Working of 555 Timer
(Unit IV)

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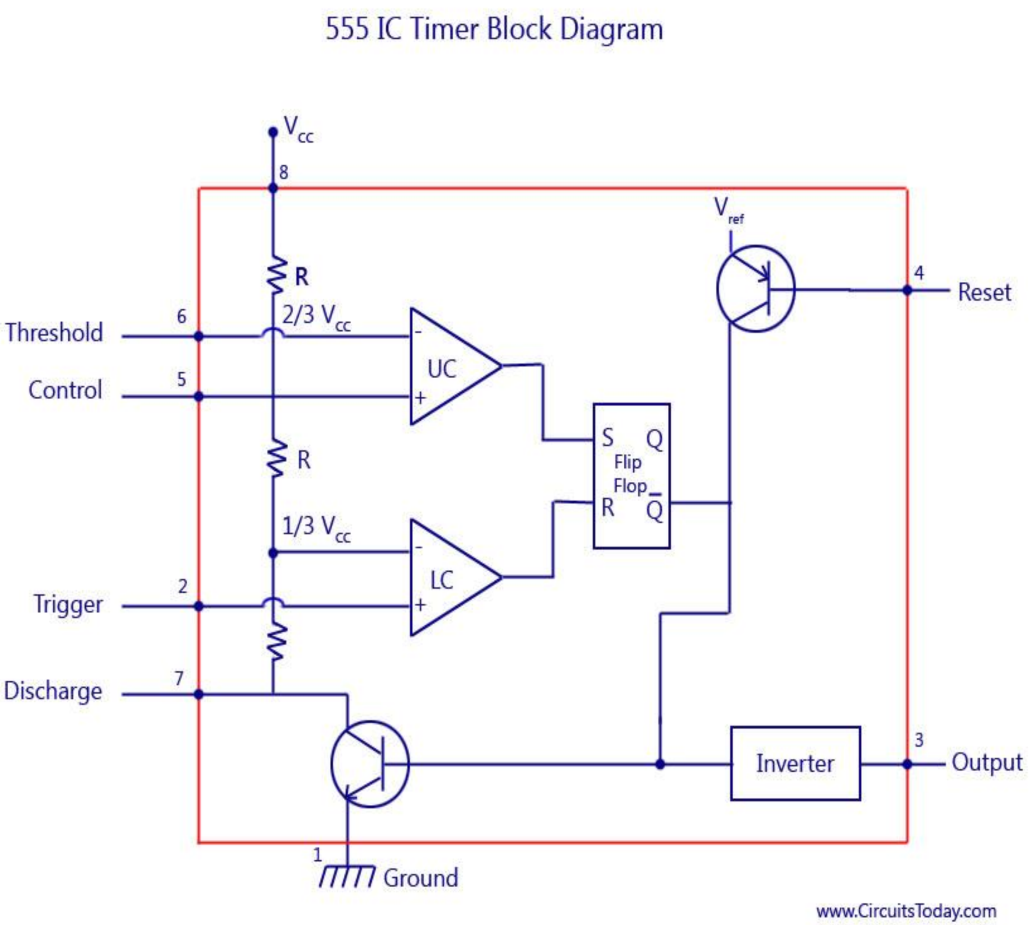
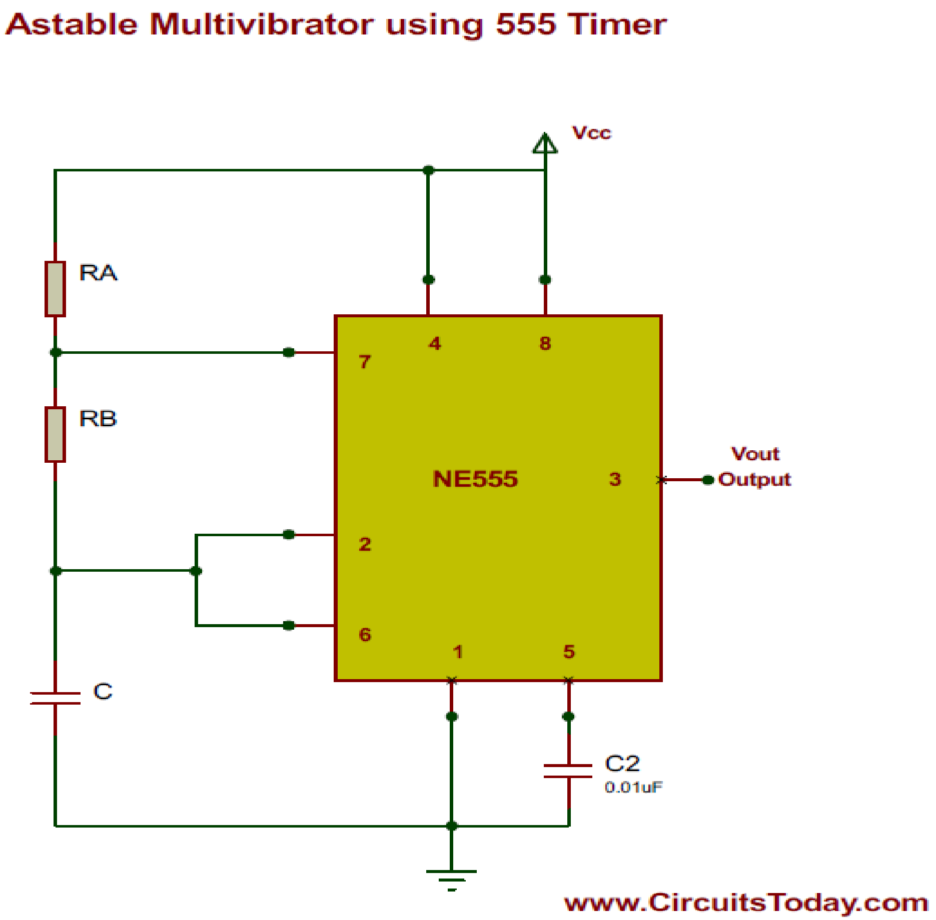
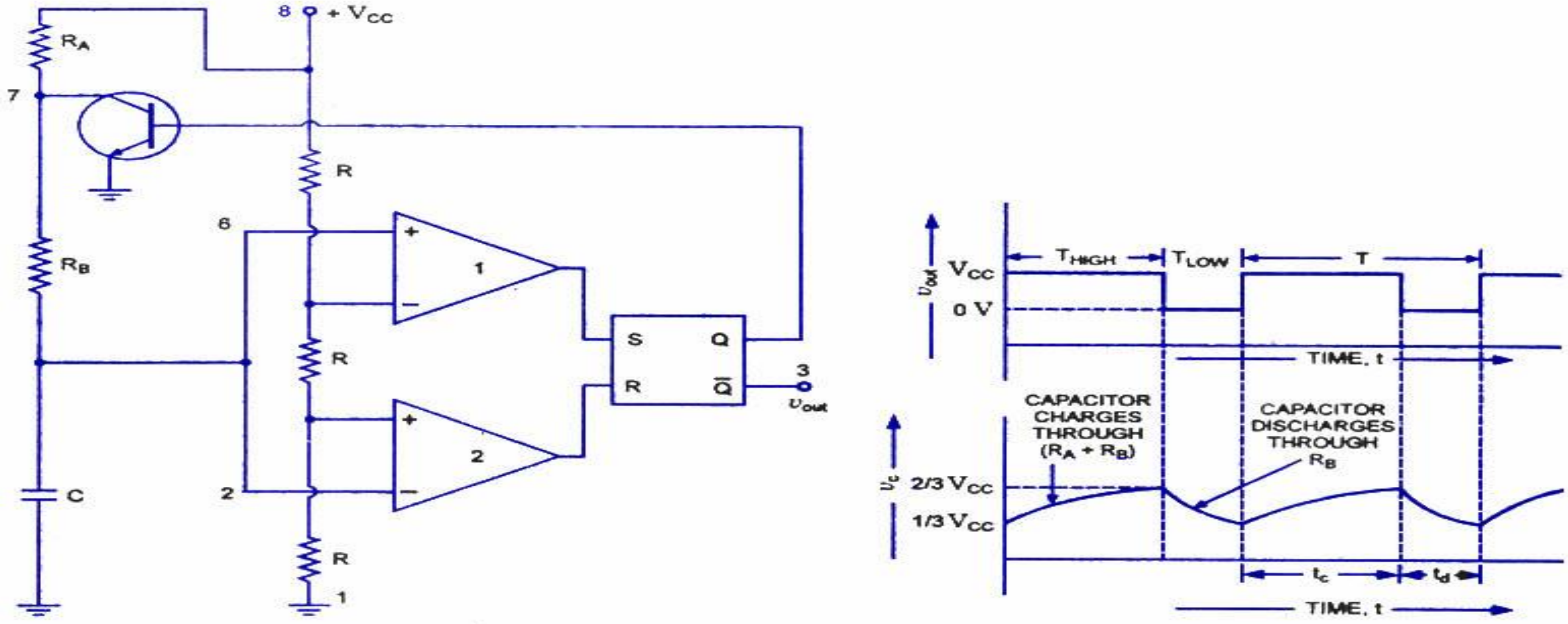
Configuration of 555 as a astable multivibrator





Working of 555 as astable

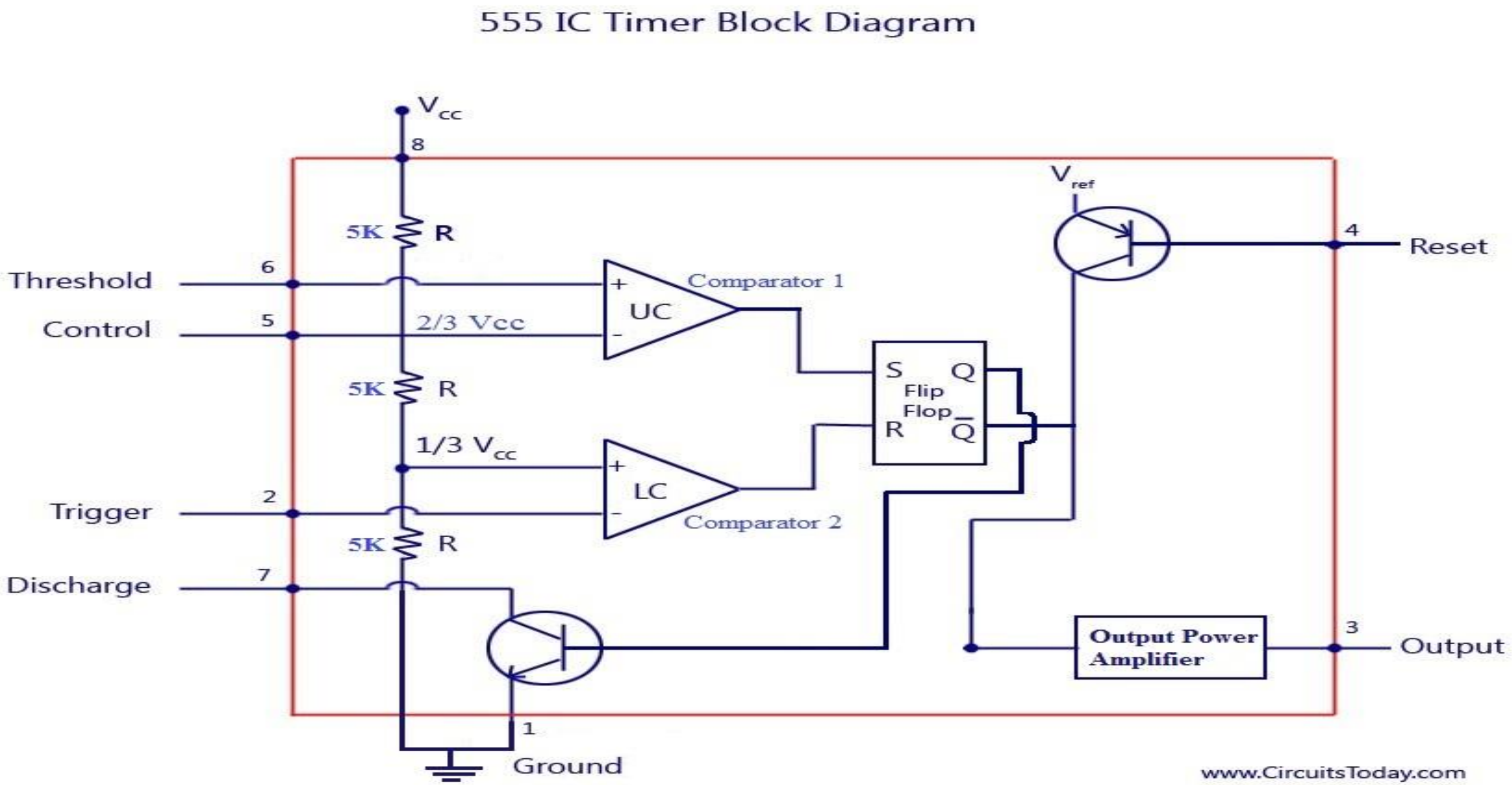


Internal Circuitry With External Connections

Capacitor and Output Voltage Waveforms

Astable Operation

555 as monostable multivibrator



Derivation

- The time during which the capacitor C charges from 1**/3 V_{CC} to 2/3 V_{CC}** is equal to the time the output is high and is given as **t_c or T_{HIGH} = 0.693 (R_A + R_B) C**, which is proved below.
- Voltage across the capacitor at any instant during charging period is given as,
- **$v_c = V_{CC}(1 - e^{t/RC})$**
- The time taken by the capacitor to charge from 0 to +1/3 V_{CC}

1/3 VCC = VCC (1-e$^{t/RC}$)

The time taken by the capacitor to charge from 0 to +2/3 V_{CC}

- or **t_2 = RC $\log_e$ 3 = 1.0986 RC**

So the time taken by the capacitor to charge from +1/3 V_{CC} to +2/3 V_{CC}

- **$t_c = (t_2 – t_1)$ = (1.0986 – 0.405) RC = 0.693 RC**

Substituting R = (R_A + R_B) in above equation we have

- **$T_{HIGH} = t_c$ = 0.693 (R_A + R_B) C**
- where R_A and R_B are in ohms and C is in farads.

Derivation

- The time during which the capacitor discharges from +2/3 V_{CC} to +1/3 V_{CC} is equal to
- the time the output is low and is given as
- **t_d or T_{L0W} = 0.693 R_B C** where R_B is in ohms and C is in farads The above equation is worked out as follows: Voltage across the capacitor at any instant during discharging period is given as
- **$v_c = 2/3\ V_{CC}\ e^{-}\ t_{d/}\ R_BC$**
- Substituting v_c = 1/3 V_{CC} and t = t_d in above equation we have
- **$+1/3\ V_{CC} = +2/3\ V_{CC}\ e^{-}\ t_{d/}\ R_BC$**
- Or **$t_d = 0.693\ R_BC$**

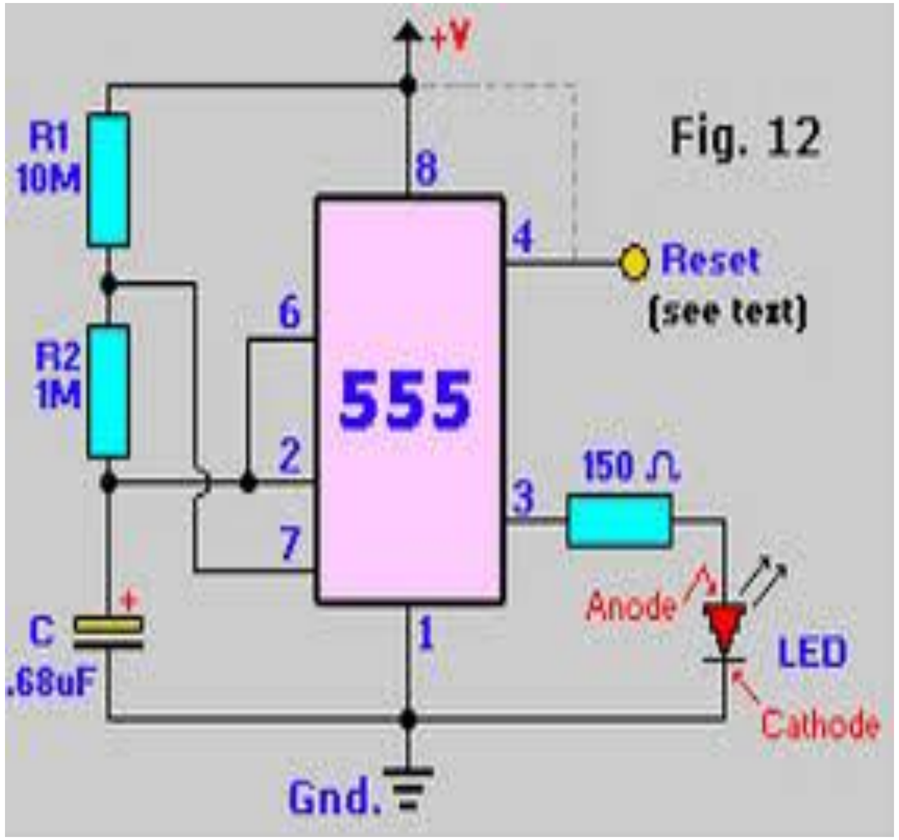
Final equation

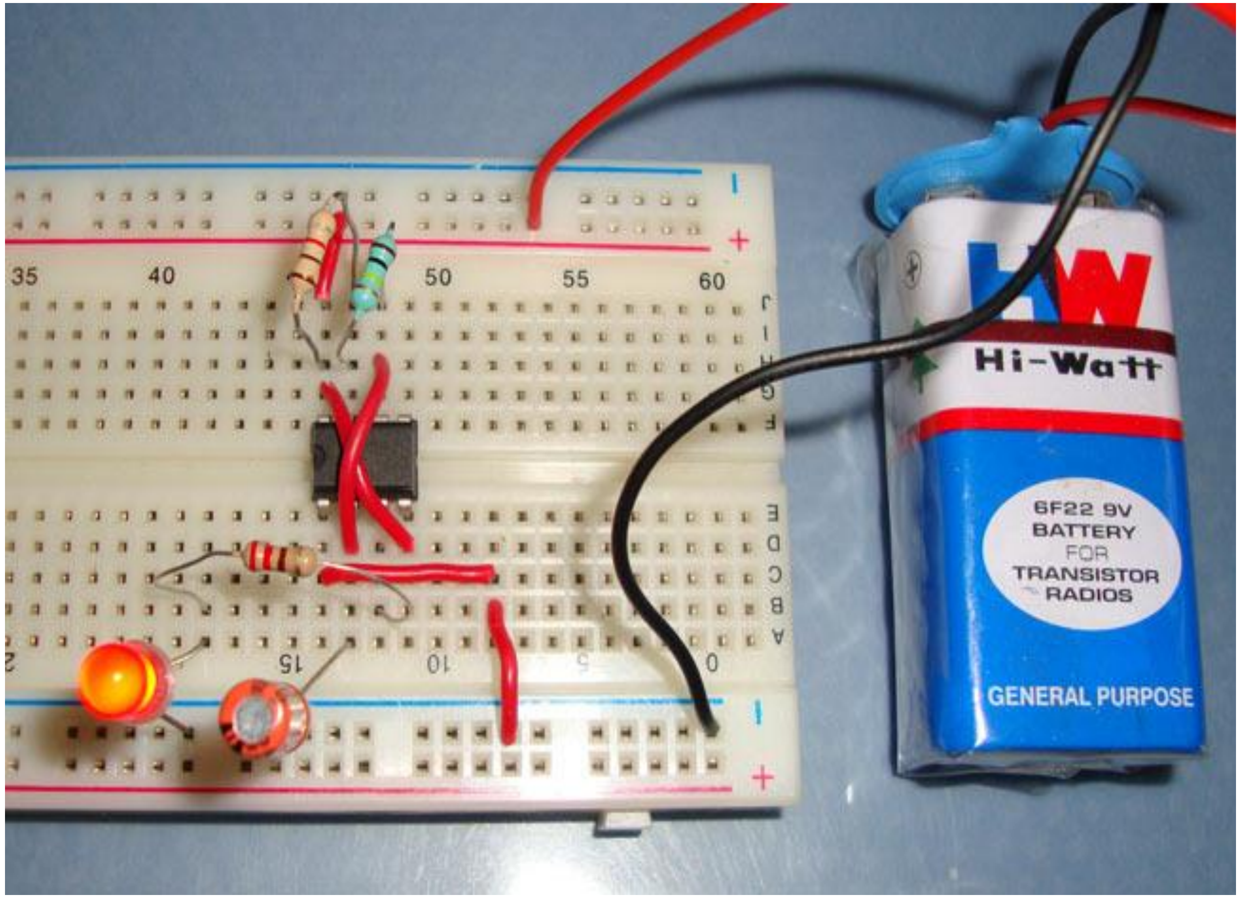
- Overall period of oscillations, **$T = T_{HIGH} + T_{LOW} = 0.693 (R_A + 2R_B) C$** , The frequency of oscillations being the reciprocal of the overall period of oscillations T is given as
- **$f = 1/T = 1.44/ (R_A + 2R_B)C$**
- Equation indicates that the frequency of oscillation / is independent of the collector supply voltage $+V_{CC}$.
- Often the term duty cycle is used in conjunction with the astable multivibrator.
- ***The duty cycle, the ratio of the time t_c during which the output is high to the total time period T is given as***
- **% duty cycle, $D = t_c / T * 100 = (R_A + R_B) / (R_A + 2R_B) * 100$**

Square wave generator using 555 astable

- From the above equation it is obvious that square wave (50 % duty cycle) output can not be obtained unless R_A is made zero. However, there is a danger in shorting resistance R_A to zero. With R_A = 0 ohm, terminal 7 is directly connected to + V_{CC}. During the discharging of capacitor through R_B and transistor, an extra current will be supplied to the transistor from V_{CC} through a short between pin 7 and +V_{CC}. It may damage the transistor and hence the timer.
- The capacitor C charges through R_A and diode D to approximately + 2/3V_{CC} and discharges through resistor R_B and terminal 7 (transistor) until the capacitor voltage drops to 1/3 V_{CC}.
- Then the cycle is repeated. To obtain a square wave output, R_A must be a combination of a fixed resistor R and a pot, so that the pot can be adjusted to give the exact square wave.

Practical working (Blinking LED)





Design a astable for frequency of 5 KHz and 75% duty cycle.

frequency = 5 kHz

$T = \frac{1}{5\,kHz} = 0.2\ ms.$

$0.2\ ms = T_{on} + T_{off}$

$T_{on} = 75\% \times 0.2\ ms$

$= 0.75 \times 0.2$

$= 0.15\ ms$

$T_{off} = 0.25 \times 0.2$

$=$ ~~0.25~~ $0.05\ ms$

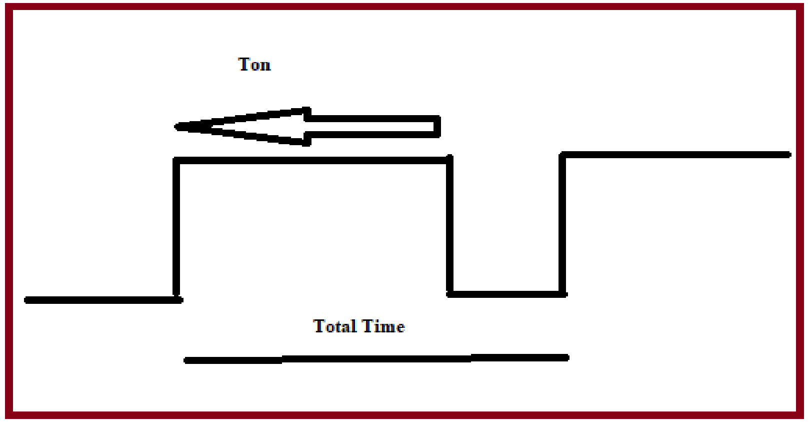
but $t_{off} = 0.693 \times R_b \times C$

assume $C = 0.1\ \mu F$

$0.05 = 0.693 \times R_b \times 0.1 \times 10^{-6}$

$\frac{0.05 \times 10^{-3}}{0.693 \times 0.1 \times 10^{-6}} = R_b$

~~721.5 kΩ~~ = Rb.

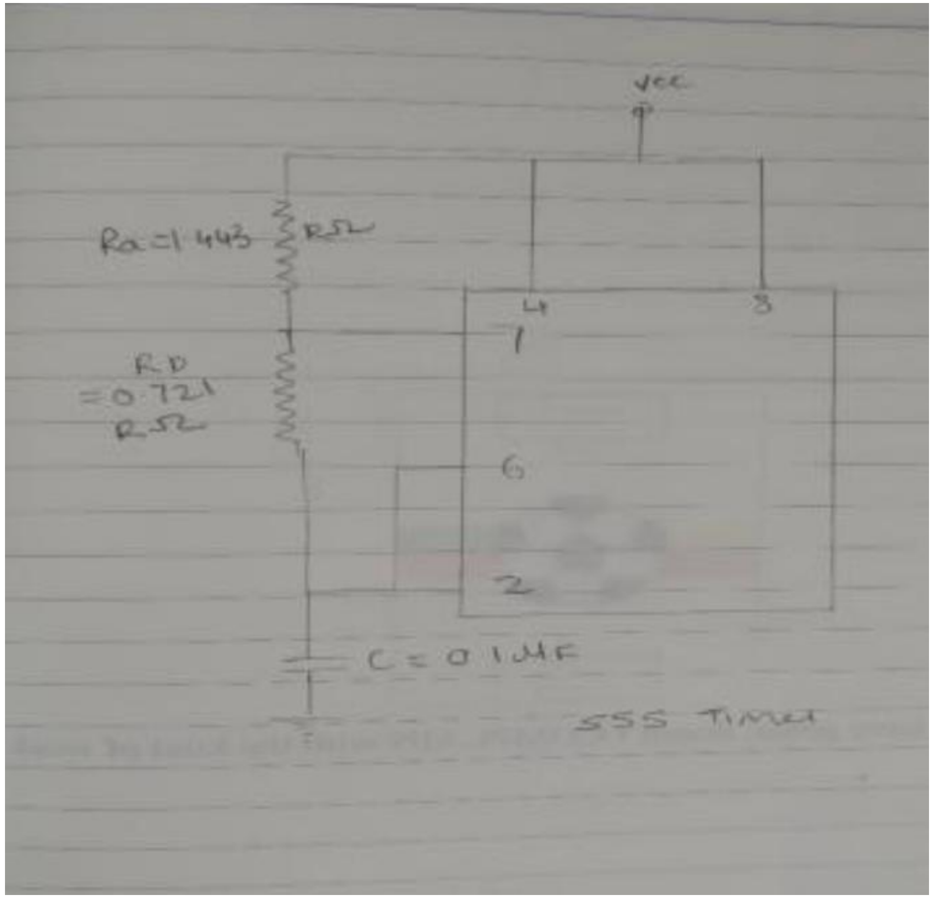


$721.5\ \Omega = R_b.$

$T_{on} = 0.693\,(R_a + R_b)\,C$

$0.15\times10^{-3} = 0.693\,(R_a + 721.5)\,0.1\times10^{-6}.$

$R_a = 1.443\ k\Omega.$



THANK YOU