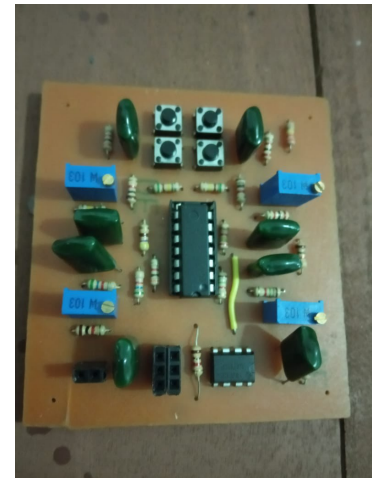




# The Analog Piano

## 1 Overview

The device is a sound synthesizer that mimics the sound of c-wave similar to that of a piano, on keypress. A speaker ( $8\Omega$  preferred) ranges around 3W can be used with the pinout to observe the sound output. The volume of the speaker and the noise level can be adjusted according to user interest. The components in the device can be adjusted according to one's interest to mimic a complete piano by implementing many such modules. The amplifier alone can be used to drive small speakers from the low power signal output of simple devices such as mobile phones.



## 2 Description

As illustrated in the block diagram below the device consists of four oscillators which are fired by a push button. These oscillators mimic the first four harmonics which are strong enough to model the c-keynote. The triggered signals get added and scaled accordingly through a scalar adder. The output is filtered and amplified before reaching the speaker. Damping time of the wave can be controlled via the damping mechanism attached through a variable resistor with each oscillator. These can be used to mimic the functionality of the damping pedal by increasing their values.

The preset in the amplifier block is allowed to be tuned by the user to get a noise-free output. For longer usage, it is recommended to keep the preset at a lower value which affects the power efficiency of the circuit. It is expected to use the device not more than fifteen minutes continuously which may harm the operation of the amplifier. Heat sinks used in the amplifier can reach up to  $100^{\circ}\text{C}$ . It is not advisable to touch them during the continuous operation of the synthesizer.

The maximum current drawn by the oscillator and scalar adder is less than 5mA. Due to such a lower requirement, it is omitted in the technical specifications.

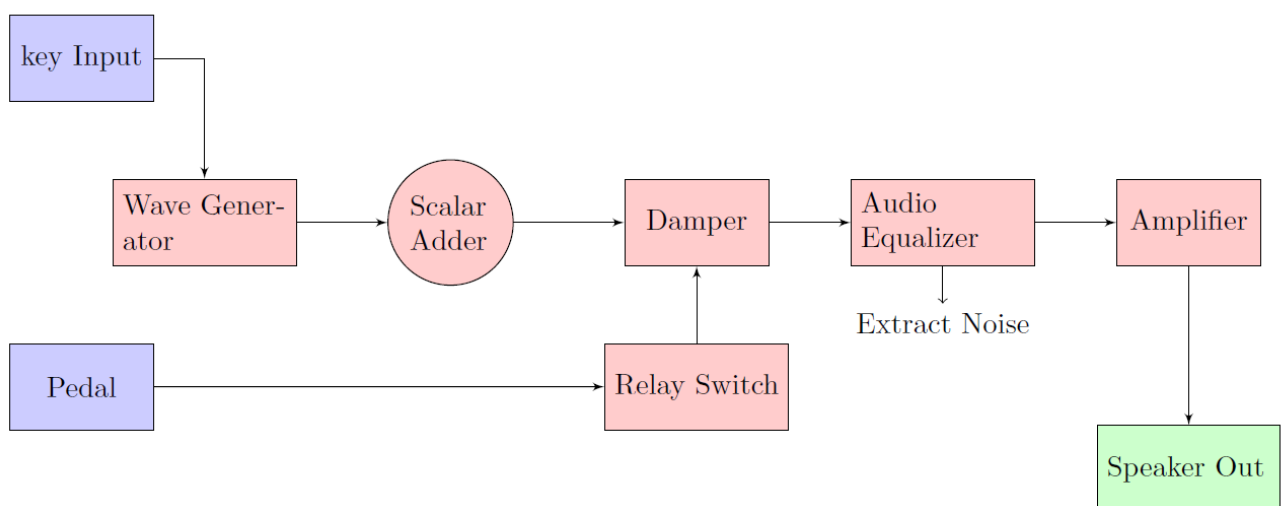


Figure 1: Circuit Block Diagram

### 3 Technical specification

Specifications are indicated for each module even though it pin-out of the device is narrower. This is done in the belief of allowing the users to make use of this to combine such modules in the creation of complete piano.

#### Oscillators

Operational Voltage(V)	Operational Frequencies(Hz)	Decaying Control Range(ms)	Output Impedance( $k\Omega$ )
3-6	281 $\pm$ 3	300 $\pm$ 100	2.49
	537 $\pm$ 3	300 $\pm$ 120	0.44
	790 $\pm$ 5	300 $\pm$ 150	2.37
	1100 $\pm$ 5	300 $\pm$ 200	7.43

#### Scalar Adder

Operational Voltage(V)	Allowed Frequency Range(Hz)	Recommended Resistance Range( $k\Omega$ )	Output Impedance( $k\Omega$ )
9-12	20-20000	0.5-50	4.53

#### Amplifier

	Unit	Value
Operational Voltage	V	9-12
Current Requirements	A	0.08-0.5
Input Impedance(Ac)	$M\Omega$	43 $\pm$ 5
Output Impedance(Ac)	$\Omega$	10 $\pm$ 5
Operational Frequency Range	Hz	200-12000
Volume Control Range	dB	20-70
Achievable Power Efficiency		63%

### 4 Pinout

#### PCB-I : Wave Generator

Pin	Signal
P1	
1	Ground
2	Power Supply +10.5 $\pm$ 1.5
3	Power Supply -4 $\pm$ 1
4	Ground
5	Power Supply +4 $\pm$ 1
6	Power Supply -10.5 $\pm$ 1.5
P2	
1	Signal Out
2	Ground

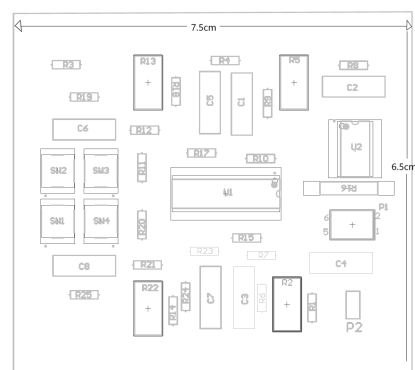
#### PCB-II : Amplifier

Pin	Signal
P1	
1	Signal In
2	Ground
P2	
1	Power Supply +10.5 $\pm$ 1.5
2	Audio Out
3	Ground
4	Audio Out
5	Power Supply -10.5 $\pm$ 1.5

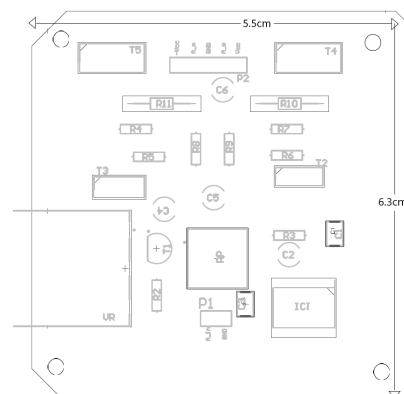
## 5 Fine-Tuning

1. **Wave Generator** : The resistance values of multi-turn presets R5, R13, R22, and R2 can be adjusted to achieve different damping time constant of the output wave. These are corresponding to frequencies 1100Hz, 790Hz, 537Hz, and 281Hz respectively. Users also have the flexibility to change R8, R17, R23, and R15 in an inversely proportional manner to vary the proportional constants of those frequencies on the final wave output.
2. **Amplifier** : The resistance value of the preset RP can be adjusted according to the power required to achieve different audio levels in the speaker output. Keeping the resistance values around  $2K\Omega$  is recommended for longer usage.

## 6 Measurements



PCB-I : Wave Generator



PCB-II : Amplifier

## 7 Application Curves

The output wave pattern(2) and its spectrum(3) at the end of wave generator are indicated in the following figures. The damping time constant can be elongated via the variable resistor attached to each oscillator.

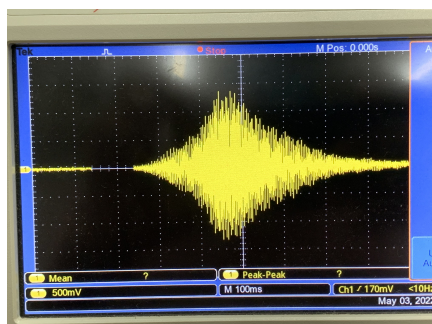


Figure 2: Final Wave Pattern

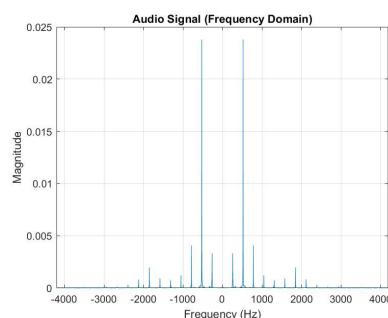


Figure 3: Frequency Spectrum

The magnitude response(4) and phase response(5) of the amplifier are indicated below. The amplifier is suitable for frequencies ranging from 0Hz to 12kHz. This is visible from the facts that the overall gain is maintained at a constant value according to the volume control and the phase is maintained at  $-180^\circ$  in that range.

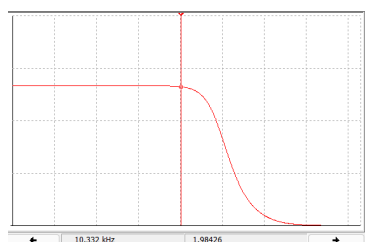


Figure 4: Magnitude

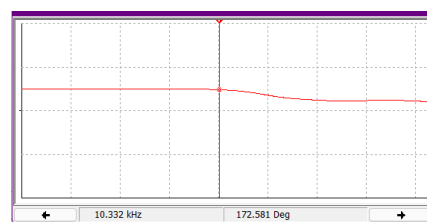


Figure 5: Phase

