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Design and Implementation of a Keypress-Activated Electronic Piano Using IC 555, LM386, and IC 7805

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Abstract: This paper presents the design and implementation of a low-cost, analog-based electronic piano utilizing three commercially available integrated circuits: the NE555 timer, LM386 audio amplifier, and LM7805 voltage regulator. The NE555 operates in astable multivibrator mode to produce square-wave signals across eight frequencies corresponding to the notes of the Indian musical scale (Sa to Sa'). Frequency selection is achieved by switching discrete resistor values via push-button inputs. The LM386 amplifies the generated audio signal to drive an 8-ohm speaker, achieving a practical gain of 18.5. A stable 5V regulated supply is derived from a 12V AC mains source via the LM7805. The design was verified through simulation on NI Multisim and hardware implementation on both breadboard and PCB platforms. Results confirm frequency accuracies within resistor tolerance limits. This work demonstrates an efficient analog approach to sound synthesis without digital processing, offering simplicity, low cost, and educational value.
Keywords: 555 Timer, Astable Multivibrator, Audio Amplifier, LM386, Voltage Regulator, Electronic Piano

I. INTRODUCTION

Electronic musical instruments represent a rich intersection of analog circuit design and acoustics. The electronic piano, in its simplest analog form, generates tonal frequencies through oscillator circuits rather than mechanical string vibration. This project constructs a functional keypress-activated electronic piano using the NE555 timer integrated circuit (IC), which operates in astable multivibrator mode to generate square-wave signals at audio frequencies.

Analog ICs such as the 555 timer, LM386 audio power amplifier, and LM7805 linear voltage regulator remain essential building blocks in electronics education and low-cost instrumentation design. This work integrates all three devices into a cohesive, self-powered audio system capable of producing the eight fundamental notes of the Indian classical musical scale (Sa to Sa'), equivalent to the Western C-major octave.

The system architecture comprises three functional stages: (1) frequency generation via the NE555 astable oscillator with switched resistor banks, (2) audio amplification via the LM386 driving an 8-ohm speaker, and (3) regulated DC power supply via the LM7805 fed from a 12V AC transformer. The entire system was simulated in NI Multisim and realized on a printed circuit board (PCB).

II. LITERATURE REVIEW

The NE555 timer IC, introduced by Signetics in 1972, remains one of the most widely used timing ICs in analog circuit design. Its astable configuration is well-established as a reliable method for generating continuous oscillating waveforms. Texas Instruments' NE555 datasheet [1] provides the foundational equations for frequency and duty cycle in astable mode, forming the basis of the frequency design in this work. Gayakwad [4] provides a comprehensive treatment of operational amplifiers and linear integrated circuits, including the behavior of comparator-based oscillators and audio amplifier topologies. The LM386 is described as an ideal low-voltage audio amplifier for battery-powered and cost-sensitive applications, capable of delivering up to 250 mW into an 8-ohm load [2]. The LM7805 three-terminal regulator datasheet [3] specifies the input, output, and thermal design parameters used in the power supply stage of this project.

Prior work on 555-timer-based tone generators, including clock-sound generator circuits documented by D. S. et al. [5], demonstrates the viability of resistor-switched frequency control for generating distinct audio tones. The present work extends this concept to cover a full musical octave with hardware verification across simulation, breadboard, and PCB stages.

III. CIRCUIT DESIGN

A. *NE555 Timer — Astable Multivibrator*

The NE555 is configured in astable mode with a fixed resistor R_A = 10 kΩ and a timing capacitor C = 0.01 µF. Eight discrete resistors serve as R_B, each selected by a dedicated push-button switch. When a button is pressed, the oscillation frequency shifts to the corresponding musical note frequency.

The output frequency of the 555 astable circuit is governed by:

$$f = 1.44 / [(R_A + 2\times R_B) \times C] \quad \dots (1)$$

Rearranging to solve for R^B given a target frequency f and fixed R_a and C:

$$R_B = [1.44 / (2 \times f \times C)] - (R_A / 2) \quad \dots (2)$$

Using R_A = 10 kΩ and C = 0.01 µF, the calculated R_B values for each of the eight musical notes are listed in TABLE I.

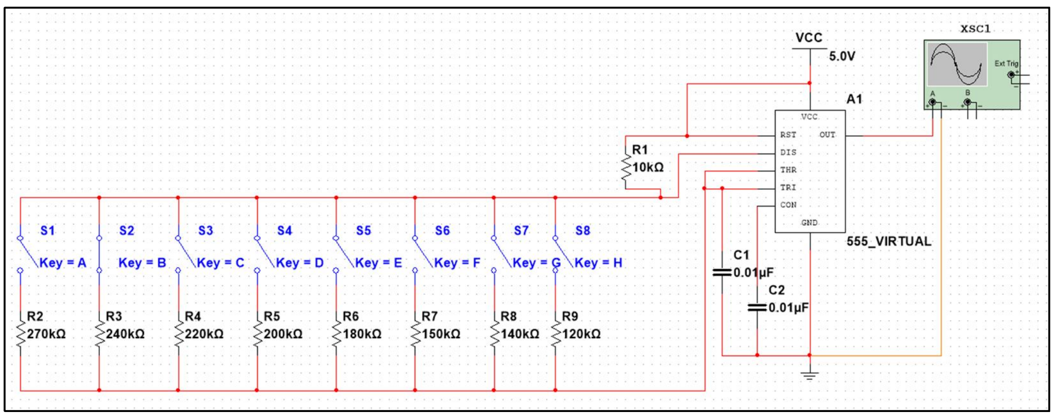

Fig. 1: NE555 Timer Astable Multivibrator Circuit

TABLE I *NE555 Resistor Values for Musical Notes (RA = 10 kΩ, C = 0.01 µF)*

Note	Freq. (Hz)	Calc. RB (kΩ)	Std. RB (kΩ)
Sa (C)	261	270.8	270
Re (D)	293	240.7	240
Ga (E)	329	213.8	220
Ma (F)	349	201.3	200
Pa (G)	392	178.7	180
Dha (A)	440	158.6	160
Ni (B)	493	141.0	140
Sa' (C')	523	132.7	130

B. *LM386 Audio Amplifier*

The LM386 is a low-voltage audio power amplifier capable of driving loads as low as 4 ohms. In this design, it amplifies the square-wave output of the 555 timer to drive an 8-ohm speaker. The gain is configured via the component network connected between pins 1 and 8. Without an external capacitor between these pins, the internal gain is 20; the as-built circuit achieves a measured gain of 18.5 due to component tolerances.

A 10 µF bypass capacitor at pin 7 (V_S) and an output coupling capacitor ensure DC blocking and stable audio output. Passive filtering at the output reduces the perceptible harshness of the square-wave input.

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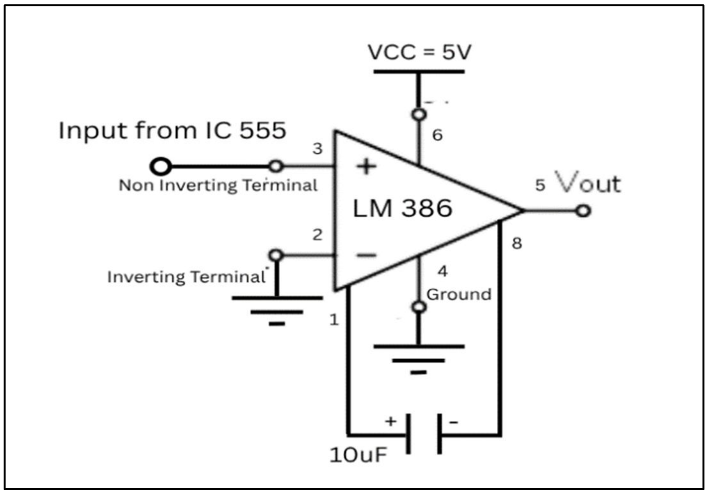

Fig. 2: LM386 Audio Amplifier Circuit

C. 5V Regulated Power Supply — LM7805

A regulated 5V DC supply is designed using the LM7805 three-terminal positive voltage regulator. The design proceeds from load requirements back through each supply stage:

Step 1 — Load Current: $I_{NE555} + I_{LM386}$ = 10 mA + 150 mA = 160 mA. With a 1.5× safety margin, I_{design} = 0.25 A.

Step 2 — Ripple Voltage: V^B = 2 V (allowable). The filter capacitor is calculated as:

$$C = I / (f \times V_B) = 0.25 / (100 \times 2) = 1250\ \mu F \quad \ldots (3)$$

A standard 1000 µF / 25V electrolytic capacitor is selected. A 12V AC transformer is chosen to satisfy the minimum input voltage requirement of the LM7805 (Vin(min) > 7V). Verification confirms VDC(max) = 15.57 V and VDC(min) = 13.57 V — both safely above 7V.

Step 3 — Power Dissipation: $P = (V_{IN} - V_{out}) \times I_{load} = (15.57 - 5) \times 0.25 = 2.64$ W. A heat sink is required for the LM7805.

Four 1N4007 diodes (I_F = 1A, V_{RRM} = 1000V) are arranged in a full-bridge rectifier configuration. Regulator bypass capacitors of 0.33 µF (input) and 0.1 µF (output) are specified per the LM7805 datasheet.

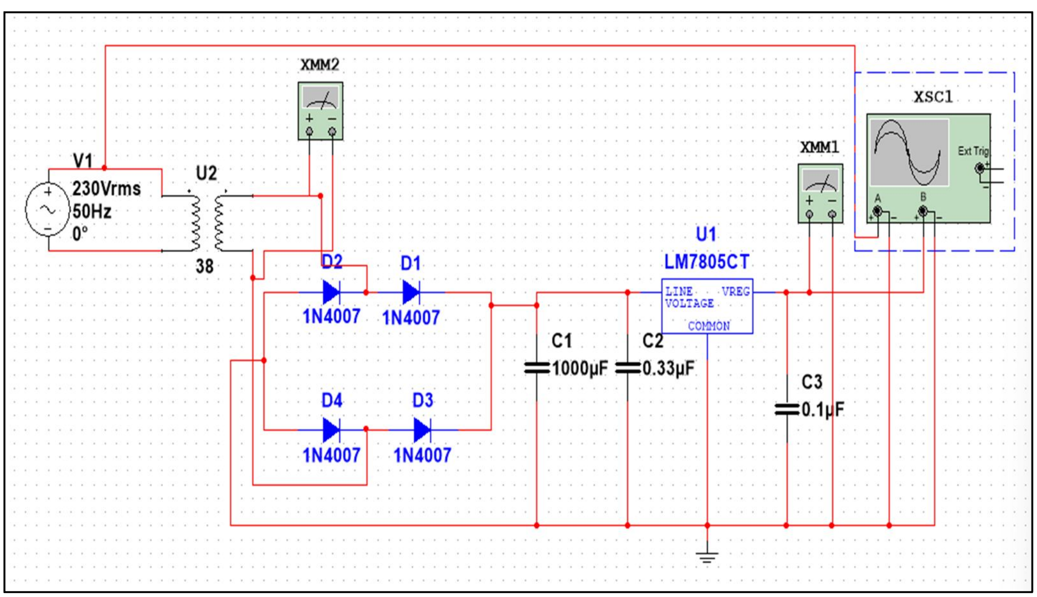

Fig. 3: 5V Regulated Power Supply (IC 7805) Circuit

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IV. RESULTS AND DISCUSSION

A. Simulation Results — NE555 Timer

The 555 astable circuit was simulated on NI Multisim with R_A = 10 kΩ and C = 0.01 μF. R_B was varied across the eight standard values and output frequencies were measured via the virtual oscilloscope. TABLE II compares the designed and simulated values.

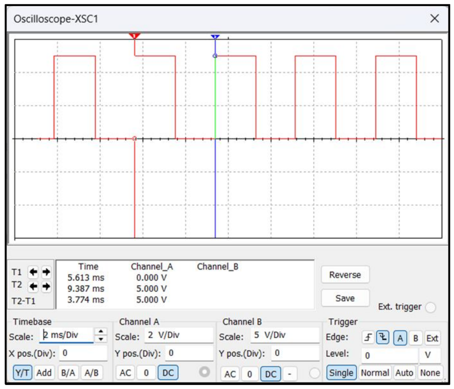

Fig. 4: Sample NI Multisim Oscilloscope Output (Sa note, R_B = 270 kΩ, f = 264.97 Hz)

TABLE II Frequency Comparison: Design vs. Simulated vs. Practical

Note	Design (Hz)	Simulated (Hz)	Practical (Hz)
Sa (C)	261	264.97	263.7
Re (D)	293	298.06	295.3
Ga (E)	329	326.26	331.5
Ma (F)	349	356.37	347.9
Pa (G)	392	397.45	396.4
Dha (A)	440	445.70	441.5
Ni (B)	493	500.00	493.8
Sa’ (C’)	523	543.77	527.1

All simulated frequencies closely follow the designed values. Deviations — generally below 5% — arise from the use of standard (E12/E24 series) resistor values in place of exact calculated values. The power supply simulation yielded a regulated output of 5.002 V against the design target of 5.0 V, confirming accurate regulation.

1) Regulated Power Supply

The 5V regulated power supply circuit was also simulated on Multisim to verify voltage regulation and ripple rejection before hardware implementation.

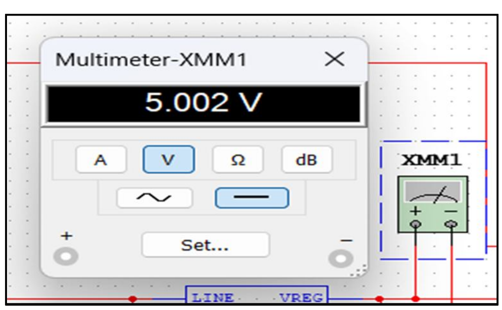

Fig. 5: Sample NI Multisim Multimeter Output

B. Hardware Results

The circuit was first assembled and characterized on a breadboard, followed by final integration on a zero PCB. Testing proceeded in three independent stages: LM386 amplifier verification, 7805 power supply verification, and 555 timer frequency verification.

The LM386 stage achieved a measured gain of 18.5 (designed: 20), within expected tolerance. The 7805 supply delivered 5.1 V on the breadboard under full load, confirming regulation. The 555 timer breadboard circuit produced frequencies within ±5 Hz of target for all eight notes.

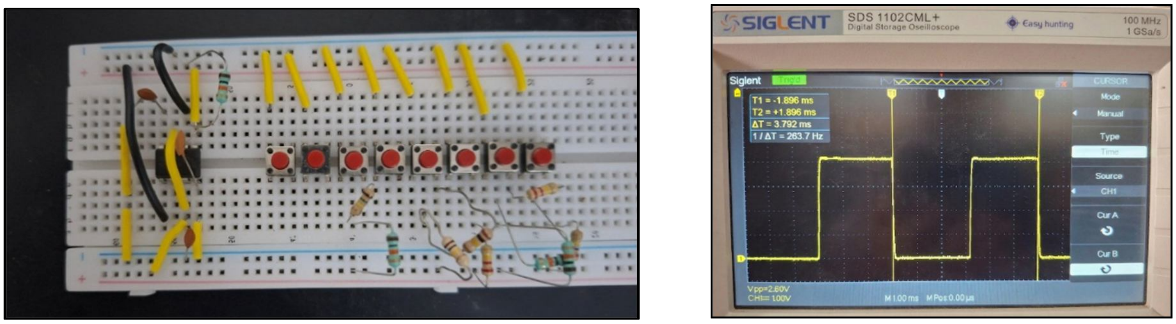

Fig. 6: IC 555 Timer Breadboard Assembly and Oscilloscope Output (Sa note, 263.7 Hz)

1) Regulated Power Supply

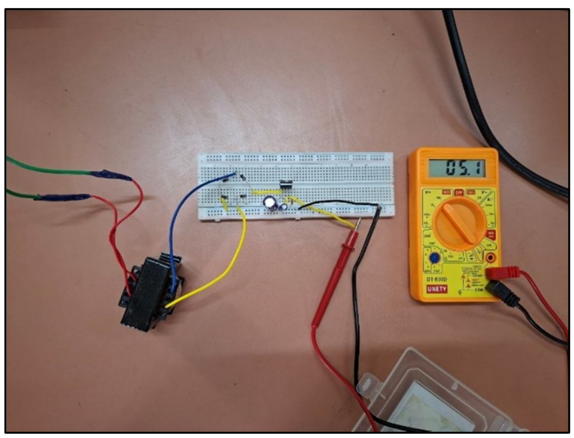

Fig. 7: Output of 7805 Voltage Regulator on Breadboard

Regulated Output Voltage = 5.1V

2) LM386 Audio Amplifier:

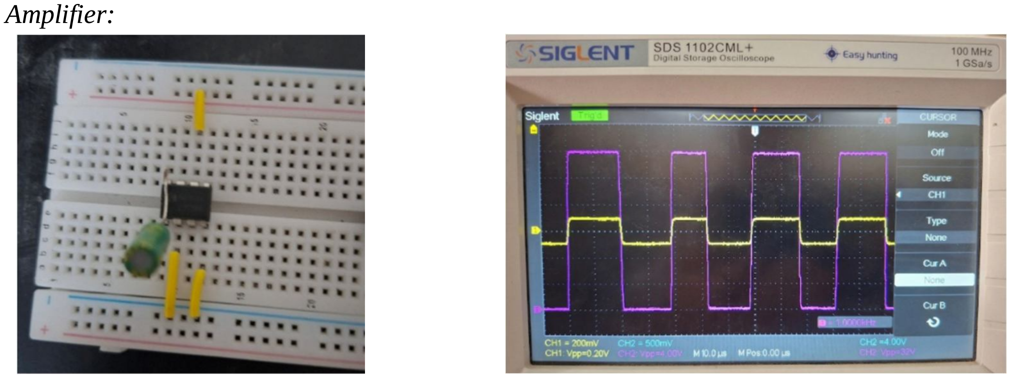

Fig. 8: Output of LM386 for Square Wave on Breadboard

Gain = 18.6

C. PCB Testing

After breadboard validation, the full circuit (NE555 + LM386 + LM7805) was assembled on a zero PCB. End-to-end functional testing confirmed correct note generation on all eight push buttons, with audible output verified through the 8-ohm speaker. Oscilloscope waveforms from the PCB closely matched breadboard results.

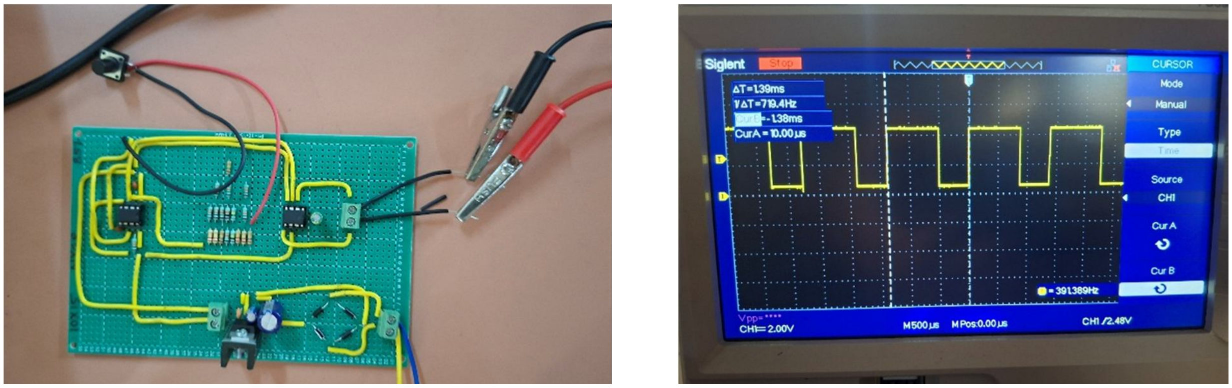

Fig. 9: Final Assembled Electronic Piano PCB and Oscilloscope Output

D. Final Product

The following image shows the complete assembled electronic piano hardware, integrating all three stages — the NE555 frequency generator, LM386 audio amplifier, and LM7805 power supply — on the final PCB with all eight push-button keys and an 8-ohm speaker.

Fig. 10: Final Assembled Electronic Piano — Complete Hardware Product

E. Frequency vs. Resistance Analysis

The relationship between R_B and output frequency follows an inverse proportion per equation (1). As R decreases from 270 kΩ (Sa) to 130 kΩ (Sa’), the frequency increases from approximately 261 Hz to 523 Hz. The practical measurements track the design curve closely across the full octave range, confirming that standard-value resistors are sufficient for acceptable musical intonation.

V. APPLICATIONS

The keypress-activated electronic piano serves several practical use cases: (1) Educational demonstrations of 555 timer-based frequency generation and audio amplification for undergraduate analog electronics courses; (2) Low-cost introductory musical instruments suitable for beginners and hobby electronics; (3) Tone generator and alert/alarm source for embedded systems where simple analog tones are required; (4) Audio frequency reference signal generator for laboratory calibration purposes.

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VI. ADVANTAGES AND LIMITATIONS

1) *Advantages:* The system uses three widely available, low-cost ICs, keeping the total bill-of-materials cost under Rs. 546 (~USD 6.50). The design is fully analog and requires no microcontroller or firmware. Its modular three-stage architecture simplifies troubleshooting. Stable frequency output is maintained across all eight notes with deviations within resistor tolerance.
2) *Limitations:* The 555 timer in astable mode produces a square wave, rich in odd harmonics, which imparts a characteristic buzzing timbre that differs from sinusoidal or sampled-audio tones. Frequency accuracy is bounded by the E-series resistor grid; sharps and flats require additional components. The design is monophonic — only one note can be active at a time.

VII. CONCLUSION

A functional, low-cost electronic piano spanning a single octave of the Indian musical scale (Sa to Sa') was successfully designed, simulated, and implemented using the NE555 timer, LM386 audio amplifier, and LM7805 voltage regulator. The 555 astable oscillator with switched resistor values produced eight distinct frequencies with deviations consistently within resistor tolerance limits. The LM386 stage amplified the audio output with a practical gain of 18.5, reliably driving the 8-ohm speaker. The LM7805 regulated power supply delivered a stable 5V output under load, with power dissipation of 2.64 W addressed by heat sink provision.

The project validates the continued relevance of classical analog ICs for educational hardware design. It demonstrates that complete audio instrument functionality can be achieved without digital signal processing, offering a platform for understanding oscillators, amplifiers, and linear regulators in an integrated, application-oriented context.

VIII. ACKNOWLEDGMENT

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