TI India Analog Design Contest 2011

Phase 1 A

Problem Statement for Team-B

Design an astable multivibrator using one TL082 Op-Amp and the passive components available on ASLKv2010 Starter Kit. The objective of your design is to maximize the frequency of oscillation. Repeat the design procedure to obtain a circuit with the lowest frequency of oscillation possible. (*No passive or active components other than what is provided on the kit must be used.*)

For your ready reference, we have included the block diagram of the astable multivibrator in Figure 1 below.

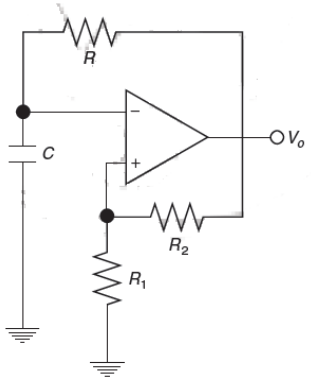

Figure 1: Astable Multivibrator

The time period of the square waveform generated by the astable multivibrator is given by

$$T = 2RC.ln\left(\frac{1+\beta}{1-\beta}\right)$$

where $\beta = \frac{R_1}{R_1 + R_2}$

Peak amplitude of triangular wave V_c generated by the astable multivibrator (across capacitor C) is given by

$$V_p = \beta V_{ss}$$

Please submit your solutions in two parts, Part A and Part B (see below).

Part A- Front Sheet

1	Name of your college	
2	Team Number	
3	Name, Semester and Branch of the Participants	
4	Name, contact number and email ID of mentor	
5	Problem Statement (A, B, C or D)	
6	CMT ID	
7	Simulation software you have used	

Part B – Report

1. Include the block diagram of your circuit. Print the block diagram from the simulation software.
   - 1.1 What was the value of R for maximum frequency of oscillation? _____
   - 1.2 What was the value of C for maximum frequency of oscillation? _____
   - 1.3 What was the value of R for minimum frequency of oscillation? _____
   - 1.4 What was the value of C for minimum frequency of oscillation? _____
   - 1.5 What was the theoretical value of highest frequency of oscillation? _____
   - 1.6 What was the theoretical value of the lowest frequency of oscillation? _____
   - 1.7 What was the peak value of capacitor voltage for maximum frequency of operation? _____
   - 1.8 What was the peak value of capacitor voltage for minimum frequency of operation? _____

Hint: Highest frequency of the astable multivibrator is limited by the slew rate (SR) of TL082 OP-Amp, and supply voltage (V_{ss}) you are applying to your circuit. Consider the following expression while measuring the highest frequency:-

$$T/2 >> \frac{2V_{ss}}{SR}$$

Here 1/T is the highest frequency possible.

2. Simulation

Simulate the circuit using TINA, PSPICE or Microcap. Free downloadable demo versions of these softwares are available on the Internet. Demo version is sufficient for this problem. Macromodel of TL082 can be downloaded from TI website.

2.1. Plot the transient response (plot of the V_o and V_c as a function of time) for maximum value of frequency of oscillation – the sample waveform is shown in Figure 2.

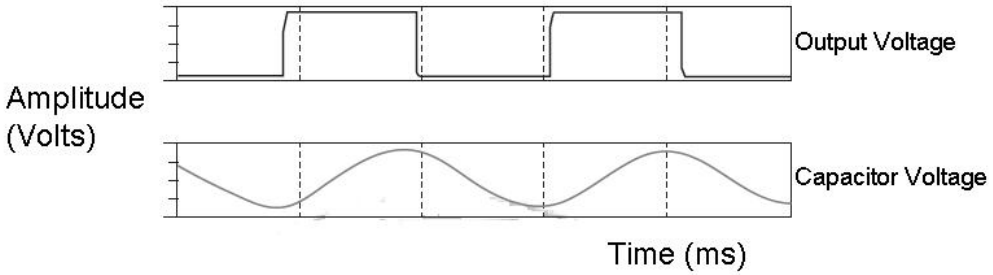

Figure 2 – Sample waveform (Transient Response)

2.2. Plot the transient response (plot of the V_o and V_c as a function of time) for minimum value of frequency of oscillation

2.3 What is the peak value of voltage V_p across the capacitor in cases 2.1 and 2.2 above?

2.4 In Figure 1, lift R_1 to +5V potential (connect R_1 to +5V instead of ground). What happens to the astable action and highest frequency of the multivibrator? Submit the readings and also the transient response.

Hint: - Hysteresis will remain same, but get laterally shifted by an offset; obtain the value of that offset.

3 Hardware implementation

3.1 Build your circuit using ASLKv2010 Starter Kit for highest possible frequency and lowest possible frequency. Take the picture of the set up and include it in the report.

3.2 Obtain the transient plots using the CRO and include a snapshot.

3.3 Fill out the values below

	Maximum frequency of oscillation	Minimum frequency of oscillation
Theoretically calculated value		
Obtained through simulation		
Measured on practical realization		

3.4 Fill out the values below.

	Value of V_p (for Maximum frequency of oscillation)	Value of V_p (for Minimum frequency of oscillation)
Theoretically calculated value		
Obtained through simulation		
Measured on practical realization		

3.5 Lift R1 from ground to a potential of 5 Volts. Fill out the values below.

	Maximum frequency of oscillation
Theoretically calculated value	
Obtained through simulation	
Measured on practical realization	

3.6 What happens to the astable action in case 3.5 ?

4 Conclusions

4.1. What problems did you face in the design phase?

4.2. What problems did you face during simulation?

4.3. What problems did you face during practical implementation?

4.4 Summarize any new learnings.

References

[1] Analog System Lab Manual by Dr. K.R.K. Rao, TI India and Dr. C.P. Ravikumar, TI India. http://uniti.in/teaching-material