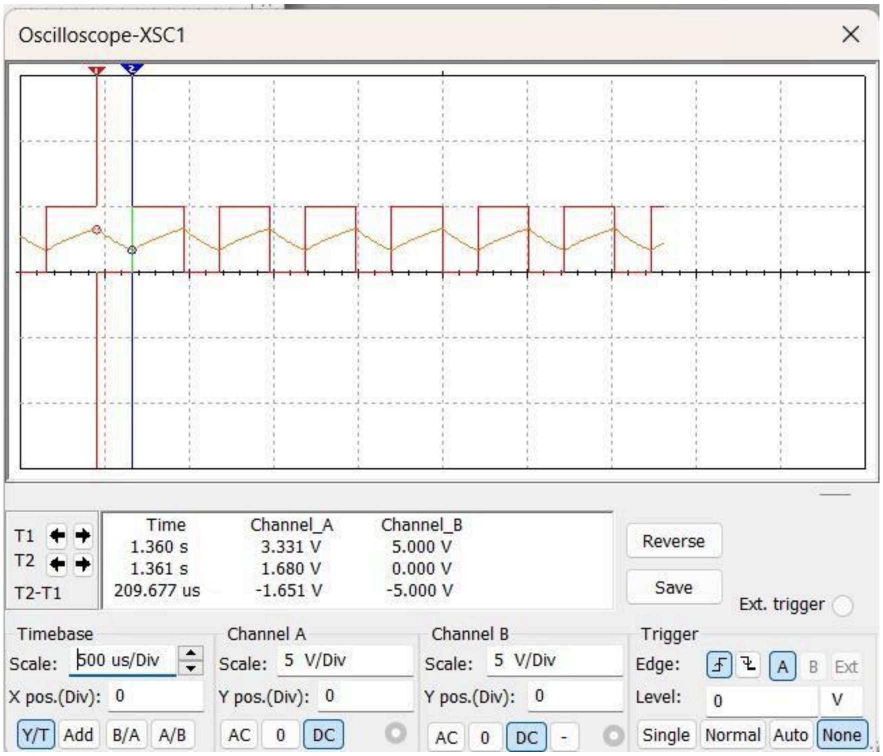
$\cancel{R_B = 0.693 +}$

$$T_{off} = 0.693 R_B C$$

PCCOE




XSC1
Ext Trig
A
B
VCC
10.0V
A1
R1
1.44kΩ
R2
2.88kΩ
C3
0.1µF
C2
0.01µF
VCC
RST
OUT
DIS
THR
TRI
CON
GND
555_VIRTUAL


Oscilloscope-XSC1
T1
T2
T2-T1
Time
1.360 s
1.361 s
209.677 us
Channel_A
3.331 V
1.680 V
-1.651 V
Channel_B
5.000 V
0.000 V
-5.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None


Oscilloscope-XSC1
T1
T2
T2-T1
Time
1.360 s
1.360 s
306.452 us
Channel_A
1.670 V
3.260 V
1.590 V
Channel_B
5.000 V
0.000 V
-5.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None

Problem statement: Design and Implement Astable multivibrator for a frequency of f=2Khz and 60% duty cycle.

Calculations:

Given:

$f = 2\ KHZ$

Duty cycle $= 60\% = 0.6$

To make circuit diagram for given parameters find RA, RB, C

$$T = \frac{1}{f} = \boxed{0.5\ ms}$$

$$\text{Duty cycle} = \frac{T_{ON}}{T}$$

$$0.6 = \frac{T_{ON}}{0.5 \times 10^{-3}}$$

$$\therefore T_{ON} = 0.6 \times 0.5 \times 10^{-3}$$

$$\boxed{T_{ON} = 0.3\ ms}$$

$$T_{off} = T - T_{ON}$$

$$= 0.5ms - 0.3ms$$

$$\boxed{T_{off} = 0.2\ ms}$$

To find RA and RB we have

$$\%D = \frac{RA + RB}{RA + 2RB} \times 100$$

$$\frac{\cancel{0}6\cancel{0}}{10\cancel{0}} = \frac{RA+RB}{RA+2RB}$$

$$6RA + 12RB = 10RA + 10RB$$

$$12RB - 10RB = 10RA - 6RA$$

$$2RB = 4RA$$

$$\boxed{RB = 2RA}$$

we have,

$$T_{ON} = 0.693(RA+RB)C$$

$$0.3 \times 10^{-3} = 0.693(RA+2RA)C$$

Assume $C = 0.1\mu F$

$$0.3 \times 10^{-3} = 0.693\,(3RA) \times 0.1 \times 10^{-6}$$

$$\frac{0.3 \times 10^{-3}}{0.1 \times 10^{-6} \times \cancel{0.693}\, 0.693 \times 3} = RA$$

$$\frac{\cancel{3} \times 10^{3}}{\cancel{3} \times 0.693} = RA$$

$$1.44 \times 10^{3} = RA$$

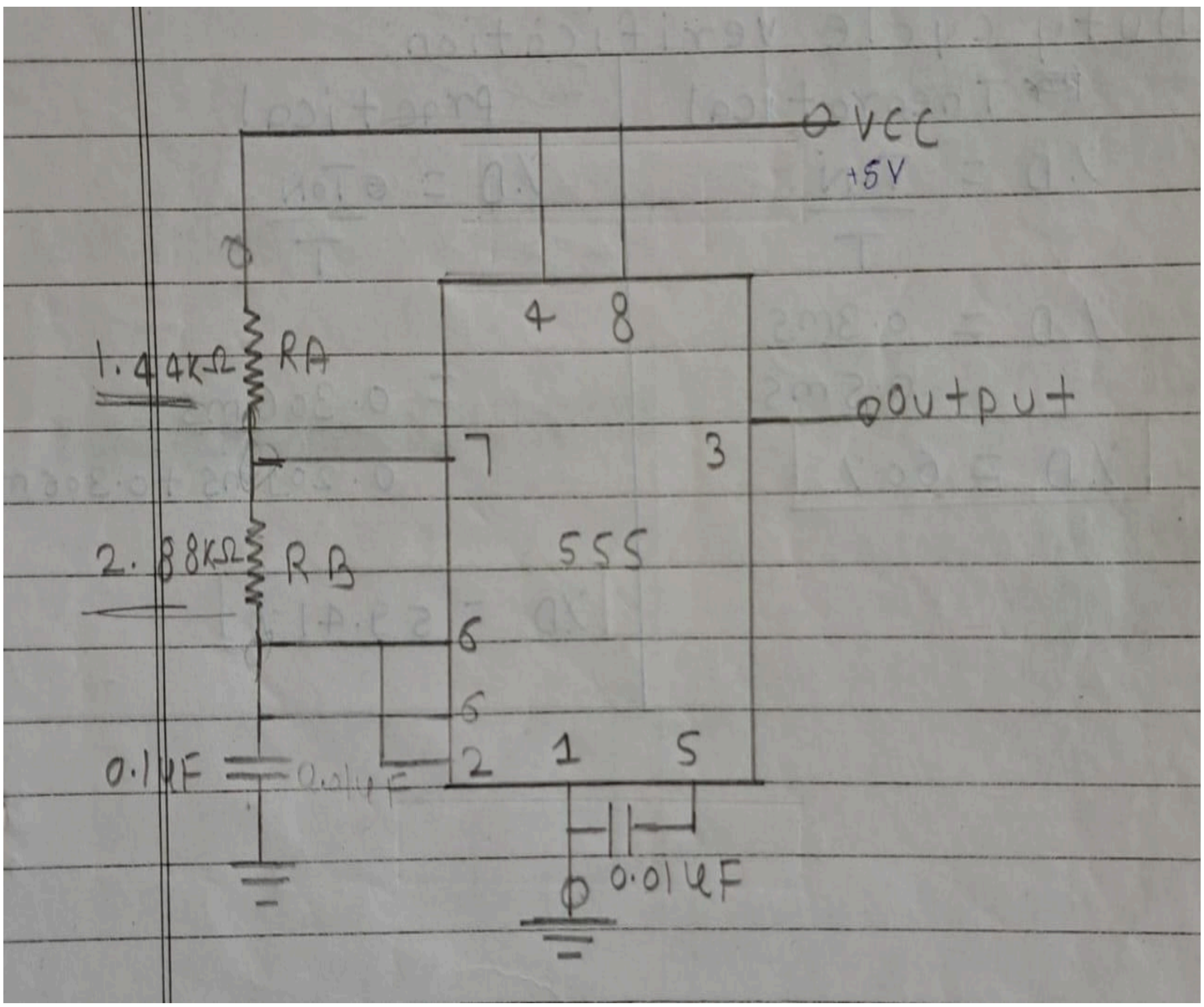
$$\boxed{RA = 1.44\,k\Omega} \approx \underline{1.5\,k\Omega}$$

$RB = 2 \times RA$

$RB = 2 \times 1.44 \times 10^3$

$\boxed{RB = 2.88\ k\Omega}$ $\approx \underline{2.7\ K\Omega}$

Circuit Diagram:



READINGS VERIFICATION:

| SR.NO | Theorotical reading | Practical reading | Hardware reading |
|---|---|---|---|
| 1 | TON=0.3ms | TON=0.306ms | TON =260 |
| 2 | TOFF=0.2ms | TOFF=0.209ms | TOFF=245 |

HARDWARE CIRCUIT