AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

408/1, Kuratoli, Khilkhet, Dhaka 1229, Bangladesh

Assignment Title:	**Final Term OBE Assignment.**		
Assignment No:	**02**	**Date of Submission:**	**December 12, 2023**
Course Title:	**DIGITAL LOGIC AND CIRCUITS**		
Course Code:	**EEE301**	**Section:**	**K**
Semester:	**FALL 2023-24**	**Course Teacher:**	**MD. SHAHARIAR PARVEZ**

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** Please submit all assignments to your course teacher or the office of the concerned teacher.

No	Name	ID	Program	Signature
1	MD. SHOHANUR RAHMAN SHOHAN	22-46013-1	B. Sc. in CSE	

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FACULTYCOMMENTS	**Marks Obtained**	
	Total Marks	

American International University-Bangladesh (AIUB)
Faculty of Engineering

DIGITAL LOGIC AND CIRCUITS
OBE Assignment [30 marks]
Fall Semester 2023-24
Submission Deadline:12/12/2023 (In Class)

CO2	**Develop** a system in context of Digital logic circuits with 555 timer and transistors for **conflicting requirements** of complex engineering problem.	P.a.3.C3

The ignition activation system of a car is attached to a digital system. The activation system turns on if the following conditions are met. The driver seat is occupied, and the driver seatbelt is fastened. The driver seat is occupied, and the driver seatbelt is fastened, and the passenger seat is occupied, and the passenger seatbelt is fastened. There are appropriate sensors present for detecting the above. Sensor for driver seat is A and sensor for driver seatbelt is B. The sensor for passenger seat is C and the sensor for the passenger seatbelt is D. **If those 2 conditions are not met, then an alarm goes off.**

Your task is to:

i. Outline the necessary steps in correct sequence of the standard procedure to design a digital system for **alarm circuit and design the system**. Also show the outlined steps, **which will trigger the alarm and implement the system with CMOS logic.**

ii. The human audible ranges from 20Hz – 20kHz. However, any sound below 250Hz is considered to be disturbingly low pitched and any sound above 4500Hz is considered to be disturbingly high pitched. Design the alarm timer circuit with a frequency of **P*20 Hz** and a duty cycle of **Q%** [where **P= N+O+I+S+E** and **Q = 100 – P]**. However, if P5 Hz is not within soothing hearing limits, take frequency, f =400Hz. Choose the capacitor value from the given list based on the suitability of your requirements. (C = 50uF/250uF/470uF)

iii. State the limitations of this developed system and explain the effect of increasing the frequency above 4500Hz.

Direction: The numbers NOISE are the middle five digits of your ID (XX-NOISE-SX
(In case the last two letters of your ID is 00, use 45 instead.)

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MARKING RUBRIC:

CP	Assessment Criteria	Evaluation Criteria				Marks
		Poor [1-2]	Average [3-4]	Good [5-6]	Excellent [7-7.5]	
P1	Outline of the standard procedure of digital system design	More than three steps are incorrect or missing and not in correct sequence	One or Two steps of the standard procedure is missing with a one or two steps not in sequence.	All the steps of the procedure have been identified with one or two steps not in correct sequence	All the steps of the procedure have been identified and in correct sequence	
	Digital Triggering Circuit Design.	Design flow has major errors and transistor level design has major flaws.	Design Flow has major error with error carried forward to transistor level design	Design Flow has minor error with error carried forward to transistor level design	Accurate Design Flow with transistor level design having no or minor errors	
P2, P6	Alarm/ Buzzer Design	Alarm design has major flaws which does not comply with the conflicting requirements with major calculation errors.	Alarm design has major flaws which does not comply with the conflicting requirements but with minor calculation errors.	Alarm design is correct and complies to the conflicting requirements but, with major calculation errors.	The alarm design is correct and comply to the requirements with no or minor calculation errors.	
	Limitation	Most of the limitations are irrelevant	Some of the limitations have been addressed	Addressed most of the major limitations	All are correct	
					Total Marks Obtained	

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Outline for design the alarm circuit:

step-1: Analyze the problem statement and Identifying challanges and objectives.

step-2: Finding the inputs and outputs of the system and establishing relationships between inputs and output.

step-3: Relating desire inputs and output according the condition

step-4: Developing a comprehensive truth table and documenting all possible input-output scenarios.

step-5: Forming a standard expression from the truth table

step-6: Simplifiying the expression using K-Map

step-7: Designing the alarm system using logic gates.

step-8: Implementing the system with CMOS Logic.

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Step-1

The car ignition activation system is integrated with a digital setup, utilizing four sensors within the vhecle. The activation criteria include the following scenarios: the drivers seat is occupied and the driver's seatbelt is fastened; or the driver's seat is occupied, and the driver's seatbelt is fastended, coupled with passenger's seat being occupied and the passenger's seatbelt being fastended. The activation system is designed to trun on only when these conditions are met with dedication sensors appropriately configured to detect each specified scenario.

Step-2:

The system incorporates specific sensors for detection, with designated inputs corresponding to the following:

A = Sensor for the driver's seat.

B = Sensor for the driver's seatbelt.

C = Sensor for the passenger's seat.

D = Sensor for the passenger's seatbelt.

An output Y will be generated for given conditions.

Step-3:

The output is set to a high state when either A and B are both high or when A, B, C and D are all high. otherwise, the output is in a low state.

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step-4:

Truth Table:

	A	B	C	D	Y
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

step-5:

$$Y = \sum(12, 13, 14, 15)$$

$$= AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$$

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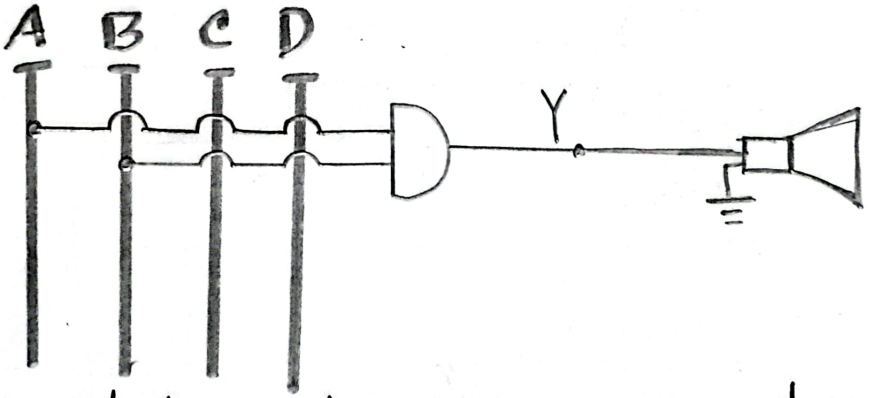
Step-6:

AB \ CD	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	0	0

A	B	C	D
1	1	0	0
1	1	0	1
1	1	1	1
1	1	1	0
AB			

$Y = AB$

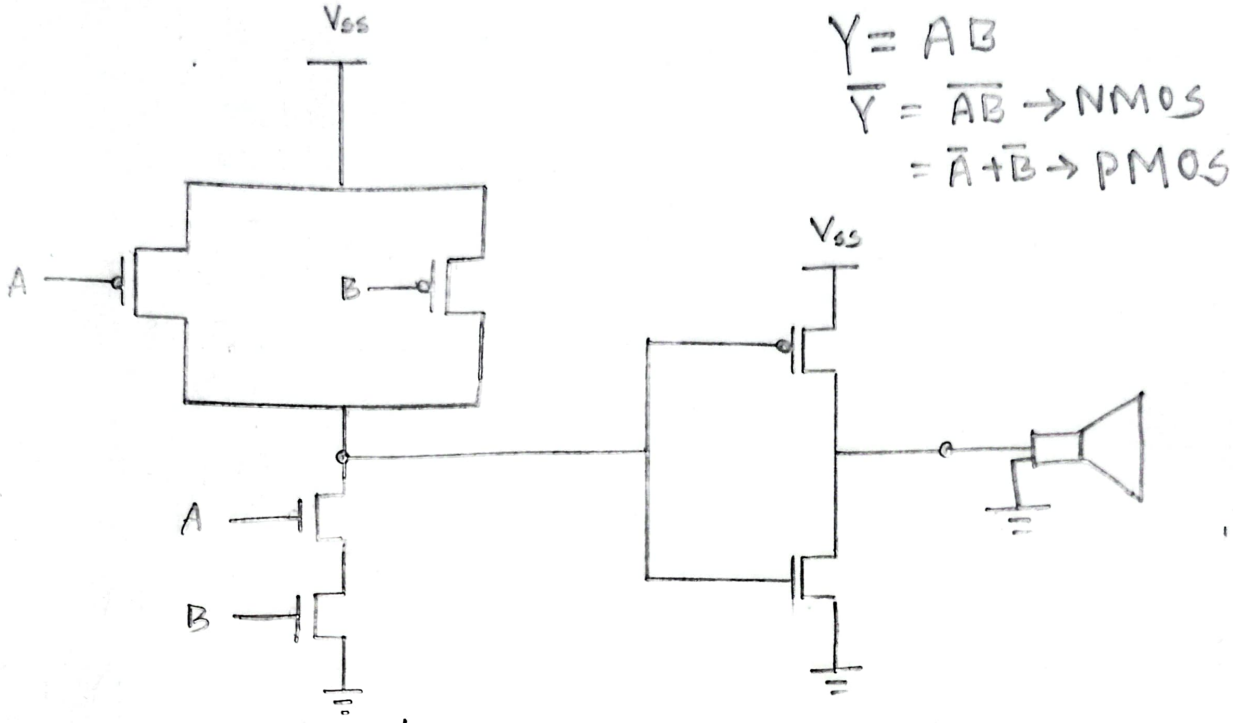
Step-7:



Design of the system using basic gates.

Here, when both A and B sensor inputs are high(1), the output of the system will be high and the alarm spaker will get enough voltage to make sound. Thus, in this way the alarm will triggered.

Step-8:



Implementation of the system using CMOS Logic

ii.

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Given, $P = N + O + I + S + E$

$= 4 + 6 + 0 + 1 + 3$

$= 14$

$\therefore P * 20\ Hz = 20 \times 14 = 280\ Hz$ [within the soothing hearing Limits]

$\therefore$ Frequency, $f = 400\ Hz$

Here, $Q = 100 - P$

$= 100 - 14 = 86$

$\therefore$ Duty Cycle, $Q\% = 86\%$

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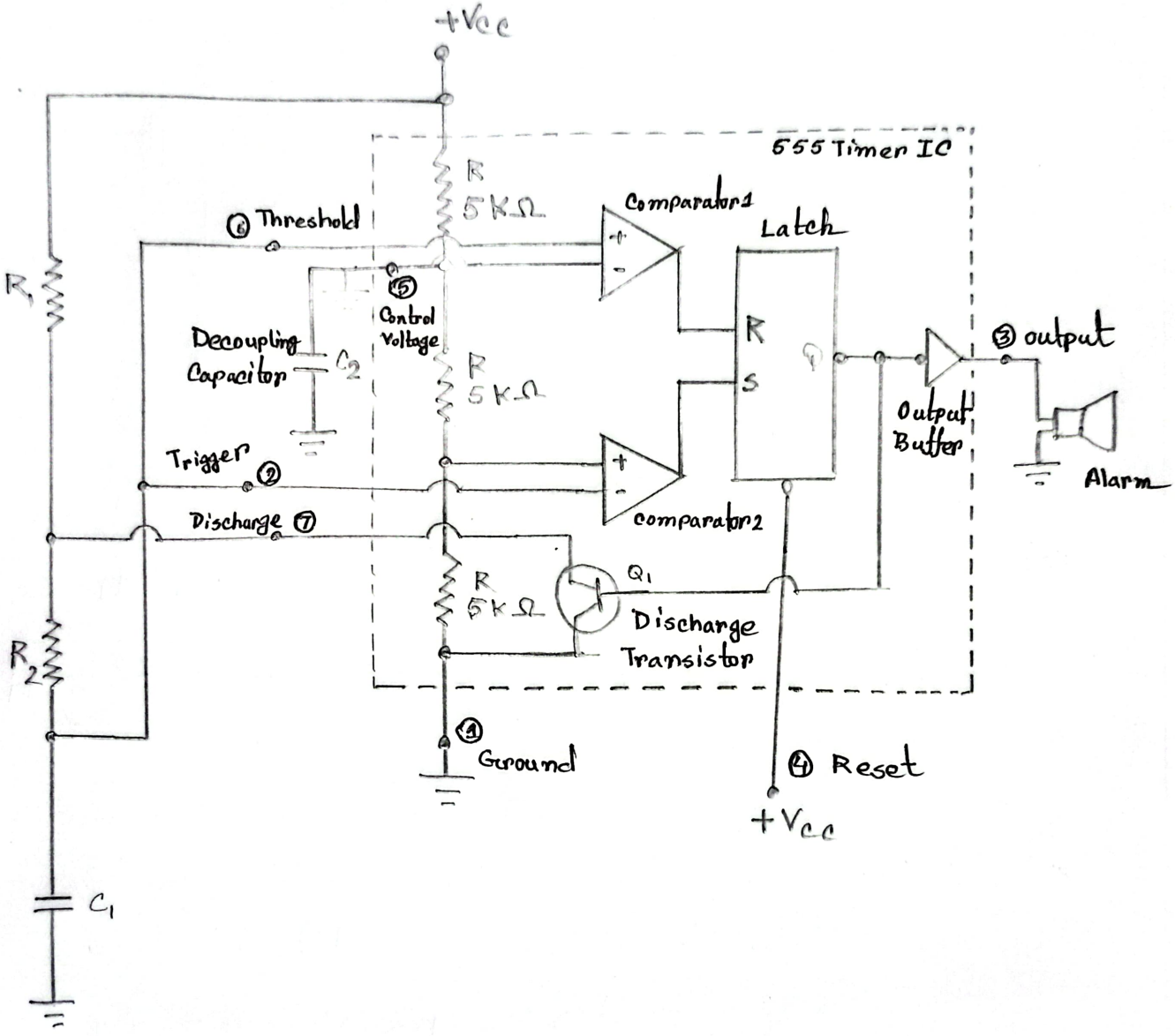
Now, we can design the alarm timer circuit with 555 timer IC in Astable mode.



Here, 400 Hz is not a very high frequency. So we need a 250uF (C_1) and 50uF (C_2) as decoupling capacitor.

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Now, Time period, $T = \frac{1}{f} = \frac{1}{400} = 0.0025\,s$

we know,

Duty Cycle, $Q\% = \frac{T_H}{T}$

$\Rightarrow T_H = Q\% \times T = 0.86 \times 0.0025$

$= 0.00215\,s$

$T_L = T - T_H$

$= 0.0025 - 0.00215$

$= 0.00035\,s$

And, $T_L = 0.693 R_2 C_1$

$\therefore R_2 = \frac{T_L}{0.693 \times C_1} = \frac{0.0035}{0.693 \times 250 \times 10^{-6}}$

$= 2.020\,\Omega$

$T = 0.693 C_1 (R_1 + 2R_2)$

$R_1 = \frac{T}{0.693 C_1} \times - 2R_2$

$= \frac{0.0025}{0.693 \times 250 \times 10^{-6}} - (2 \times 2.020)$

$= 10.39\,\Omega$

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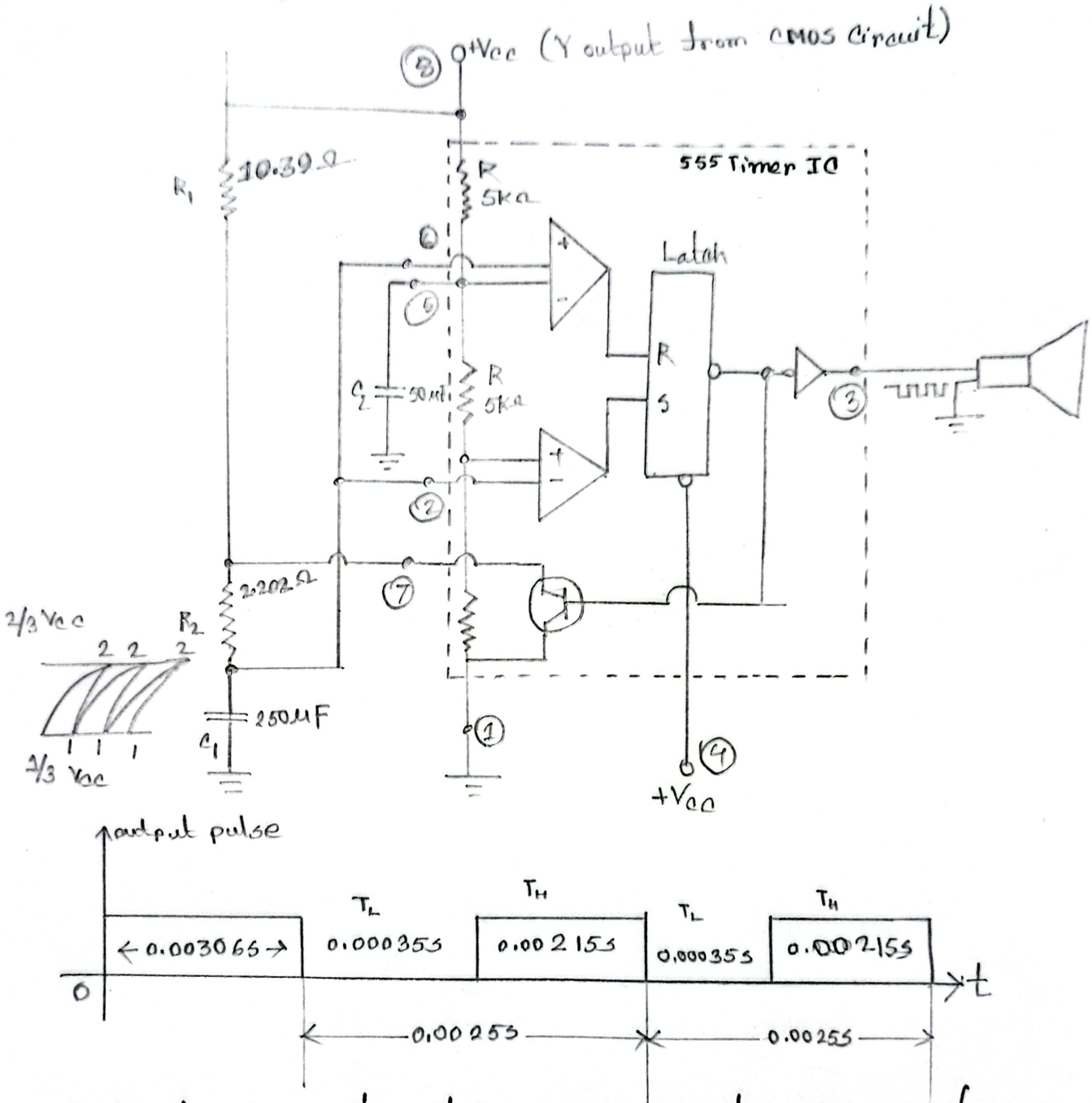
Final circuit Diagram with values



Initially the capacitor takes 0.00306s to charge from 0 to 2/3 Vcc.
So, we get output time period of 0.00255 after the inital 0.00306s. Thats why the alarm will buzz for 0.00215s and stop for 0.00035s and it will be maintain 400 Hz frequency.

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(iii) Limitations:

1. The system's performance hinges significantly on the precision and dependability of its sensor. Inaccuracies in these sensors may result in erroneous readings, potentially leading to incorrect activation of the ignition.
2. The system is susceptible to generating false alarms if the sensors detect inaccurate information.
3. Its scope of functionality is confined to detecting the occupancy of the drivers and passenger seats and the status of seatbelts. It does not consider other variables that might influence safe driving conditions, such as the driver's condition, vehicles speed, or road conditions.
4. Any malfunction in the car's electrical system, such as dead battery or failure of other components, could impact the system's operation.

Effect of increasing frequency above 4500 Hz:

1. Frequencies above 4500 Hz are considered distrubingly high pitched. Increasing the alarm frequency beyond this limit could lead discomfort, unpleasent or even potential harm to individuals hearing.
2. At higher frequency, problem can occur with the 555 timer IC.