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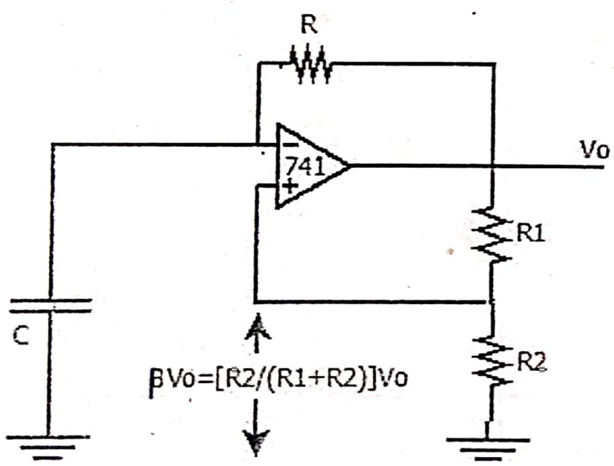
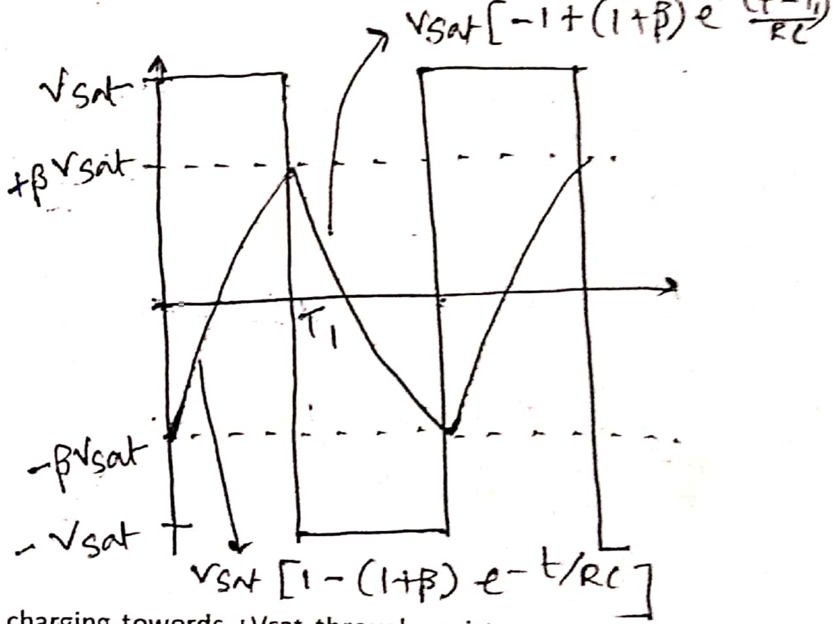
Multivibrator:

Multivibrator is a relaxation oscillator generating nonsinusoidal waveform. There are three classes of multivibrators: astable, bistable & monostable.

Astable multivibrator:

- The principal of generation of square wave o/p is to force an opamp to operate in the saturation region. A fraction of o/p voltage is β=R2/(R1+R2) of the o/p is feedback to the +ve i/p terminal. Thus the Vref is βV_0 & take values as +βVsat or –βVsat. The o/p is also feedback to the –ve i/p terminal after integrating by means of a lowpass RC combination whenever i/p at the –ve terminal just exceeds Vref switching takes place resulting in a square wave o/p. the square wave generator is called astable multivibrator.





When the o/p is a +Vsat, the capacitor now starts charging towords +Vsat through resistance R. The voltage at the +ve i/p terminal is hold at +βVsat by R1 & R2 combination. This condition continues as the charge on C rises, untill it has just exceeded +βVsat, when the voltage just greater than this reference voltage,the o/p is driven to –Vsat. At this instant, the capacitor starts to discharge through R towords -Vsat. When the o/p voltage switches to –Vsat , the capacitor charge more & more negetively untill its voltage just exceeds –βVsat. The cycle isrepeats itself.

The voltage across the capacitor as a function of time is given by, $V_c=V_f+(V_i-V_f)e^{-t/RC}$

The final value Vf=+Vsat , Initial value= -βVsat

$V_c = V_{sat} + (-\beta V_{sat} - V_{sat}) e^{-t/RC}$

$\quad = V_{sat} - V_{sat}(1+\beta) e^{-t/RC}$

At $t = T_1$, voltage across capacitor reaches βV_{sat}

So, $V_c = \beta V_{sat} = V_{sat} - V_{sat}(1+\beta) e^{-T_1/RC}$

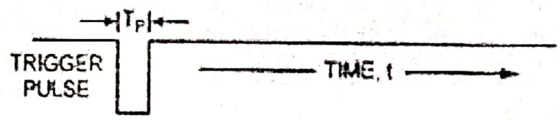
$T_1 = RC \ln (1+\beta)/(1-\beta)$

Total time period,

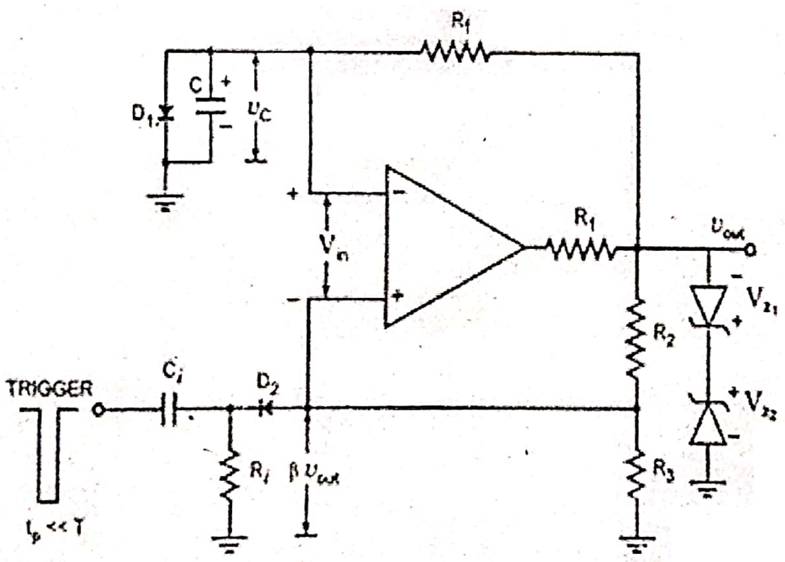
$T = 2T_1 = 2RC \ln (1+\beta)/(1-\beta)$

Monostable multivibrator:

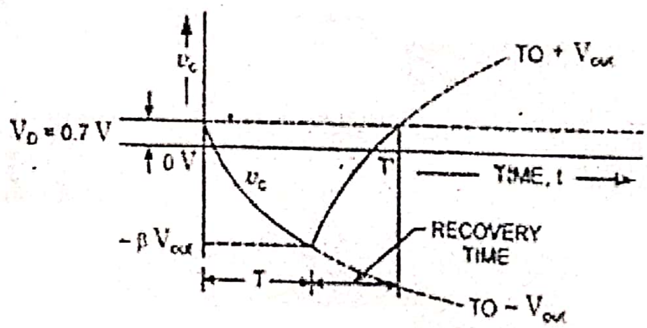
Monostable multivibrator has one stable ~~sathe~~ state & other is quasistable state. The ckt is useful for generating signal o/p pulse of adjusting signal o/p pulse of adjustable time duration in response to a trigger signal.



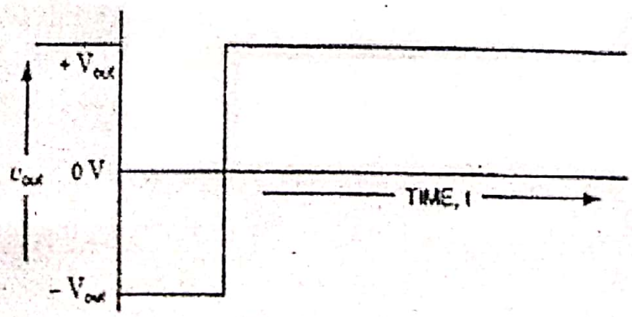
(b) Negative Trigger Pulse



(a) Basic Circuit



(c) Waveform of v_c



(d) Output Waveform

Pulse Generator

A diode D_1 clamps the capacitor voltage to 0.7v when the o/p is at +Vsat. A negative going pulse signal of magnitude V_1 passing through the differentiator R_iC_i & diode D_2 prodeces a negative going triggering impulse & is applied to the +ve i/p terminal. In stable state , the o/p V_0 is +Vsat. The diode D_1 conducts & V_c the voltage across the capacitor C gets clamped to +0.7v. the voltage at the +ve i/p terminal through R_1R_2 is +βVsat. Now, if a negative trigger of magnitude V_1 is applied to the +ve i/p terminal, the o/p of opamp will switch from +Vsat to –Vsat. The diode will now get reverse biased & the capacitor gets charge exponentially to –Vsat through resistance R. the voltage at the +ve i/p terminal is now –βVsat. When the capacitor voltage V_c becomes just slightly negative than –βVsat. The capacitor C now starts charging to +Vsat through R until V_c is 0.7v.

The o/p voltage, $V_0 = V_f + (V_i - V_f)\, e^{-t/RC}$

Where V_f=final value= -Vsat

V_i=initial value=V_D (diode forword voltage)

The o/p V_C is, $V_C = -Vsat + (V_D + Vsat)e^{-t/RC}$

At t=T , $V_C = -\beta Vsat$

$-\beta Vsat = -Vsat + (V_D + Vsat)e^{-t/RC}$

Or, $Vsat(1-\beta) = Vsat(1+V_D/Vsat)e^{-t/RC}$

Or, $(1-\beta) = (1+V_D/Vsat)\, e^{-t/RC}$

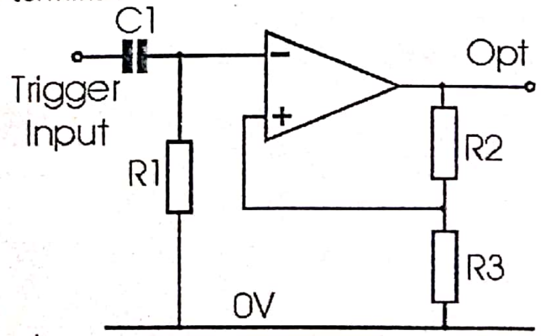
Or, $e^{-t/RC} = (1+V_D/Vsat) / (1-\beta)$

Or, $t/RC = \ln (1+V_D/Vsat) / (1-\beta)$

At t=T, $T = RC \ln (1+V_D/Vsat) / (1-\beta)$

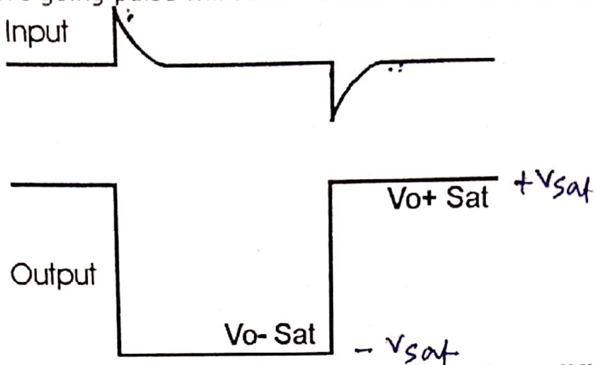
Bistable multivibrator:

An incoming waveform is converted into short pulses and these are used to trigger the operational amplifier to change between its two saturation states. To prevent small levels of noise triggering the circuit, hysteresis is introduced into the circuit, the level being dependent upon the application required. A fraction β=R3/(R2+R3) pf the o/p is feedback to the +ve i/p terminal. A RC combination is used in –ve i/p terminal.



Bistable multivibrator operational amplifier circuit

The bistable circuit has two stable states. These are the positive and negative saturation voltages of the operational amplifier operating with the given supply voltages. The circuit can then be switched between them by applying pulses. A negative going pulse will switch the circuit into the positive saturation voltage, and a positive going pulse will switch it into the negative state.



Waveforms for the bistable multivibrator operational amplifier circuit

It is very easy to calculate the points at which the circuit will trigger. The positive going pulses need to be greater than Vo-Sat through the potential divider, i.e. Vo-Sat x R3 / (R2 + R3), and similarly the negative going pulses will need to be greater than Vo+Sat through the potential divider, i.e. Vo+Sat x R3 / (R2 + R3). If they are not sufficiently large then the bistable will not change state.

What are the basic difference between Astable, monostable and biostable multivibrator ?

→ i) An astable multivibrator has no stable state but only two quasi-stable states which is keeps on oscillating automatically at a rate determined by the circuit component.

Monostable multivibrator has one stable state and one quasi-stable state. The circuit remains in the stable state untill a triggering pulse causes a transition to the quasistable state. Then after some time it returns automatically to its stable state.

Bistable multivibrator has two stable states. The circuit remains in one of these stable states untill a triggering signal causes transition to the other stable state.

ii) An astable multivibrator is also called free-running multivibrator, that produce a ~~so~~ train of square wave pulses at a fixed frequency.

A ~~bistable~~ monostable multivibrator is also called one-shot multivibrator.

Bi~~Mono~~stable multivibrator is called filpflop that produces a single pulse either positive or [4] negative

that produces a single

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