Op-amp based monostable multivibrator

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 1(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.

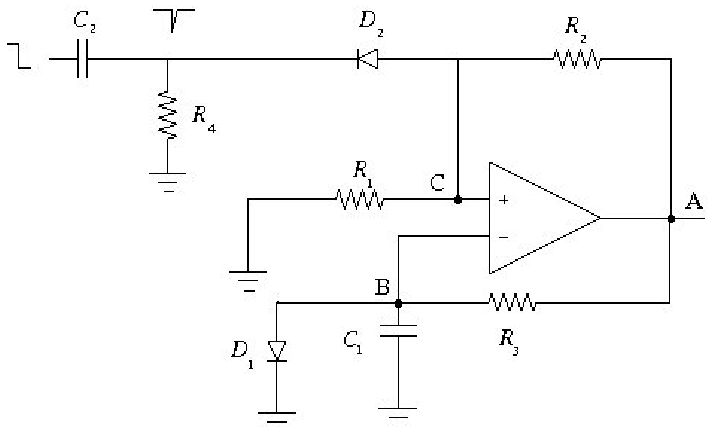

Figure 1 (a)

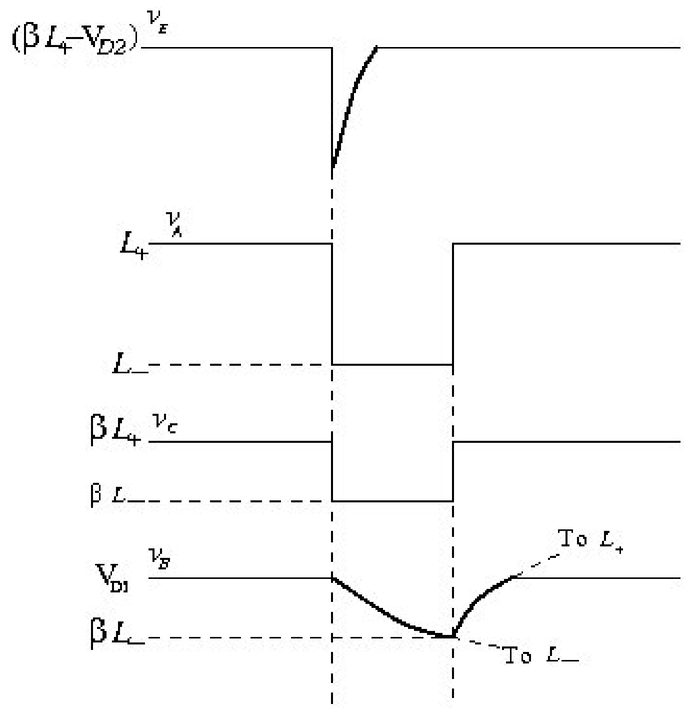

Figure 1 (b)

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. β 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. 2.

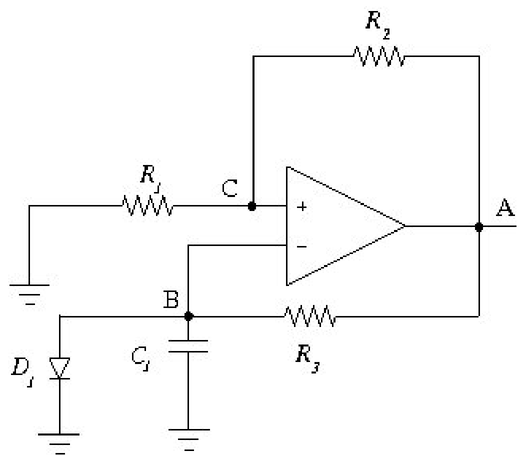

Figure 2

The capacitor now starts discharging towards L^- through R_3. V_C is at βL^-. 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 $\tau = R_3C_1$. Let the capacitor voltage be $V_{C1}(t) = Ae^{-t/\tau}+B$.

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 $t = T$, $V_{C1}(t) = \beta L^-$.

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

$T = \tau \ln \frac{V_{D1} - L^-}{\beta L^- - L^-}$, $\tau = R_3C_1$.