MULTIVIBRATORS

UG (III part)

~ Dr S. Roy

The multivibrator is a switching circuit generating non-sinusoidal waves such as square wave, rectangular waves saw-tooth waves etc. A transistor can be used as a switching circuit. Due to capacitive effects in a transistor, the output does not directly follow its input. ~~Fig (1)~~ Thus there is always delay between the application of input and change in the output. It is shown in fig (1). In order to measure how quickly the output changes, we consider the following few terms.

1. Time delay (t_d):- The time interval between the beginning of the input pulse and the output voltage or current to reach 10% of its maximum value is defined as time delay

2. Rise time (t_r):- It is the time required for the output to change from 10% of its final value to 90% of its final value

3. Turn-on time T_{ON}: The sum of time delay and rise time is defined in turn-on time. Thus

$$T_{ON} = t_d + t_r \simeq 40 \text{ nsec for high speed switching silicon transistor.}$$

The ON time of transistor is ~~given~~ obtained by charging of a capacitor through resistor in

(2)

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Multivibrator

which $Q = Q_0(1 - e^{-t/CR})$. For capacitor $Q \propto V$

$\therefore V = V_0(1 - e^{-t/CR})$

or, $\frac{V}{V_0} = 1 - e^{-t/CR}$

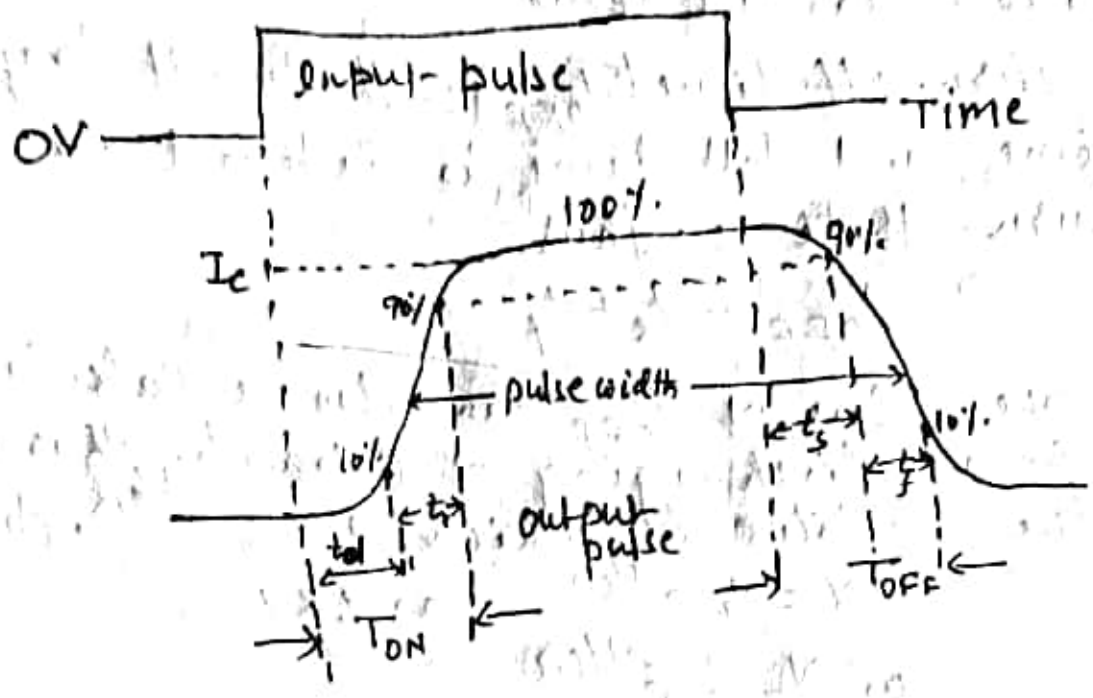

Fig (1)

~~4. Storage time~~

$e^{-t/CR} = 1 - \frac{V}{V_0}$

or, $-\frac{t}{CR} = \log\left(1 - \frac{V}{V_0}\right)$

or, $t = -CR\log\left(1 - \frac{V}{V_0}\right)$

From this eqn, we can calculate t_d for which $\frac{V}{V_0} = 10\% = \frac{10}{100}$ and t_r for which $\frac{V}{V_0} = \frac{90}{100}$. Finally we obtain $T_{ON} = 0.69CR$.

(4) Storage time (t_s) :- The time interval between the end of the input pulse (trailing edge) and when the output falls to 90% of its maximum value is defined as storage time.

5. Fall time (t_f) :- The time interval during which the output falls from 90% of its maximum value to 10% is called as fall time

6. Turn-off time (T_{OFF}) :- The sum of storage time and fall time is defined as turn-off time. Thus

$$T_{OFF} = t_s + t_f$$

The value of T_{OFF} can also be calculated from discharging of capacitor through the resistor in which $Q = Q_0 e^{-t/CR}$, obviously

$$V = V_0 e^{-t/CR} \quad \text{as } Q \propto V$$

$$\text{or } \frac{V}{V_0} = e^{-t/CR}$$

$$\text{or, } -\frac{t}{CR} = \log \frac{V}{V_0}$$

$$\text{or, } t = -CR \log \frac{V}{V_0}$$

This equation gives the value of t_s & t_f and hence the value of T_{OFF}. Here V_0 = initial value and V = final value of voltage.

6. Pulse width (W) :- The time duration of the output pulse measured between two 50% level of rising and falling waveform is defined as pulse width.