

Paper keyboard synthesizer

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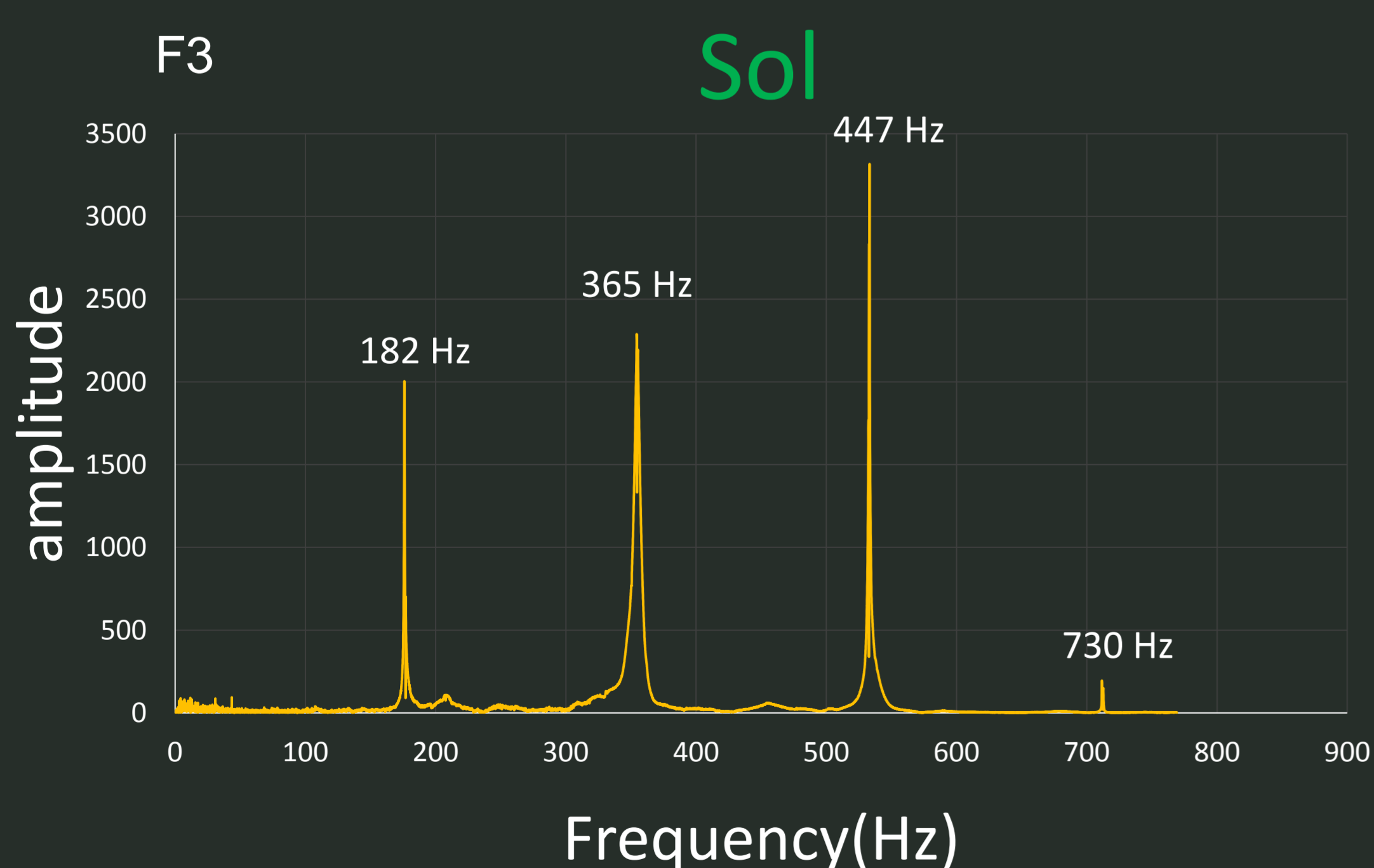
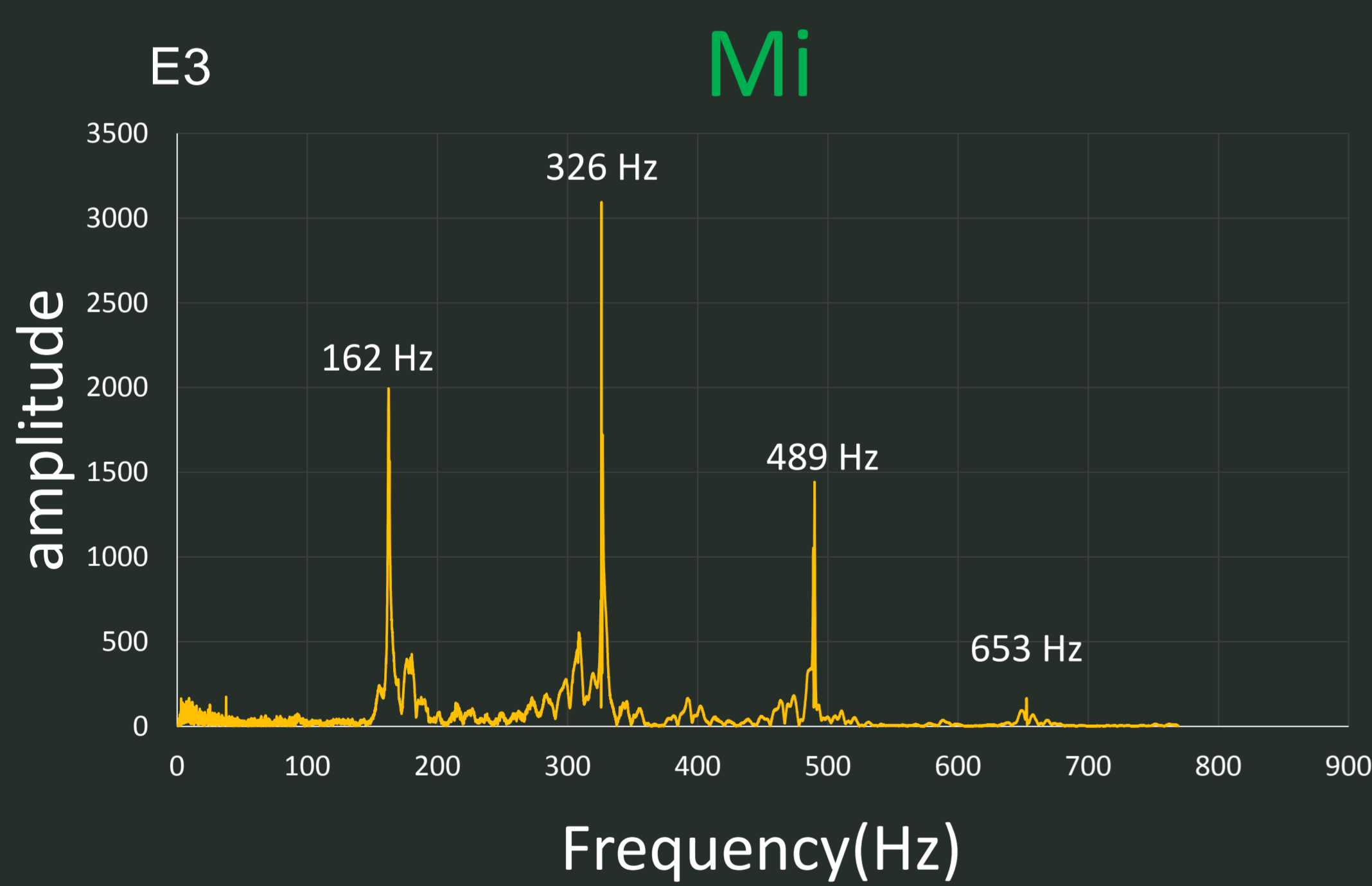
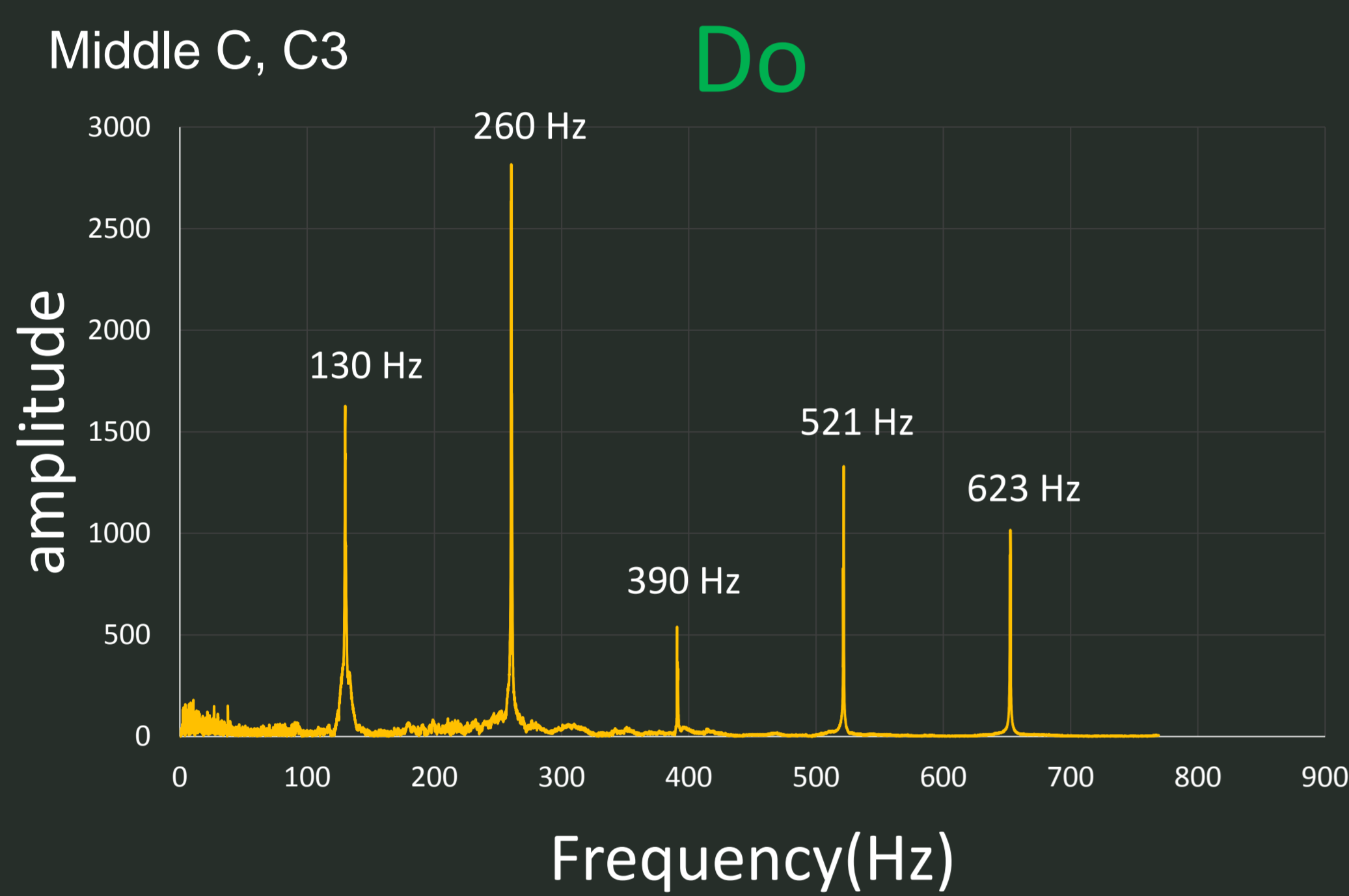
Experiment physics I, Department of physic, National Central University

Introduction

The sound synthesizer is the machine that can generate different instrument sounds after analyzing their composition of frequencies using Fourier transform. In this work. We use Arduino to synthesize the sound using pulse width modulation and direct digital synthesis. Simple capacitor sensors composed by a drawing paper are used as a keyboard to play different notes by your hands.

Analyze

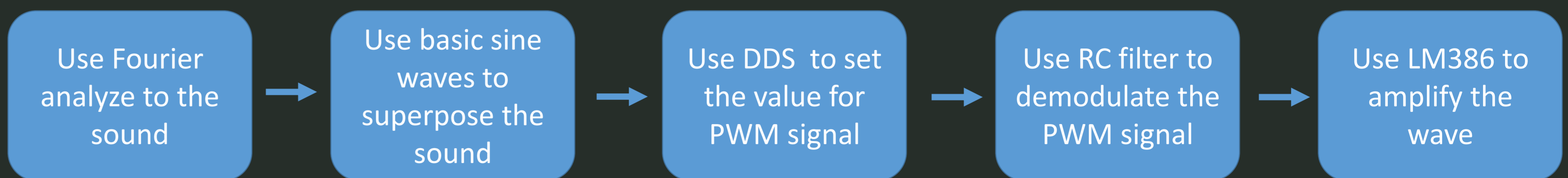
Fourier transform is used to analyze the sound of a traditional instrument. Take piano as example, the ratio between the fundamental frequencies of the first key and the next key is $2^{\frac{1}{12}}$. The amplitude difference in harmonics sets up the tone color of sound.



Reference

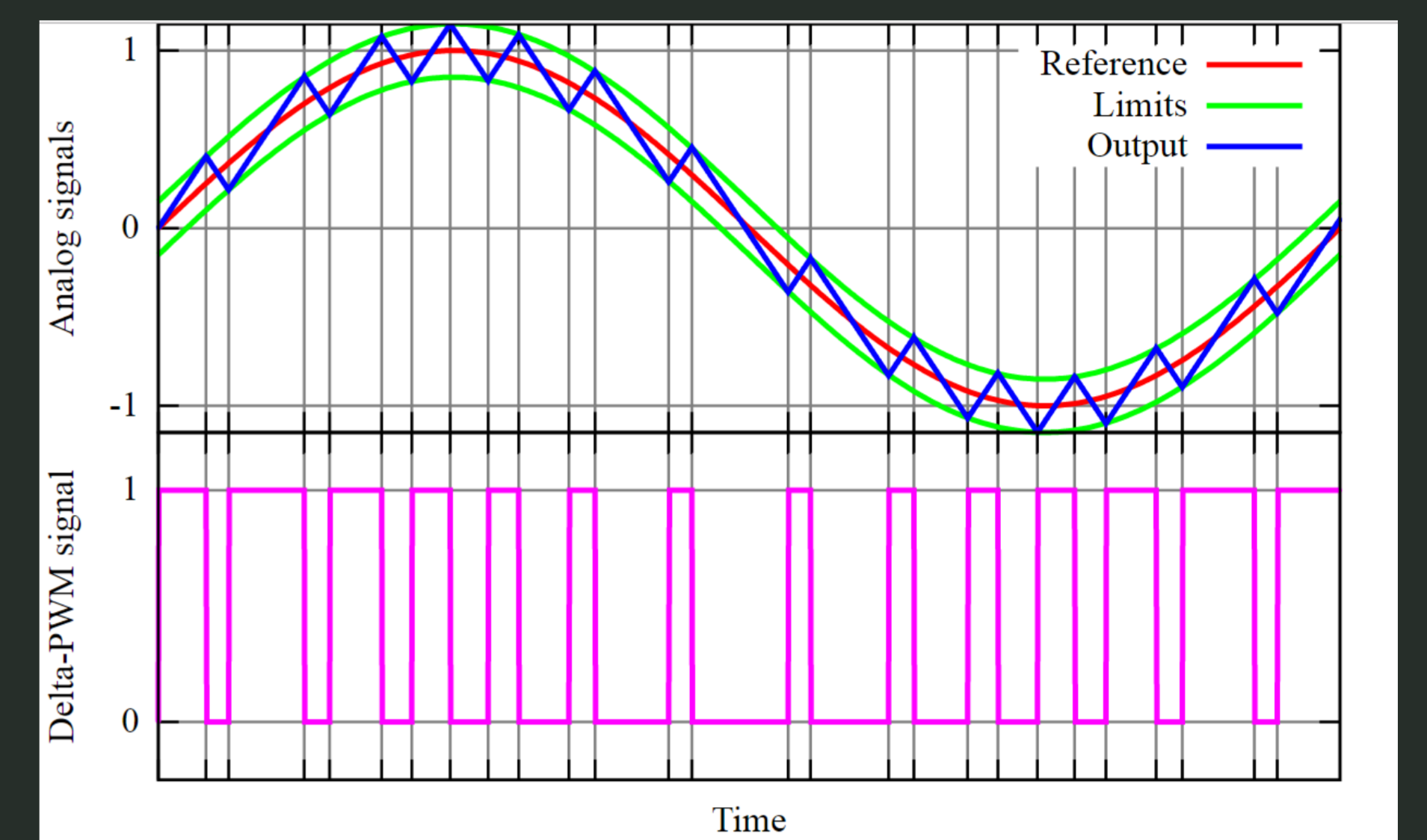
https://en.wikipedia.org/wiki/Pulse-width_modulation
<https://swf.com.tw/?p=946>
 Texas instrument LM386 data sheet

Procedure



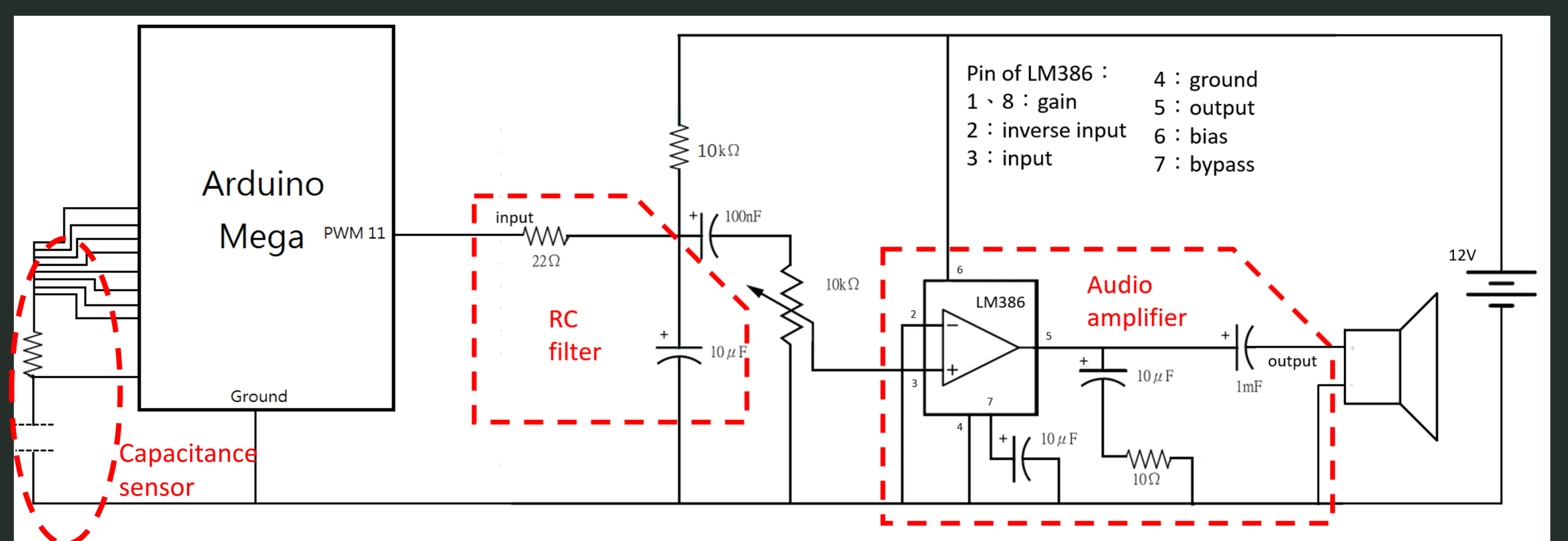
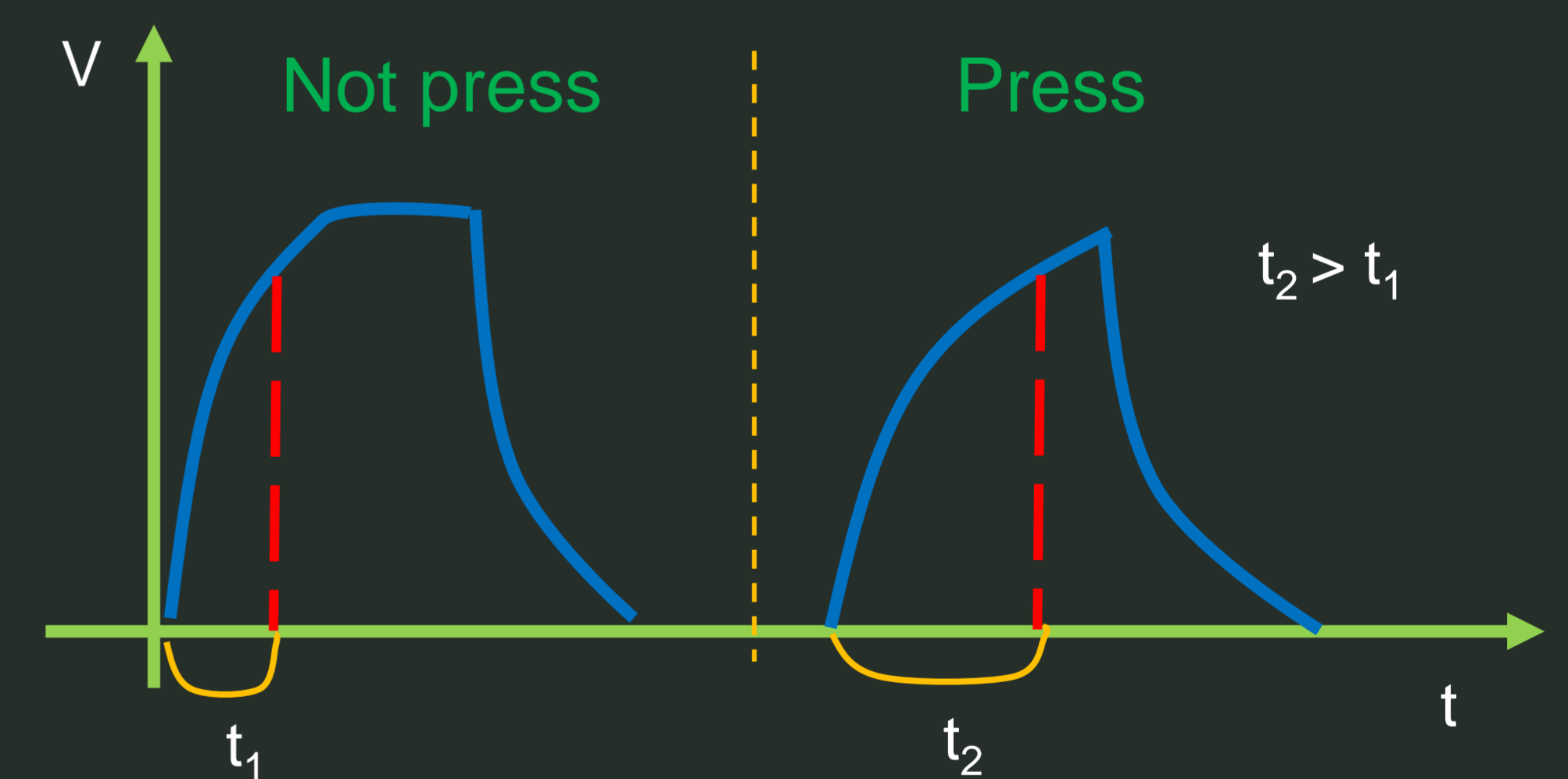
PWM & DDS

Pulse width modulation (PWM) signal is the continuous pulse with different duty cycles. The duty cycle represents the digitized output value. Arduino uses direct digital synthesis (DDS) method to digitize the waveform and output that waveform through PWM.



Capacitance sensor

Capacitance sensors are composed by metal clips on a paper with pencil drawings. It can be seen as variable capacitors depending on whether you touch the drawing or not. Your finger changes RC charging time of a certain key. Arduino detects the change and outputs the corresponding sound.



Circuit

Our circuit can be divided into two parts. One is the RC filter. The other is the audio amplifier. The RC filter demodulates PWM single to restore the sound. The audio amplifier circuit uses LM386 to amplify the signal.

Conclusion

1. The ratio between the fundamental frequencies of the first key and the next key is $2^{\frac{1}{12}}$.
2. DDS and PWM can be used to synthesize all kinds of sounds.