ASTABLE MULTIVIBRATOR

INTRODUCTION

The student will analyze and construct an astable multivibrator. The circuit will be simulated using nominal component values selected by the student to provide for specific operations. The circuit component parameters will be measured. And theoretical calculations of the multivibrator's performance will be made. The multivibrator will be constructed to observe actual perfomance.

BACKGROUND

A multivibrator is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flip flops. An astable multivibrator has two states, neither one stable. The circuit therefore behaves as an oscillator with the time spent in each state controlled by the charging or discharging of a capacitor through a resistor.

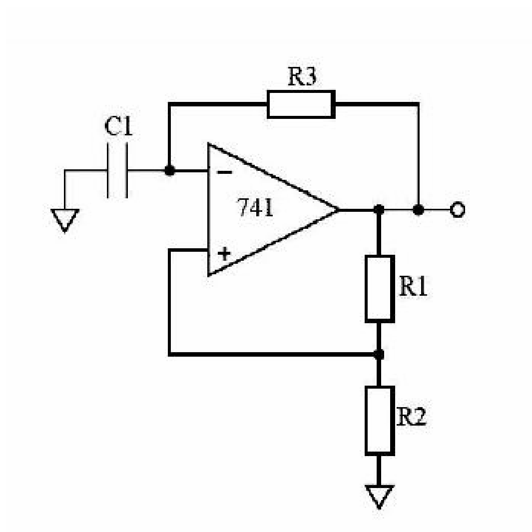

Figure 1: Astable Multivibrator

The astable multivibrator may be created directly with transistors or with use of integrated circuits such as operational amplifiers (op amps) or the 555 timer. Most operational amplifiers are powered by a positive and negative rail voltage, the output never able to exceed these rail voltages. Depending upon inital conditions, the op amp's output will drive to either positive or negative rail. Upon this occurance, the capacitor will either charge or discharge through the resistor R_2, its voltage slowly rising or falling. As soon as the voltage at the op amp's inverting terminal reaches that at the non-inverting terminal (the op amp's output voltage divided by R_1 and R_2), the output will drive to the opposing rail and this process will repeat with the capacitor discharging if it had previously charged and vice versa. Once the inverting terminal reaches the voltage of the non-inverting terminal the output again drives to the opposing rail voltage and the cycle begins again. Thus, the astable multivibrator creates a square wave with no inputs.

Period of astable multivibrator displayed in Figure 1: $T = 2C_1R_3\ln(1+2\frac{R_2}{R_1})$

THEORETICAL PROCEDURE

Find the square wave's period for a frequency of 250Hz:

T = ________________________

Find values for R_1, R_2, R_3 and if C_1 is 0.1uF (Let R_1= 10R_2= 100kOhms) that should produce a square wave of frequency 250Hz.

R_1 = ____________________ R_2 = _____________________

R_3 = ____________________ C_1 = _____________________

Select components with nominal values as close as possible to those calculated in the prelab. Measure the resistor impedances with the digital multimeter and the capacitor's capacitance with the LCR meter.

R_1 = ____________________ R_2 = _____________________

R_3 = ____________________ C_1 = _____________________

Determine expected amplitude and frequency using the measured component values. Assume a power supply voltage of +/- 12 volts.

Amplitude = _____________ Frequency = _____________

EXPERIMENTAL PROCEDURE

Construct the astable multivibrator displayed in Figure 1 using a uA741 operational amplifier and the components selected in the theoretical procedure.

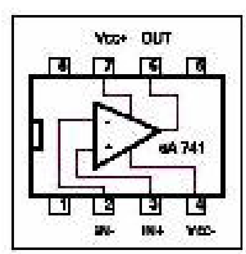

Figure 2:
uA741 Pin Lavout

The operational amplifier should be powered with rail voltages of +/- 12 Volts using the DC power supply. Set the power supply before connecting to the operational amplifier. Do not connect the DC power supply to the circuit with the current on. Turn the power on and observe the operation of the multivibrator. Record the amplitude and frequency of the square wave.

Amplitude = _____________ Frequency = _______________

Save the oscilloscope screenshot for use in lab report

SIMULATED PROCEDURE

Construct a PSPICE schematic of the astable multivibrator displayed in Figure 1 using measured component values, part uA741 as the operational amplifier, DC power sources. Set the initial condition (IC) of the capacitor to 0.001 volts.

Double click on the output wire to and label 'Output'. In a similar fashion, label the inverting terminal of the operational amplifier 'Capacitor'.

Simulate the astable multivibrator in transient (time-domain) mode and add traces of both the output and the capacitor voltages.

Record amplitude and determine the frequency of the square wave:

Amplitude = ______________ Frequency = _____________

Save a schematic screenshot and a screenshot of the transient analysis for display in lab report.

Modify the initial condition of the capacitor to -0.001 volts.

Simulate the astable multivibrator in transient mode and add traces of both the output and capacitor voltages

Save a screenshot of the transient analysis for use in lab report

QUESTIONS

Display the frequency and amplitude for the theoretical, experimental and simulated portions of the lab in a table. Describe any distinctions between the theoretical, experimental and simulated results.

What differences can be noticed between the experimental and simulation waveforms? Think in terms of the wave shape, noise, rise and fall times, etc.

What difference is noticed in the transient analysis when the initial condition of the capacitor is modified slightly to a negative voltage? Why does this change occur?

What could have affected the initial condition of your experimental circuit, assuming that the capacitor had no initial charge across it.