INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

THIRUVANANTHAPURAM, KERALA

ANALOG LAB PROJECT

PIANO USING 555 TIMER IC

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2nd Year

Aim: Creation of electric piano using NE555 timer circuit.

Components required:

1. 555 timer IC
2. Breadboard(s)
3. Speaker 8 ohm
4. Momentary push button switches
5. Resistors(in ohm): 8 x 1k, 4.7 k
6. Capacitors : 100nF, 10uF
7. Connecting wires
8. (5-9)V Power supply

Introduction

The document describes a circuit that uses a 555 timer IC to create a simple piano by generating tones with a speaker. The 555 timer is wired in astable mode and connected to buttons that change the timing resistor value. This alters the frequency produced, mimicking different piano notes. When a button is pressed, it completes the circuit and the speaker diaphragm vibrates at the corresponding frequency, producing an audible tone. The circuit demonstrates how the 555 timer can be used for tone generation by varying resistor values to change the oscillation frequency and pulse width.

A 555 timer IC has 3 operating modes:

1. Astable mode- 555 works as an electronic oscillator.
2. Monostable mode- 555 functions as a ‘one-shot’ pulse generator.
3. Bistable mode- 555 works like a flip flop.

In this project,it is mainly used in astable mode.

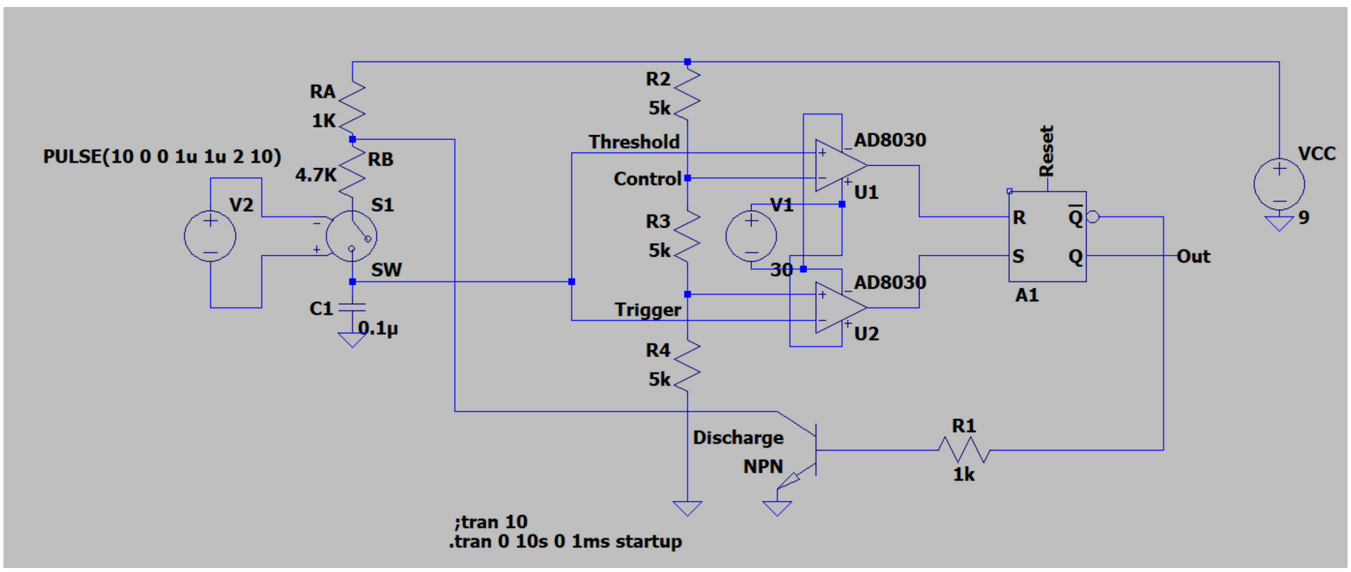
Sound is a Mechanical Wave as it is produced by to and fro movement of particles of the medium. A Loudspeaker is an electronic transducer which converts electrical signals to pressure variations to make the sensation of sound. The diaphragm of the loudspeaker will vibrate according to the frequency and amplitude of electric signals. Audible frequency range of humans is from 20Hz to 20KHz, so we are going to generate frequencies in this range using a 555 timer and feed it to the loudspeaker.

Working

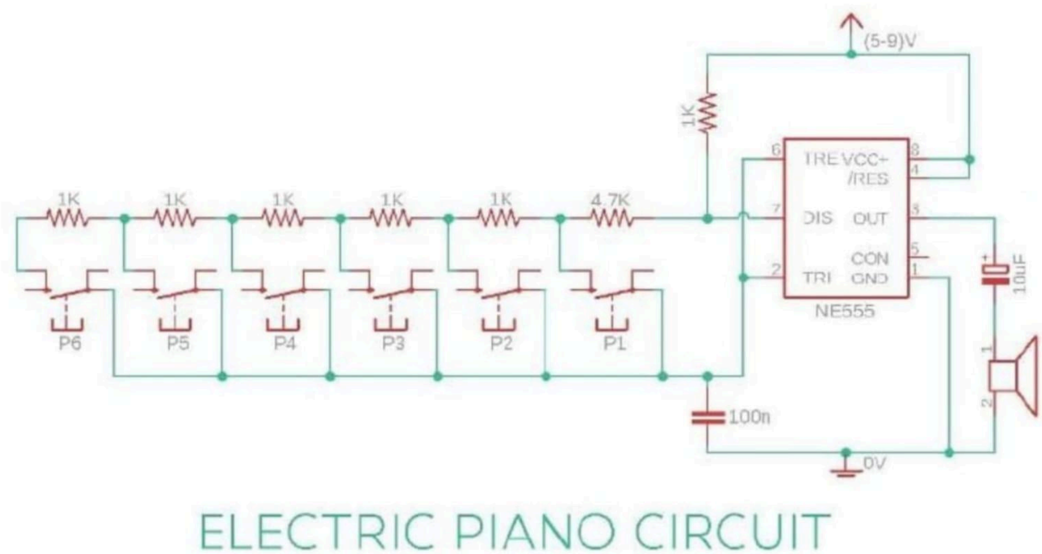
The working principle of a simple piano circuit using a 555 timer IC involves generating different frequencies to correspond to different musical notes. The 555 timer, when configured in astable mode (free-running multivibrator), can produce square waves of varying frequencies. These frequencies can be used to create tones for each key on the piano.
According to the circuit, when we press a button, the circuit becomes complete and the speaker produces a sound. Different sounds can be perceived as we press different buttons since we change the values of the resistors. This leads to the diaphragm of the speaker to oscillate with different frequencies and produce different sounds.

555 timer IC in Astable Multivibrator Mode

Initially, when there is a power supply, current will start flowing through the three 5 kΩ resistors. At this stage, there is no current through the capacitor in the piano circuit due to the presence of push-button switches. Thus the comparator 1 output (R)goes to -Vcc and the comparator 2 output (S) goes to +Vcc.So, S=1,R=0 (logic levels) , therefore Q = 1 and discharge =0. When the push button is pressed the capacitor starts charging. As the voltage across the capacitor crosses 3V, Comparator 2 output will go to -Vcc(logic 0). This being connected to the SR latch (ie, S=0) ensures that it will maintain its output as such (since R =0). As soon as the capacitor crosses 6V, comparator 1 output will go to +Vcc. At this stage, R=1; S=0 and hence Q= 0. So the discharge transistor is turned on and the capacitor discharges. Once the threshold value is below 6V, the comparator 1 output goes back to -Vcc (R=0). This maintains the memory state until the trigger drops below 3V. Subsequently, S becomes 1 and the output goes to logic high. The discharge transistor is turned off and the capacitor once again starts the charging cycle.This cycle repeats as long as the push buttons are pressed.
Since the trigger and threshold are shorted , there is no possibility of the invalid S=1,R=1 case to happen with the SR latch.



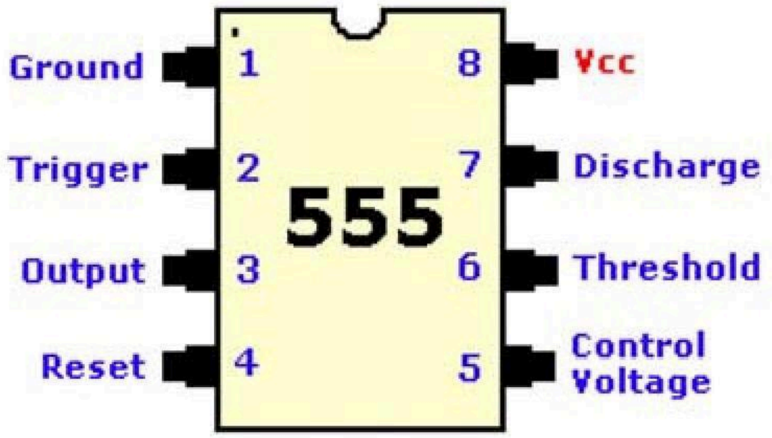
Circuit Diagram



Explanation

- Astable multivibrator is also called as Free Running Multivibrator.It has no stable states and continuously switches between the two states without application of any external trigger.The IC 555 can be made to work as an astable multivibrator with the addition of three external components: two resistors (R1andR2) and a capacitor(C).

- The pins 2 and 6 are connected, and hence there is no need for an external trigger pulse. It will self-trigger and act as a free-running multivibrator. The rest of the connections are as follows:



a. Pin 8 is connected to the supply voltage (VCC).
b. Pin 3 is the output terminal, and hence the output is available at this pin.
c. Pin 4 is the external reset pin. A momentary low on this pin will reset the timer. Hence, when not in use, pin 4 is usually tied to VCC.
d. The control voltage applied at pin 5 will change the threshold voltage level. But for normal use, pin 5 is connected to ground via a capacitor (usually 0.01 µF), so the external noise from the terminal is filtered out.
e. Pin 1 is the ground terminal.

- The timing circuit that determines the width of the output pulse is made up of R1, R2, and C.

- R2 varies from switch 1 to switch 10 accordingly(all the resistors that make up Rb are in series):

  SW10 – Rb1+Rb2+Rb3+Rb4+Rb5+Rb6+Rb7+Rb8+Rb9+Rb10
  SW9 – Rb1+Rb2+Rb3+Rb4+Rb5+Rb6+Rb7+Rb8+Rb9
  SW8 – Rb1+Rb2+Rb3+Rb4+Rb5+Rb6+Rb7+Rb8
  SW7 – Rb1+Rb2+Rb3+Rb4+Rb5+Rb6+Rb7
  SW6 – Rb1+Rb2+Rb3+Rb4+Rb5+Rb6
  SW5 – Rb1+Rb2+Rb3+Rb4+Rb5
  SW4 – Rb1+Rb2+Rb3+Rb4
  SW3 – Rb1+Rb2+Rb3
  SW2 – Rb1+Rb2
  SW1 – Rb1

Calculations

Frequency of each switch are:-

1. Fsw1= 1.44/((Ra+2Rb)*c) = 1.44/((0.985+2*4.662)*0.1*10^(-6+3) = **1.386 kHz**

2. Fsw2= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985))*0.1*10^(-6+3) = **1.173 kHz**

3. Fsw3= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987))*0.1*10^(-6+3) = **1.010 kHz**

4. Fsw4= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982))*0.1*10^(-6+3) = **0.888 kHz**

5. Fsw5= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997))*0.1*10^(-6+3) = **0.790 kHz**

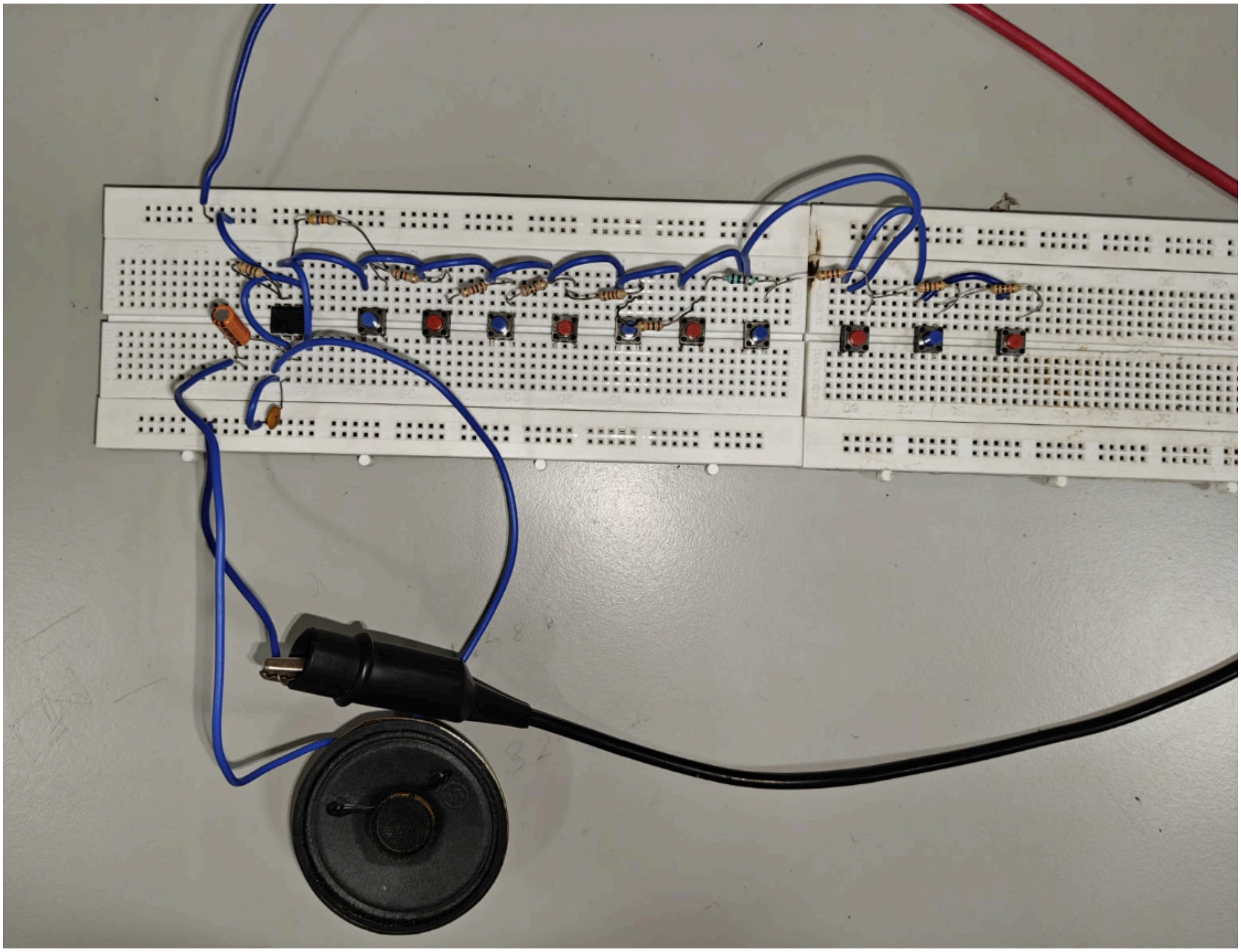
6. Fsw6= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997+0.982))*0.1*10^(-6+3) = **0.713 kHz**

7. Fsw7= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997+0.982+0.985))*0.1*10^(-6+3) = **0.650 kHz**

8. Fsw8= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997+0.982+0.985+0.987))*0.1*10^(-6+3) = **0.597 kHz**

9. Fsw9= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997+0.982+0.985+0.987+0.995))*0.1*10^(-6+3) = **0.551 kHz**

10. Fsw10= 1.44/((Ra+(2Rb))*c) = 1.44/((0.985+(2*(4.662+0.985+0.987+0.982+0.997+0.982+0.985+0.987+0.995+0.982))*0.1*10^(-6+3) = **0.512 kHz**



Conclusion

Thus, the designed circuit exploits the astable mode of 555 timer IC and the properties of a speaker. We observe that as the value of resistance increases, frequency decreases and we move from high pitch to low pitch. More resistors of different values can be added to produce sounds of different frequencies; also a potentiometer can be patched to the circuit to tune the piano.