

## Op-amp based monostable multivibrator

**Aim:** To understand the operation of monostable multivibrator

A monostable multivibrator is a class of multivibrator that has one stable state and one temporarily stable state (quasistable state). On application of a trigger pulse, the circuit makes a transition from stable state to quasistable state. The circuit then returns to its stable state on its own. The duration of the quasistable state is determined by the circuit components (R and C).

The circuit diagram of the circuit is shown in Fig 4(a). A rectified differentiator circuit with  $R_4$  -  $C_2$  -  $D_2$  is used to produce a negative-going narrow pulse which then serves as a trigger to the monostable circuit.

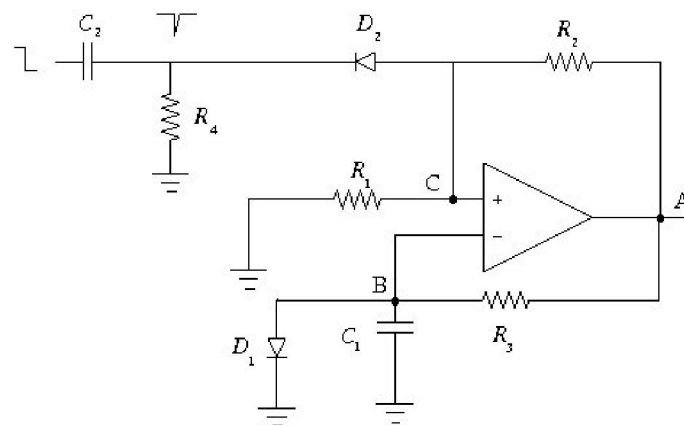


Figure 4 (a)

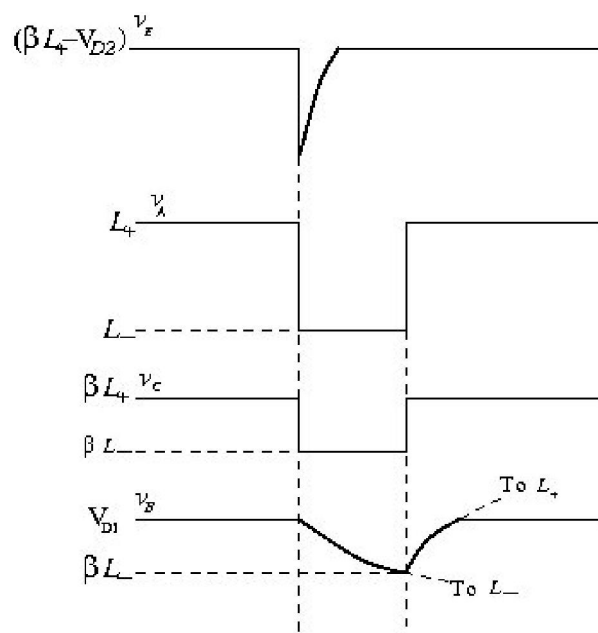


Figure 4 (b)

In the stable state, i.e., when the trigger input has not yet gone low,  $V_o$  is high ( $=L^+$ ).  $R_4$  is chosen to be much larger than  $R_2$  and therefore the current through  $D_2$  is small. In other words,  $V_C$  is given approximately by simple voltage division,  $V_C = \frac{R_1}{R_1+R_2} L^+$ , i.e.,  $V_C = \beta L^+$ . Node B is clamped at about 0.7 V. For the op-amp in the stable state  $V_+ = V_C = \beta L^+$ ,  $V_- = V_B = 0.7$  V.  $\beta$  is chosen so that  $V_+ > V_-$  and the op-amp output is at  $L^+$ , consistent with our analysis.

When the input voltage goes low, a negative-going pulse is produced at node C. If this voltage goes below  $V_{D1} \approx 0.7$  V, the op-amp output changes from  $L^+$  to  $L^-$ . The diode  $D_2$  is now off and the differentiator circuit is therefore not in the picture. The simplified circuit in this phase is shown in Fig. 5.

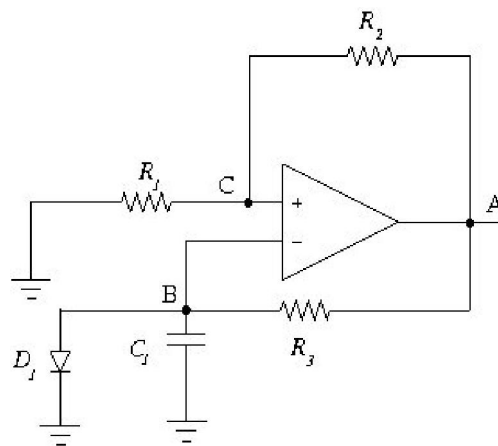


Figure 5

The capacitor now starts discharging towards  $L^-$  through  $R_3$ .  $V_C$  is at  $\beta L^-$ . When  $V_B$  becomes less negative than  $V_C$ , the op-amp output changes back to  $L^+$  since  $(V_+ - V_-) = V_C - V_B$  is now positive. Beyond this point,  $C_1$  starts charging towards  $L^+$  through  $R_3$  and  $V_B$  gets clamped at 0.7 V when  $D_1$  turns ON. The  $L^+$  phase of the output for a time interval that depends on  $\tau = R_3 C_1$ . Let the capacitor voltage be  $V_{C1}(t) = A e^{-t/\tau} + B$ .

Let the discharging start at  $t=0$  (see Fig. 4(b)). Then, we have  $V_{C1}(t) = V_{D1}$  at  $t=0$ , and  $V_{C1}(\infty) = L^-$ , giving  $B = L^-$  and  $A = V_{D1} - L^-$ .

$V_{C1}(t)$  is therefore given by,

$$V_{C1}(t) = (V_{D1} - L^-) e^{-t/\tau} + L^-.$$

The pulse starts for  $T$  seconds, and at  $t = T$ ,  $V_{C1}(t) = \beta L^-$ .

$$\beta L^- = (\beta L^+ - L^-) e^{-T/\tau} + L^-,$$

$$T = \tau \ln \frac{V_{D1} - L^-}{\beta L^- - L^-}, \quad \tau = R_3 C_1.$$

### **Lab session**

1. Design the monostable multivibrator circuit for 3 ms pulse width.
2. Simulate the circuit (see Fig. 4(a)) with the values calculated from step (1). Verify the monostable pulse width at the output with the period specified in step (1) by applying the negative going pulse.