A-stable Multivibrator

Tabish
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<u>Aim</u>: To assemble an A-stable multivibrator by using two NPN transistors, and study its time period.

<u>Apparatus</u>:

Component	**quantity**
1k, 1/4 watt resistor	2 nos.
100k, 1/4 watt resistor	2 nos.
LED	2 nos.
CL100 transistor	2 nos.
10μF capacitor	2 nos.

1 Introduction

Astable Multivibrator is a two stage switching circuit in which the output of the first stage is fed to the input of the second stage and vice versa. The outputs of both the stages are complementary. This free running multivibrator generates square wave without any external triggering pulse. The circuit has two states and switches back and forth from one state to another, remaining in each state for a time depending upon the discharging of a capacitor through a resistor.

2 Principle of the experiment

This circuit shows a typical simple astable circuit. It works as follows: Consider that Q1 is turned on and conducting, and Q2 is off. The voltage on the collector of Q1 will be close to zero, causing C1 to charge via R1 and Q1 collector-emitter. The charge on C1 will keep increasing and so will the voltage at the base of Q2. During this time, because Q2 is not conducting, the capacitor C2 will charge via R4, through the base-emitter of Q1. This charging of C2 will be very fast because R4 is small. So, the end of C2 connected to the collector of Q2 will be at voltage +Vcc (actually less by the BE voltage of Q1) with respect to the base of Q1.

When the voltage at the base of Q2 crosses 0.6 volts, which is required to conduct the base-emitter diode of Q2, the transistor Q2 switches on, and its LED lights up. The voltage at the collector of Q2 goes to near zero. The right end of C2 is suddenly brought to 0 volts. So, the other end (base of Q1), sees a voltage -Vcc because of the charge on the capacitor. That switches off Q1.

The capacitor C2 now starts charging through R2 and the CE of Q2, making the voltage across the it less negative, and then zero and then positive. C2 keeps charging via R2 until it reaches about 0.6V (required to conduct the BE diode of Q1), at which point Q1 will switch on again. The LED in series with Q1 will light up again, and the cycle continues.

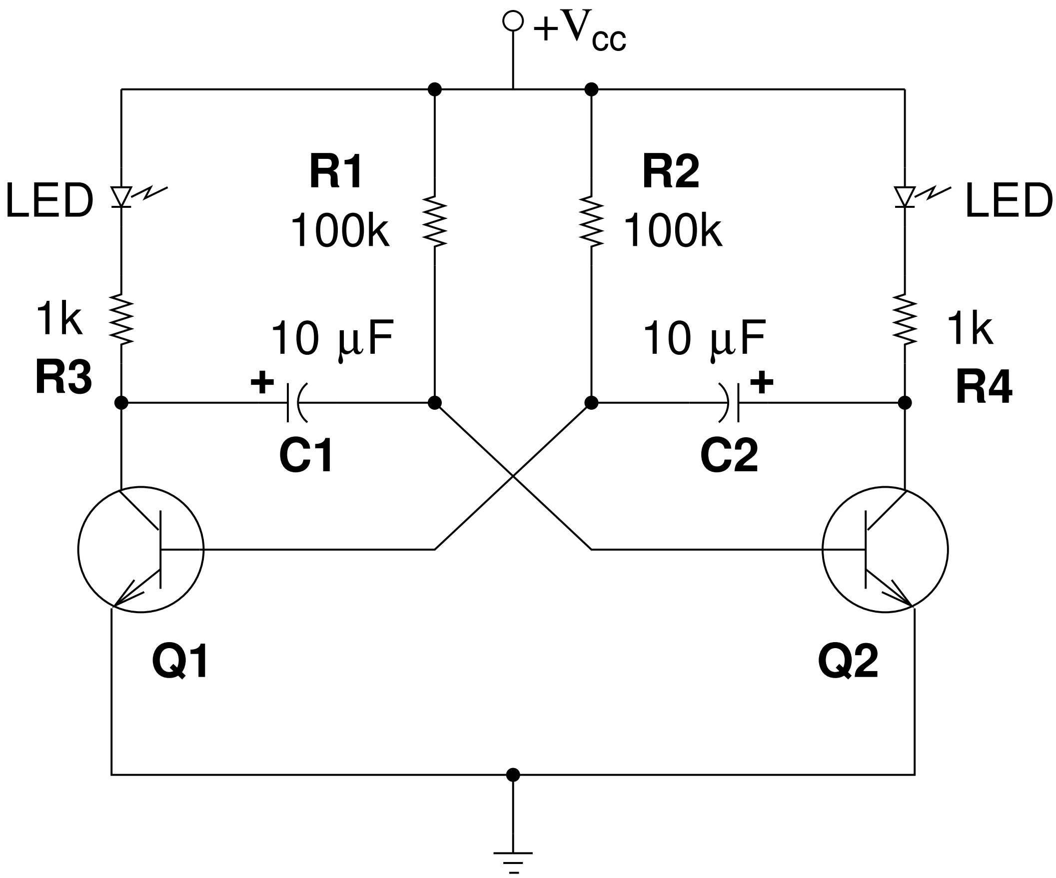

Figure 1: Circuits for A-stable multivibrator using NPN transistors.

So, the time LED of Q2 remains on is the time taken by the capacitor C2 to charge from -Vcc to 0.6 volts. Normally Vcc is about 10-12 volts, so 0.6 volts is neglected, and taken to be zero. So, one needs to calculate how much time does a capacitor take to charge from -Vcc to 0, if it is being charged by a voltage +Vcc. That is fairly straight forward.

Applied voltage across a capacitor C and the resistor R should be equal to the applied voltage, Vcc:

$$V_{cc} = IR + Q/C$$

$$V_{cc} = R\frac{dQ}{dt} + Q/C$$

This can be integrated easily, with the condition that at $t = 0$, the voltage across the capacitor is V_0, to give

$$V(t) = V_{cc} - (V_{cc} - V_0)e^{-t/RC}.$$

For our case, the initial voltage $V_0 = -V_{cc}$ and we have to find out the time T at which $V(T) = 0$. This gives:

$$T = \log(2)RC,$$

$$T = 0.693RC,$$

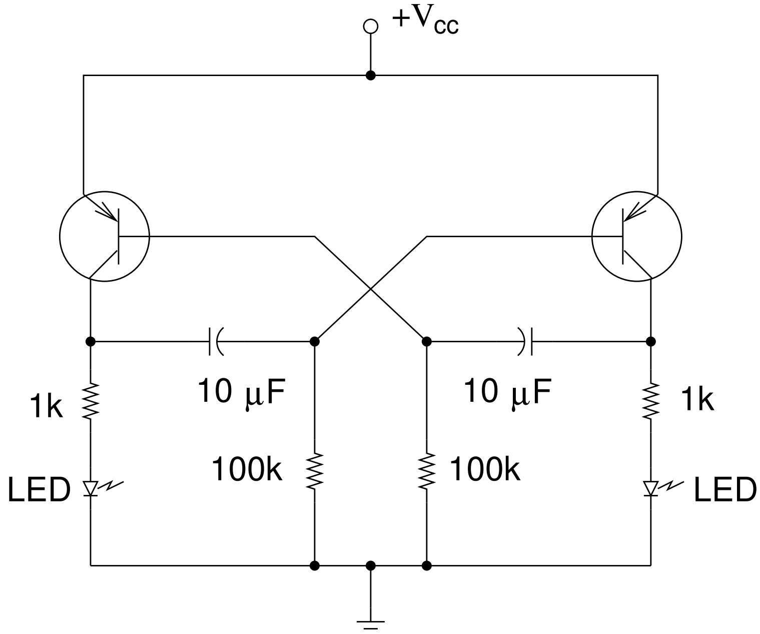

Figure 2: Circuits for A-stable multivibrator using PNP transistors.

3 Soldering tips

- Soldering requires two main things: a soldering iron and solder. Soldering irons are the heat source used to melt solder. Irons of the 15W to 30W range are good for most electronics/printed circuit board work. Anything higher in wattage and you risk damaging either the component or the board.
- **Safety:** Remember that when soldering, the resin in the solder releases fumes. These fumes are harmful to your eyes and lungs. Therefore, always work in a well ventilated area. Hot solder is also dangerous. Be sure not to let it drip around because it will burn you almost instantly.
- **Surface Preparation:** A clean surface is very important if you want a strong, low resistance joint. All surfaces to be soldered should be cleaned with sand paper.
- **Component Placement:** After the component and board have been cleaned, you are ready to place the component on the board. Bend the leads as necessary and insert the component through the proper holes on the board. To hold the part in place while you are soldering, you may want to bend the leads on the bottom of the board at a 45 degree angle.
- **Apply Heat:** Apply a very small amount of solder to the tip of the iron. This helps conduct the heat to the component and board, but it is not the solder that will make up the joint. Now you are ready to actually heat the component and board. Lay the iron tip so that it rests against both the component lead and the board. Normally, it takes one or two seconds to heat the component up enough to solder, but larger components and larger soldering pads on the board can increase the time.

- **Apply Solder And Remove Heat:** Once the component lead and solder pad has heated up, you are ready to apply solder. Touch the tip of the strand of solder wire to the component lead and pcb copper, but not the tip of the iron. If everything is hot enough, the solder should flow freely around the lead and the pcb copper. Once the copper surface is completely coated, you can stop adding solder and remove the soldering iron (in that order). Don't move the joint for a few seconds to allow the solder to cool. If you do move the joint, you will get what's called a **"cold joint"**.
  Applying heat and putting solder should be done quickly, as prolonged heating can damage your components.

- **Cold Solder Joints:** A cold joint is a joint in which the solder does not make good contact with the component lead or printed circuit board pad. Cold joints occur when the component lead or solder pad moves before the solder is completely cooled. Cold joints make a really bad electrical connection and can prevent your circuit from working.

  Cold joints can be recognized by a characteristic grainy, dull gray colour, and can be easily fixed. This is done by first removing the old solder with a desoldering tool or simply by heating it up and flicking it off with the iron. Once the old solder is off, you can resolder the joint, making sure to keep it still as it cools.

4 Measuring the time period

Apply power to the circuit, about 10-12 volts, and watch the LEDs blink. Note the time taken for a hundred blinks of any one of the LEDs, using a stop-watch. Find the time period, and compare with the theoretical value.