Analysis of Astable Multivibrator using Transistors

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Astable multivibrator is a class of multivibrators in which the output state is not stable. It has two quasi stable states (logic LOW and HIGH). This circuit[1] is also known as free running multivibrator as it does not require external triggering for its operation.

1 Schematic Diagram

The schematic of astable multivibrator using transistors drawn in eSim is as shown below.

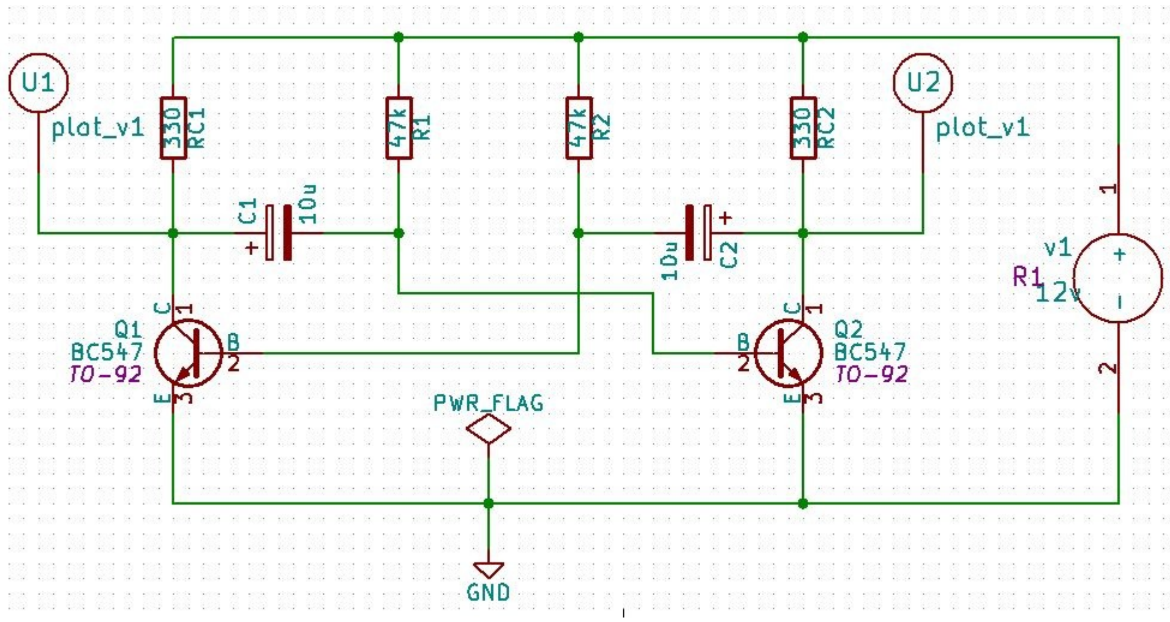

Figure 1: *Astable Multivibrator*

2 Theory

This circuit is wired using two BC547 npn transistors Q_1 and Q_2, two collector resistances R_{C1} and R_{C2} (330Ω), two base resistances R_1 and R_2 (47kΩ) and two collector to base capacitances C_1 and C_2 (10μF).

All the circuit elements are connected as in the schematic shown in figure 1.

Due to minute variations during manufacturing, no two transistors can be made identical. Assume that Q_1 conducts more. This makes Q_1 ON. When Q_1 is ON, the collector voltage of Q_1 (ie., V_{C1}) drops to V_{CEsat} (0.2V approx.). Since, it is coupled to the base of the transistor Q_2, it forces Q_2 to switch to OFF state.

At the same time, the capacitor C_1 charges to V_{CC} (+12V here) through the resistor R_1 with a time constant of R_1C_1. This charging increases the voltage across the capacitor C_1. When this voltage is sufficient enough to turn ON Q_2, Q_2 will become ON and it forces Q_1 to go to OFF state. This process continues and the voltage at the collector terminal of both the transistors switches from V_{CEsat} to V_{CC}.

3 Simulation Results

Ngspice and Python plots obtained after simulation are shown in figures 2 to 7.

[1] S Salivahanan, N Suresh Kumar, A Vallavaraj, *Electronic Devices and Circuits*, Tata McGraw Hill, New Delhi, 1998

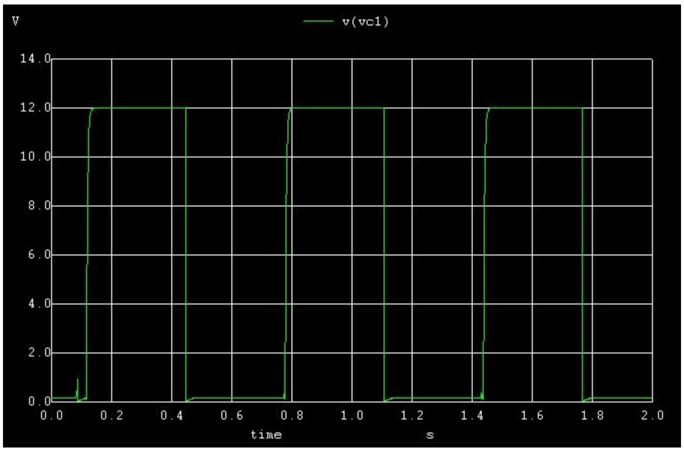

Figure 2: *Collector voltage of Q_1*

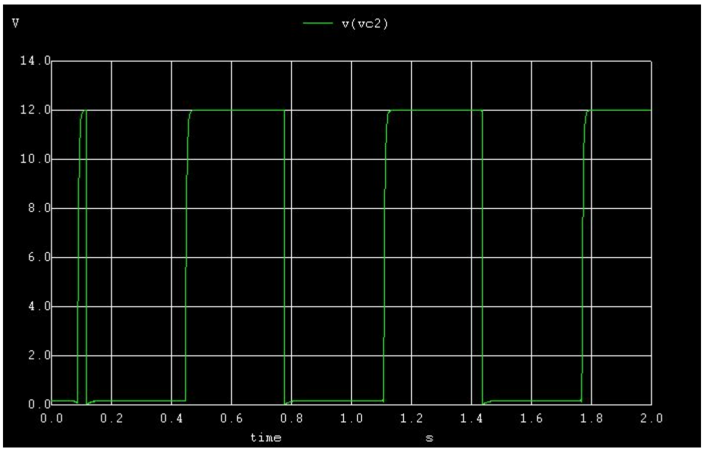

Figure 3: *Collector voltage of Q_2*

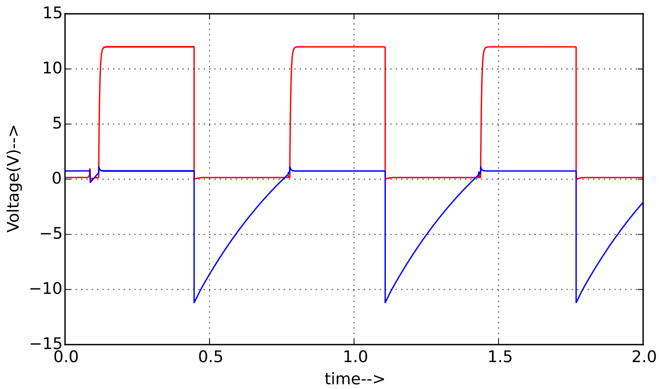

Figure 4: *Collector voltage of Q_1 (Red) and Base voltage of Q_2 (Blue)*

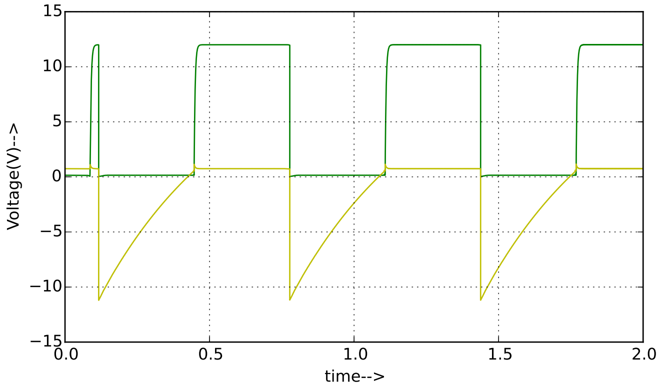

Figure 5: *Collector voltage of Q_2 (Green) and Base voltage of Q_1 (Yellwo)*

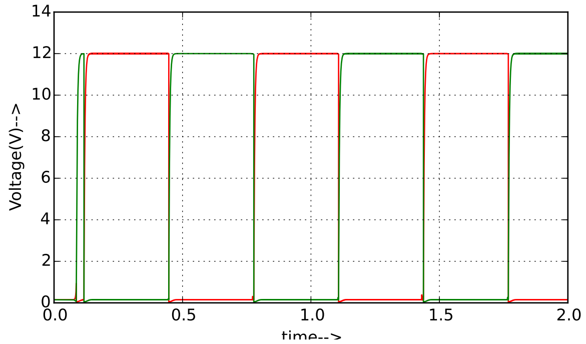

Figure 6: *Collector voltage of Q_1 (Red) and Collector voltage of Q_2 (Green)*

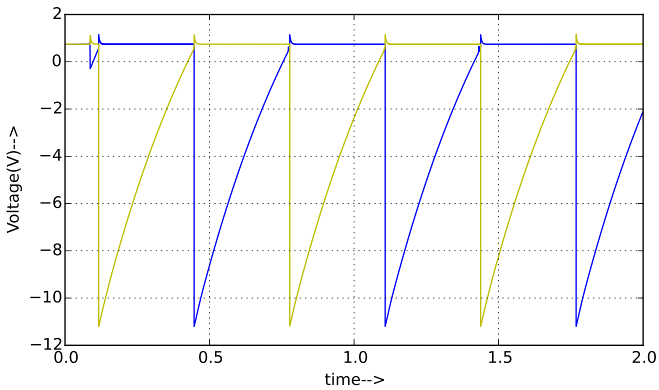

Figure 7: *Base voltage of Q_1 (Yellow) and Collector voltage of Q_2 (Blue)*