Documentation

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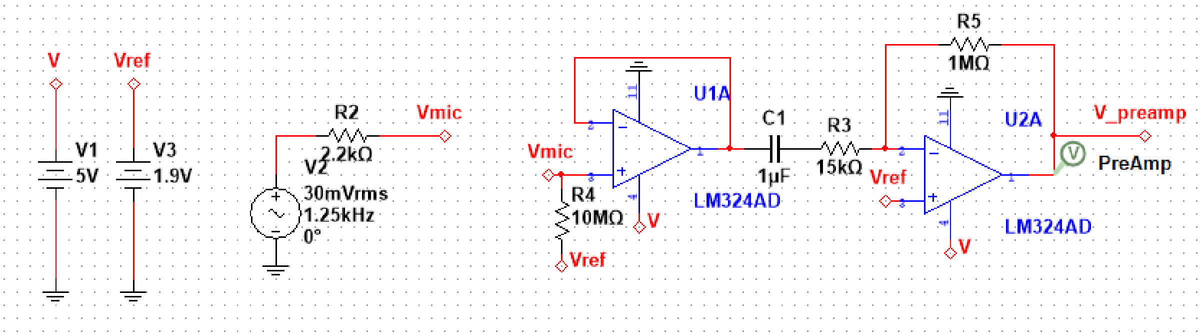
1 Microphone

1.1 Physical principles

We have used a capacitive microphone. It is built up by a diaphragm that detects the sound waves. The movement of the diaphragm causes the two plates in the capacitor to move, and thereby varying the capacitance, because the capacitance is inversely proportional with the distance between the two plates.

1.2 Multisim circuit schematics

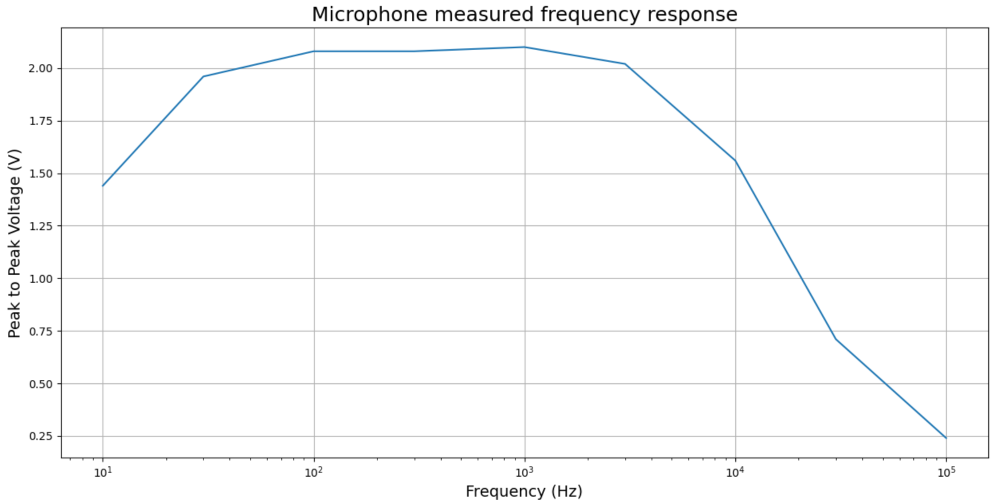


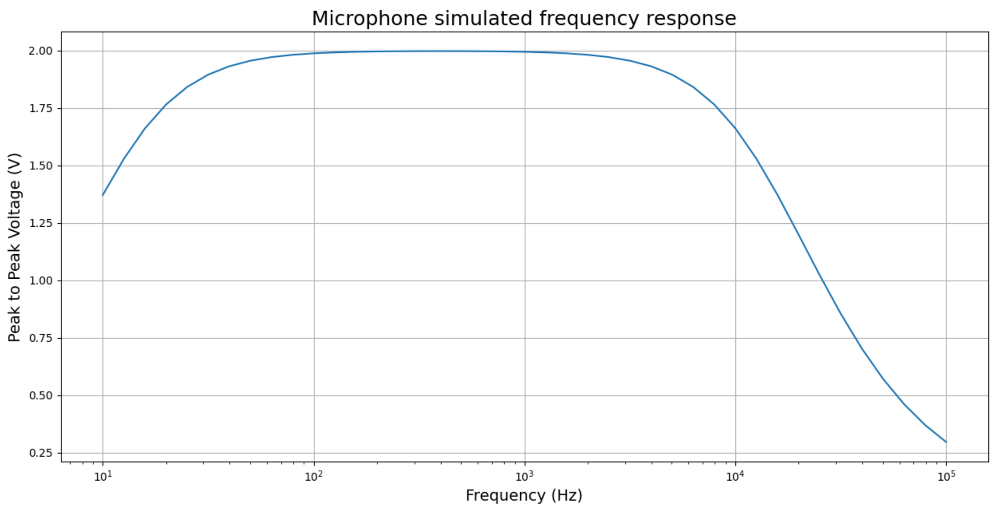
1.3 Measurements

Input amplitude: 30mVpp Input offset: 100mV

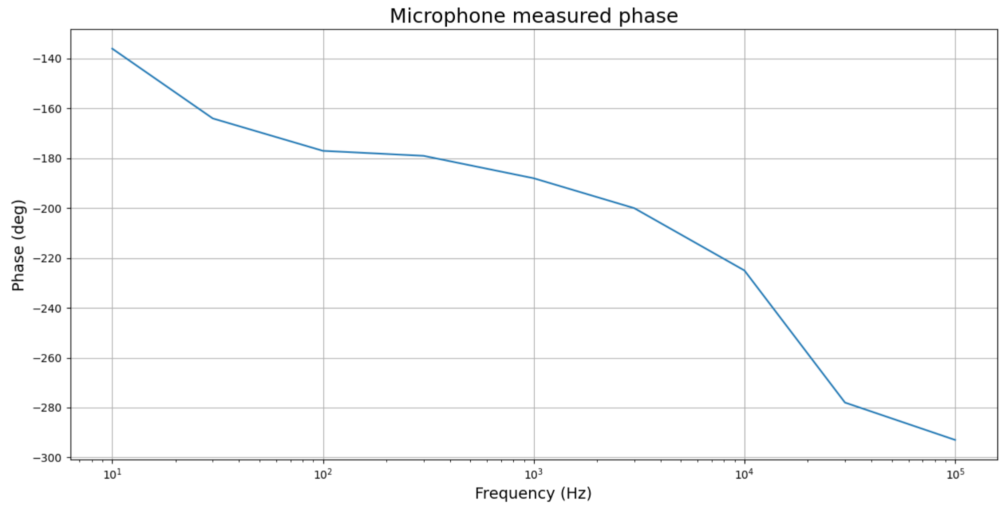
Input frekvens (Hz)	Output Vpp (V)	Phase (deg)
10	1.44	-136
30	1.96	-164
100	2.08	-177
300	2.08	-179
1000	2.10	-188
3000	2.02	-200
10000	1.56	-225
30000	0.71	-278
100000	0.24	-293

1.3.1 Peak to peak





1.3.2 Phase



2 Filter

2.1 Cut-off frequencies

2.1.1 Low pass filter

R1: 10kΩ
R2: 10kΩ
C1: 10nF
C2: 10nF
$f_{0l} = \frac{1}{2\pi RC} = 1.59$ kHz

2.1.2 High pass filter

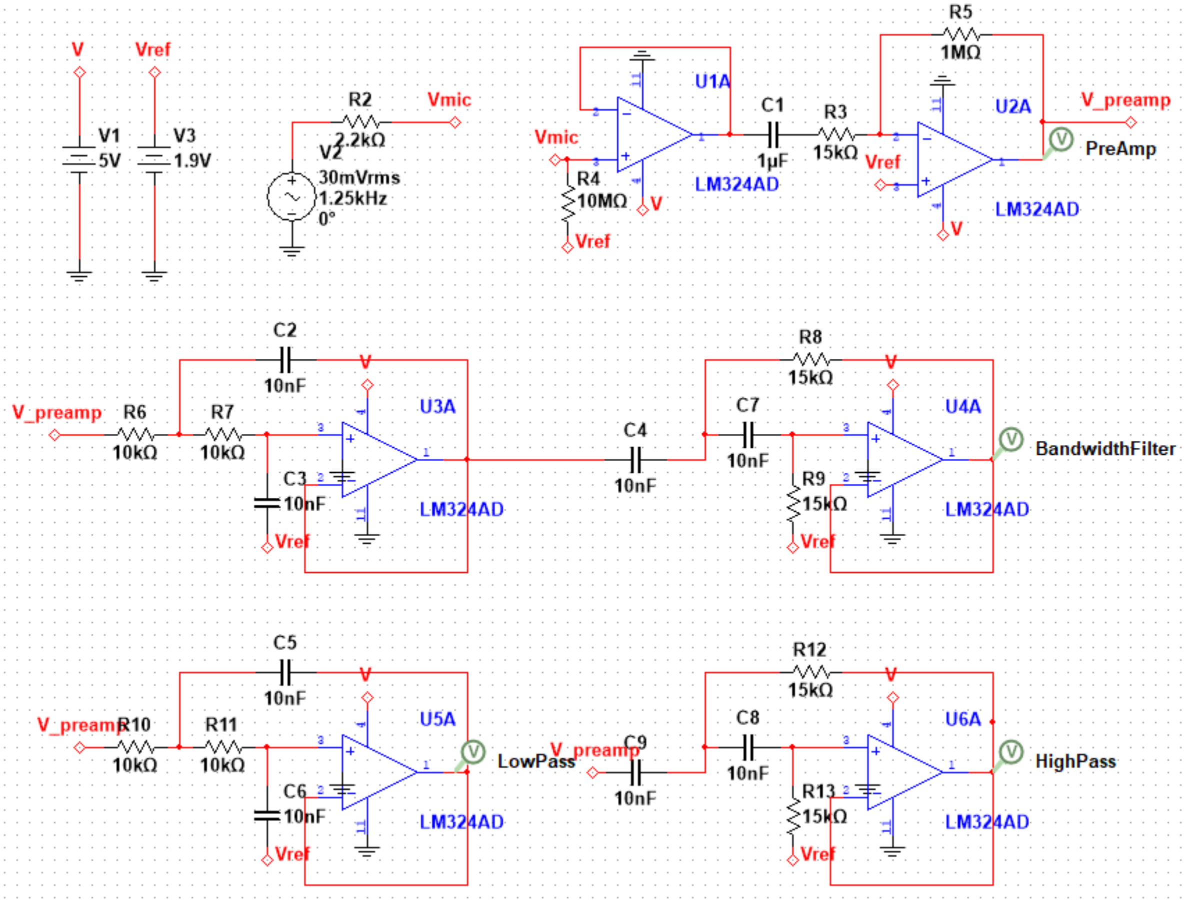
R1: 15kΩ
R2: 15kΩ
C1: 10nF
C2: 10nF
$f_{0h} = \frac{1}{2\pi RC} = 1.06$ kHz

2.1.3 Bandpass filter

Bandwidth: $f_{0l} - f_{0h} = 0.53$ kHz

2.2 Multisim circuit schematics

Extension of microphone schematic with added filters. Made filters twice, first to see effects of each filter seperately, then to see the overall effect of both filters on the circuit.

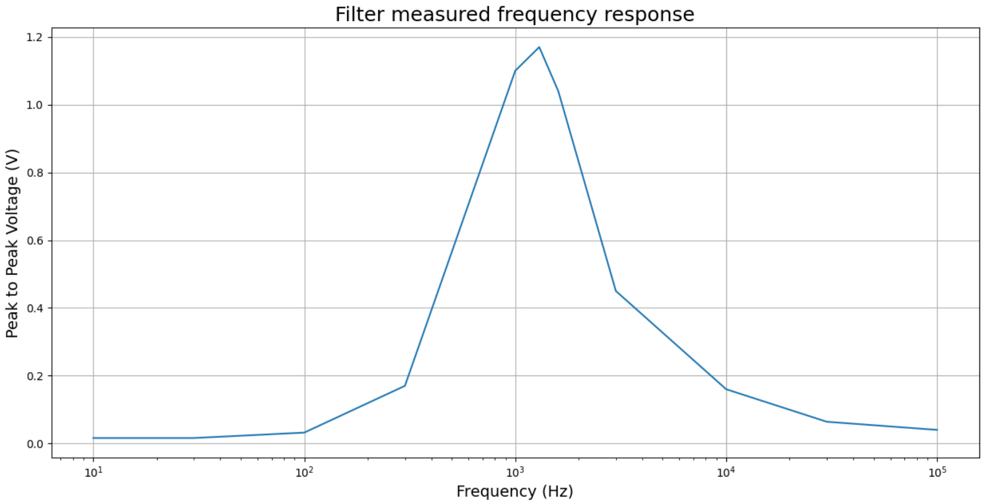


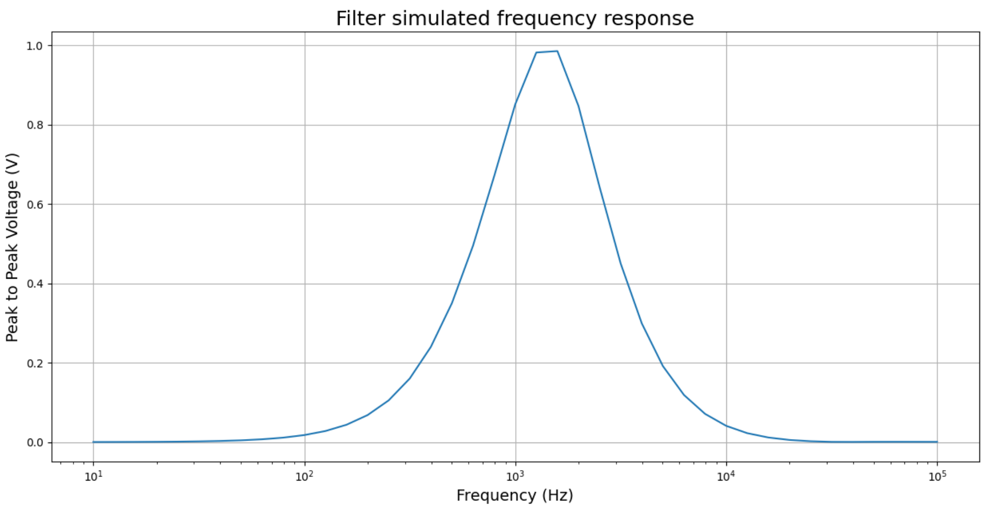
2.3 Measurements

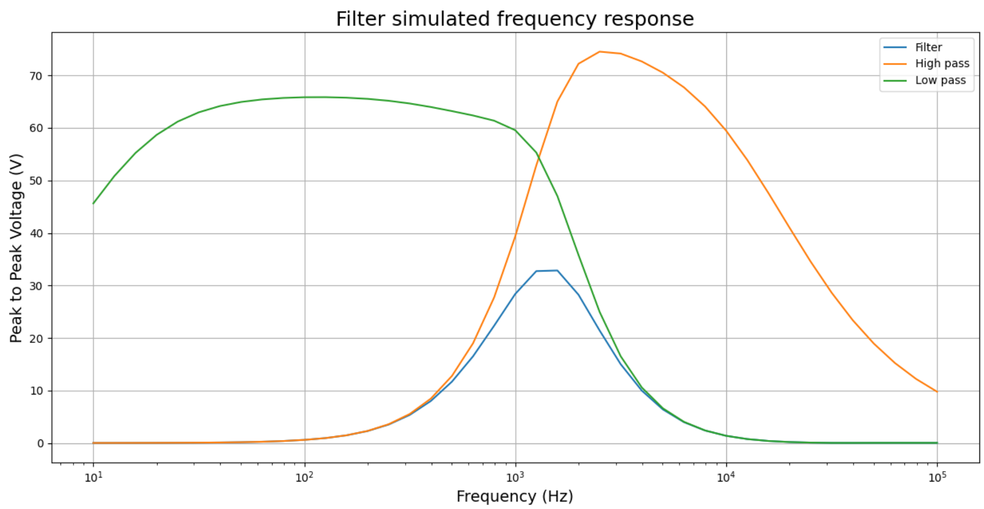
Input amplitude: 30mVpp
Input offset: 100mV

Input frekvens (Hz)	Output (Vpp)	Phase (deg)
10	0.016	0
30	0.016	0
100	0.032	-10
300	0.170	-53
1000	1.10	-150
1300	1.17	-204
1600	1.04	-231
3000	0.450	-310
10000	0.160	-365
30000	0.064	-365
100000	0.040	-365

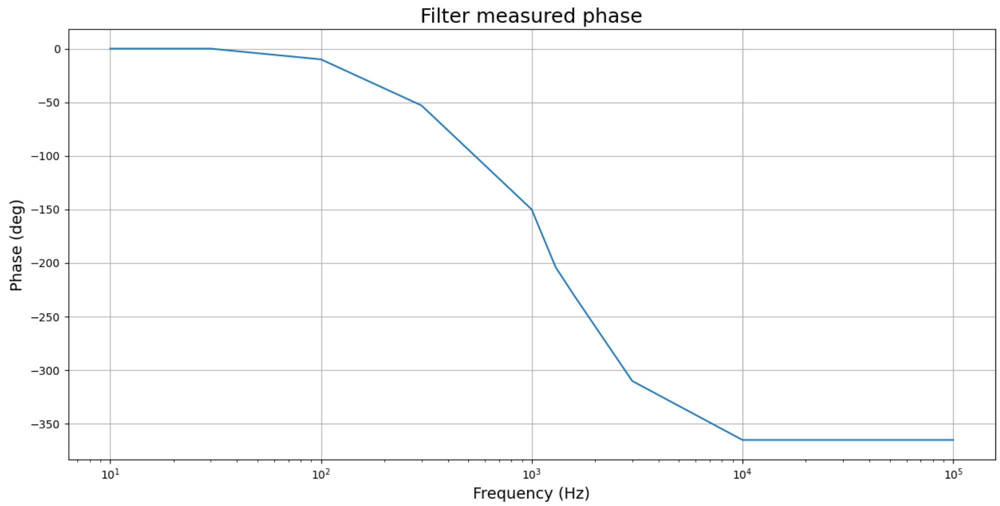
2.3.1 Peak to peak





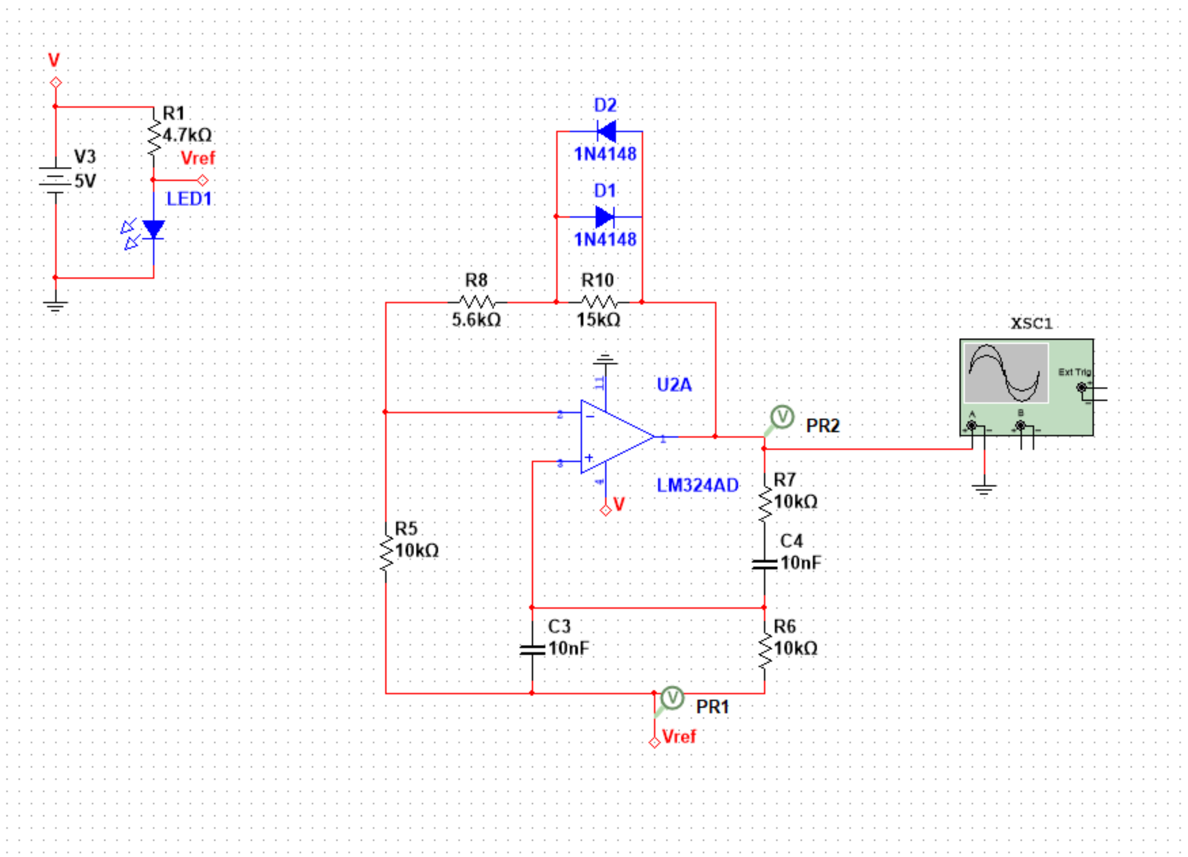


2.3.2 Phase



3 Oscillator

3.1 Multisim circuit schematics



3.2 Measurements

3.2.1 Amplitude (Peak to peak)

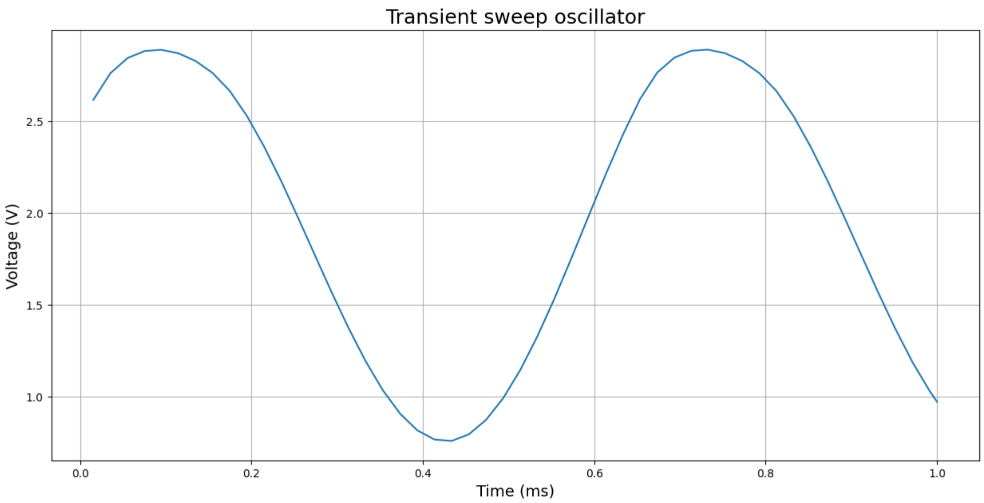
Measured peak to peak: 1.26V
Simulated peak to peak: 2.1V

Big difference in peak to peak due to error in physical components, especially capacitors.

3.2.2 Frequency

Measured frequency: 1.578kHz
Simulated frequency: 1.567kHz

3.2.3 Transient sweep

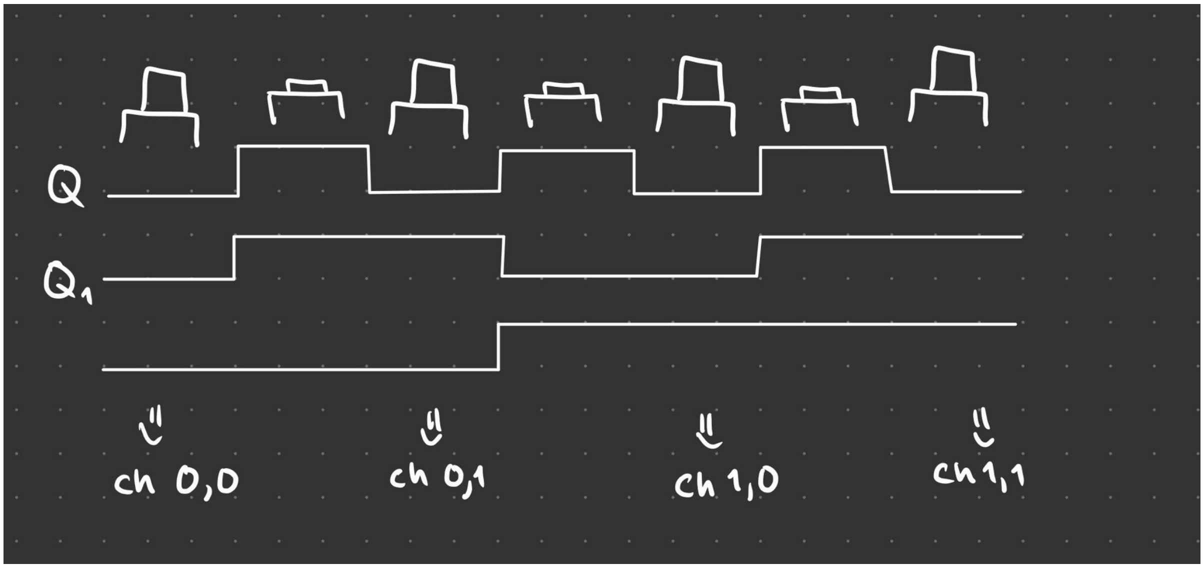


4 Digital controller

4.1 Function description

In our circuit, we use the reference voltage for both the oscillator, the microphone with filter and the piano. To control which of these that sends their output to the loudspeaker, we have implemented a digital control. The control consists of two flip flops and a multiplexer. It has four channels, each with a light. The button gives signal when pushed and a push will change the signal.

4.2 Waveform diagram



5 LM555 piano

5.1 Description

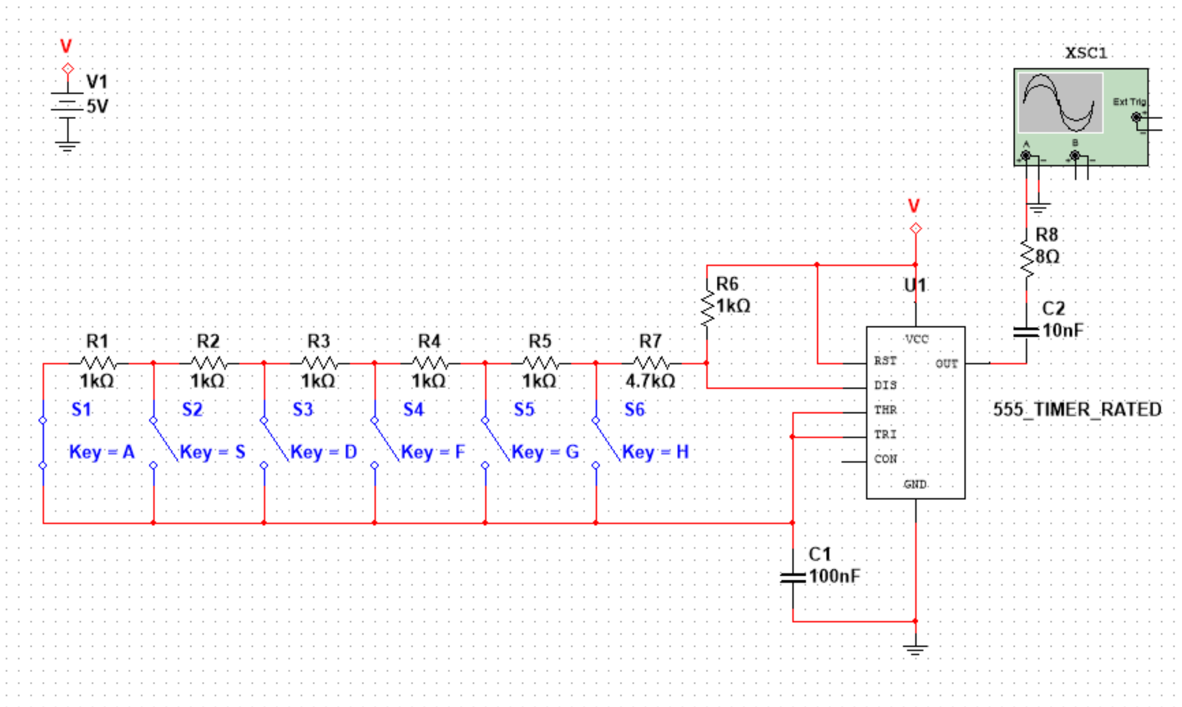
Depending on which button that is pressed, the resistance will vary. The change in resistance also changes the frequency with the relation

$$f = \frac{1.44}{(R1 + R2) \cdot C1}.$$

Because the resistance is inversely proportional with the frequency, a higher resistance equals a lower frequency.

Design inspired by this circuit.

5.2 Multisim circuit schematics



5.3 Measuerments

Key number	Measuerd frequency (Hz)	Theoretical frequency (Hz)	Simulated frequency (Hz)
1	1353	1385	1303
2	1135	1161	1130
3	977	1000	962
4	856	878	840
5	765	783	763
6	690	706	690