ic555a.sqproj

Description

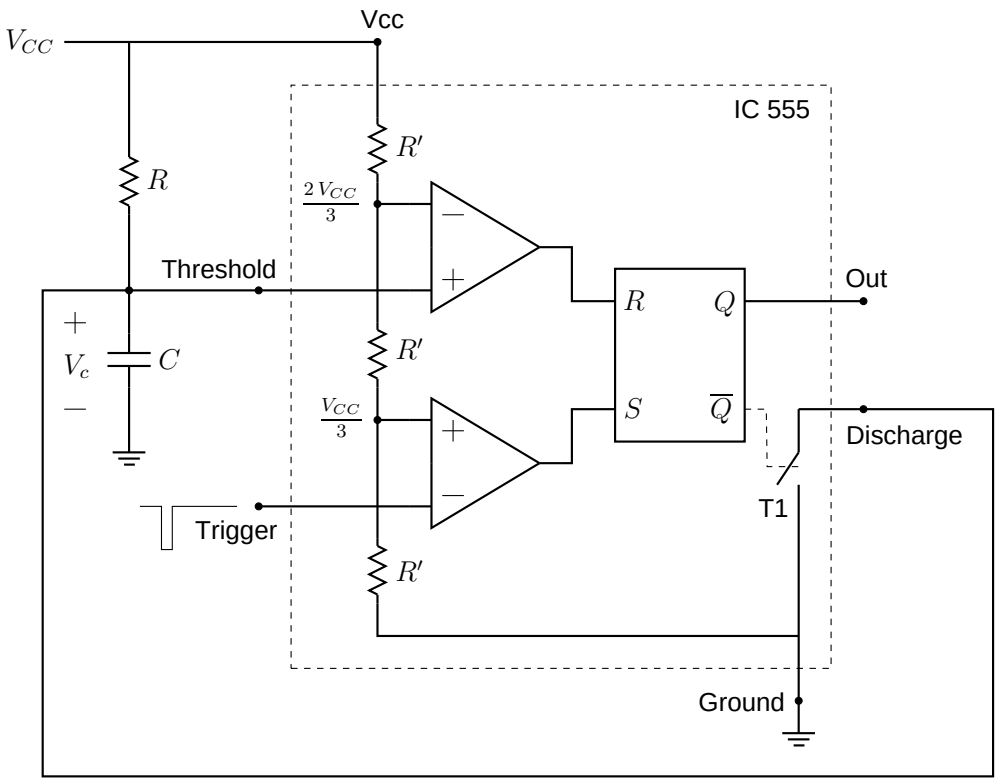

Figure 1: Monostable operation of the 555 timer.

The purpose of a monostable circuit is to produce an output pulse of a desired duration when a short input triggering pulse is applied. In the circuit of Fig. 1, the triggering pulse is required to be negative-going. Fig. 2 shows the waveforms resulting from the application of a trigger pulse. Before t_0, we have a steady-state situation in which the flip-flop output Q is low. The switch T1 (which is actually a BJT) is closed since $\overline{Q}$ is high. The capacitor voltage is therefore $V_c = 0\,V$. During this time, $R = S = 0$, and the flip-flop holds its present state. At $t = t_0$, the triggering pulse goes low, thus making $S = 1$. Note that the capacitor voltage V_c remains $0\,V$ since it cannot change instantaneously, and we have $R = 0$, $S = 1$. The flip-flop output Q goes high, $\overline{Q}$ goes low, the switch T1 opens, and the capacitor starts charging toward V_{CC} with a time constant $\tau = RC$.

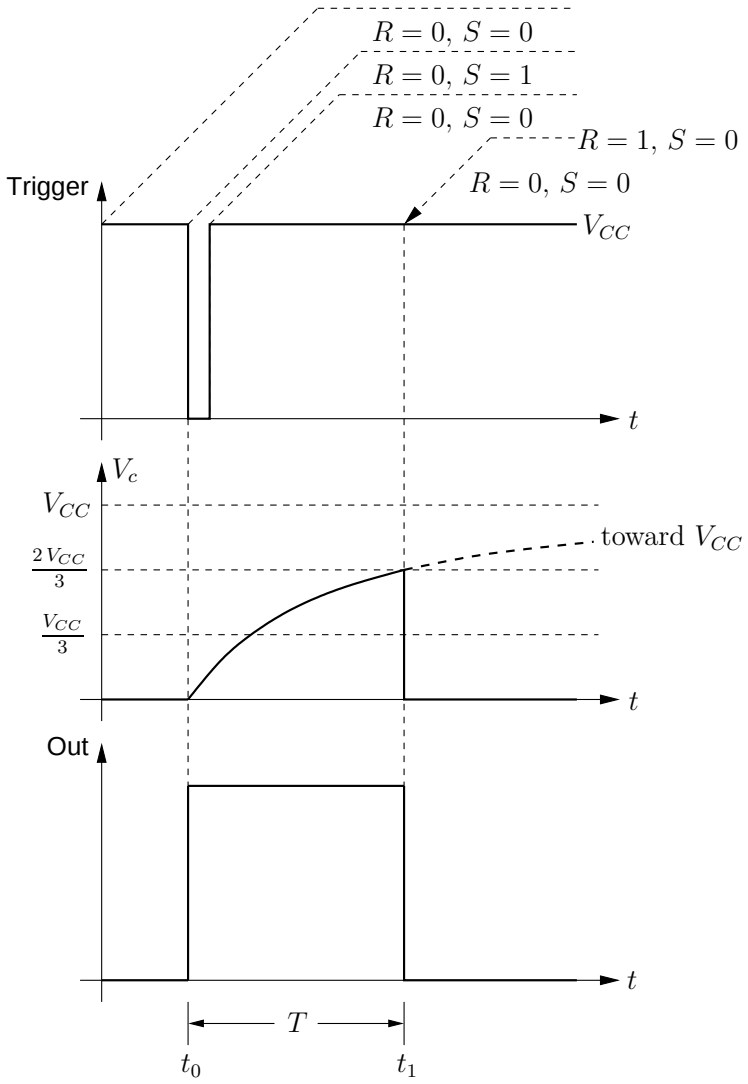

Figure 2: Waveforms for monostable operation of the 555 timer.

In the meanwhile, the trigger pulse (which is by design shorter in duration than the output pulse) has become high again (see Fig. 2), and we have $R = S = 0$. This situation continues up to $t = t_1$ at which point V_c crosses $2\,V_{CC}/3$, thus causing $R = 1$, $S = 0$, which resets the flip-flop, and it is once again in the stable state, with $Q = 0$, $R = 0$, $S = 0$, $V_c = 0\,V$.
The duration of the output pulse (T in Fig. 2) is determined by the time taken by the capacitor to charge from $0\,V$ to $2\,V_{CC}/3$ with a time constant of $\tau = RC$, and is given by,

$$T = R\,C\ln 3\,. \tag{1}$$

Exercise Set

1. For $R = 1\,\mathrm{k}\Omega$ and $C = 1\,\mu F$, calculate the expected pulse width T. Verify by simulation.

2. By simulation, obtain waveforms for V_c and Q. Compare with the expected waveforms shown in Fig. 2.

3. What will happen if C is increased/decreased by a factor of 2? Verify by simulation.