Analog Electronics Project

Guided by:

Dr. Vinayak Hande

Submitted by:

Priyanka Kurkure (2015EEB1061)

Astable Multivibrator using BJTs

March 15, 2017

Overview

An Astable Multivibrator or a Free Running Multivibrator is the multivibrator which has no stable states. Its output oscillates continuously between its two unstable states without the aid of external triggering. The time period of each states are determined by Resistor Capacitor (RC) time constant.

Goals

1. To make an astable multivibrator using NPN bipolar junction transistors.
2. To improve the sharpness of the edges of square pulse oscillations generated by the multivibrator using added circuitry.

Circuit Diagram :

Attached in the repository

Working

- When the circuit is switched on one transistor will driven to saturation (ON) and other will driven to cutoff (OFF). Consider U1 is ON and U2 is OFF.
- During this time Capacitor C2 is charging to Vcc through resistor R.
- U2 is OFF due to the -ive voltage from the discharging capacitor C1 which is charged during the previous cycle. So the OFF time of U2 is determined by R''C1 time constant.
- After a time period determined by R''C1 time constant the capacitor C1 discharges completely and starts charging in reverse direction through R''.
- When the Capacitor C1 charges to a voltage sufficient provide base emitter voltage of 0.7V to the transistor U2, it turns ON and capacitor C2 starts discharging.
- The negative voltage from the capacitor C2 turns off the transistor U1 and the capacitor C1 starts charging from Vcc through resistor R2and base emitter of transistor U2. Thus the transistor U2 remains in ON state.
- As in the previous state, when the capacitor C2 discharges completely it starts charging towards opposite direction through R'.
- When the voltage across the capacitor C2 is sufficient to turn ON transistor U1, U1 will turn ON and capacitor C1 starts discharging.

- This process continuous and produces rectangular waves at the collector of each transistors.
- **Note** : Charging time is very less compared to discharging time.

Design

R2– Collector Resistor

The resistance R2should be designed to limit the collector current Ic with in a safe limit.

R2= V/Ic , where V is the voltage across the resistor R.

In normal cases, **V = (Vcc – Vce) = (Vce – 0.3)** but when an emitter load like LED is connected,

V = (Vcc – Vce – Vled) , where Vled is the voltage drop across LED.

Usually the maximum collector current Ic will be much higher than than the current required for emitter load such as LED. In these cases Ic should be chosen in such a way that it should not exceed the max current limit of emitter load.

So,

- **R2= (Vcc – Vce – Vload) / Ic**

R'' & R' – Base Resistors

R'' & R' should be chosen such that it should give the required collector current during saturation state.

- Min. Base Current, $Ib_{min} = Ic / \beta$, where β is the hFE of the transistor
- Safe Base Current, $Ib = 10x\ Ib_{min} = 3 \times Ic / \beta$
- **R'', R' = (Vcc – Vbe) / Ib**

T1 & T2 – Time Period

- T2 = OFF Period of transistor U1 = ON Period of Transistor U2 = **0.693R'C2**
- T1 = OFF Period of transistor U2 = ON Period of Transistor U1 = **0.693R''C1**

From these equations we can find the value of C1 and C2.

Duty Cycle

It is the ratio of time Tc during which the output is high to total time period T of the cycle.

Thus here, **Duty Cycle = Toff/(Toff + Ton)** when the output is taken from the collector of the transistor T.