



# Session 2: oscillations

Applied Electronics for Sound and Music  
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# Outline

- Brief theoretical basics
- Building a dual 40106 oscillator
- Fun hints?



# Oscillators

- “oscillation” is when something moves back and forth, in any way or trajectory.
- Some mechanical oscillators around us: pendulums, springs, rubber bands, ... ..
- These should be excited (get energy) to start oscillating and the oscillation is damped over time (the oscillator loses energy).
- Which mechanical oscillators make sound?



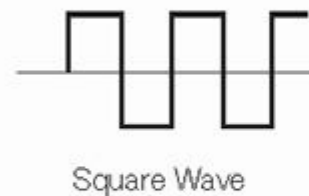
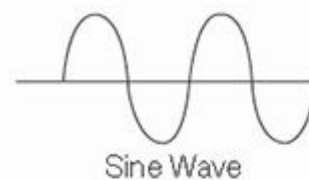
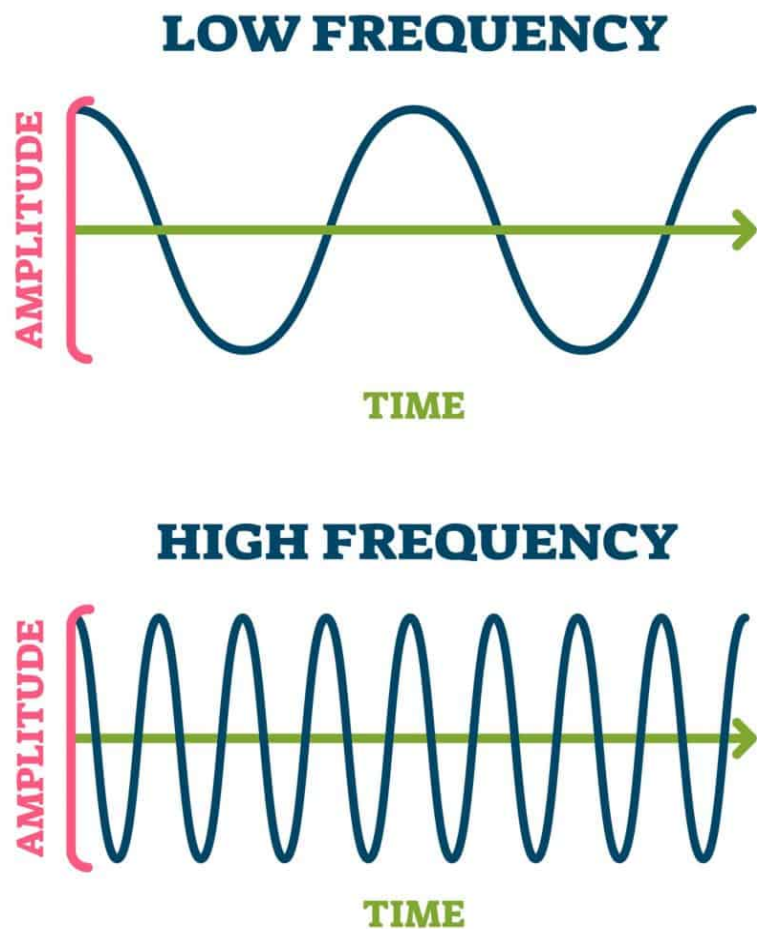
# Oscillators

- There has to be some changing voltage to produce sound with a speaker
- Electronic oscillators are devices that produce a wave (a voltage oscillation). Usually, the energy is put in by the power supply (e.g. battery) and the oscillation never ends while there is power, unlike mechanical oscillators, like guitar strings.
- Are one of the primary sound sources in electronic sound synthesis!

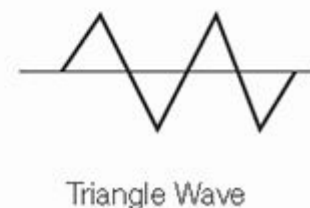
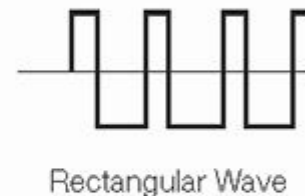
# Oscillators

- An (electronic) oscillator's output is characterized by: **amplitude**, **frequency** and **shape**
- Amplitude: how many volts it travels back and forth. Unit: V
- Frequency: how many times per second one oscillation happens. Unit: Hz
- Shape: the 'trajectory' the signal takes while oscillating

# Oscillators



Some Waveforms





# Oscillators in music

- In (relatively) modern advanced synthesizers, VCOs (Voltage Controlled Oscillators) are used. Their frequency depends on the special input called “control voltage”.
- These circuits are somewhat complicated and almost always require a stable bipolar power supply

# Oscillators in music

- Before creative music engineers like Don Buchla and Bob Moog started making VCOs (and other modules) for musical use, electronic music pioneers used lab equipment and abandoned military equipment as oscillators
- They weren't voltage-controlled, and mostly produced constant tones
- Read/listen: Silver Apples – Silver Apples





# Oscillators in music

- Assembling an oscillator (not a VCO) with a manually tunable frequency is rather easy nowadays
- Despite not being advanced, it can easily be musically useful
- Oscillators built during this session are used in some electronic drum sound generators, such as the TR-808 cowbell and TR-606 hi-hats

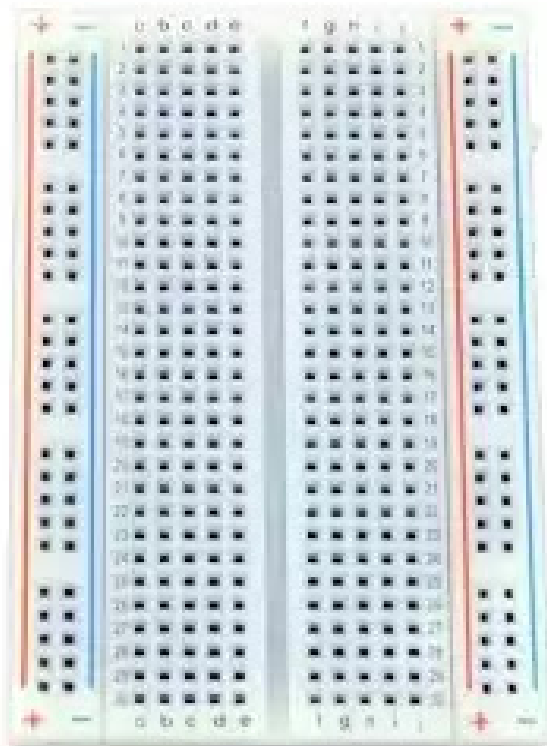


# Protoboard basics

- Before assembling your circuit on a veroboard (the one with vertical perforated copper traces), you should test your circuit on a solderless protoboard!

# Protoboard basics

Breadboard front



Uncover Breadboard back

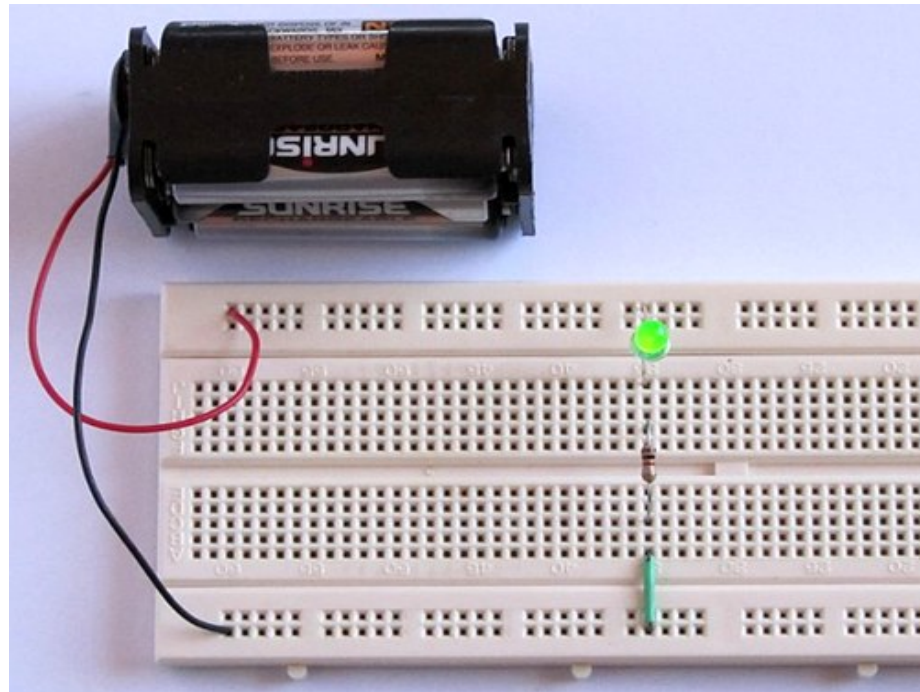
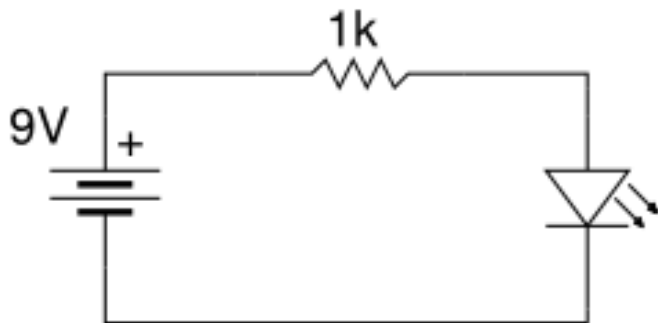


Breadboard metal strip



# Protoboard basics

- Let's light an LED to see how the breadboard works!



# CD40106 Oscillator

- Now that we learned to build a simple circuit on the breadboard, let's build something a bit more fun: a squarewave oscillator!
- It uses three parts: a resistor, a capacitor, and an inverting Schmitt trigger



# Resistors and capacitors

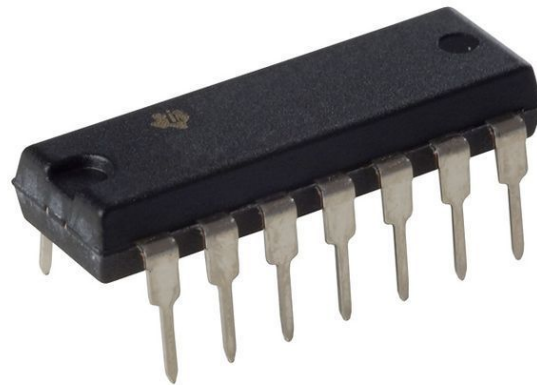
- Resistor is used to limit current in circuits (e.g. the LED exercise) by converting energy into heat. Resistance is measured in Ohms ( $100\Omega$ ,  $100r$ ), Kiloohms ( $100K = 1000 * 100r$ ) and Megaohms ( $1M = 1000 * 1K = 1000 * 1000 * 1r$ )
- The more ohms, the more resistance it puts up to the current.
- Can be fixed (most), variable, light-dependent, etc

# Resistors and capacitors

- Capacitor stores and releases electric charge, and has many applications. Can be thought of as a resistor with resistance going down as the frequency of the signal over it goes up.
- Capacitance is measured in nanofarads (nF), microfarads ( $\mu\text{F} = 1000 * \text{nF}$ )
- The more farads, the more charge it can store
- Can be unpolarized or polarized. Mind the polarity and the voltage rating!

# The CD40106

- Schmitt trigger is a complicated device consisting of multiple transistors
- Luckily, six of them at once are available in a standard DIP14 chip/IC package (Dual In-line Package, 14 pins)

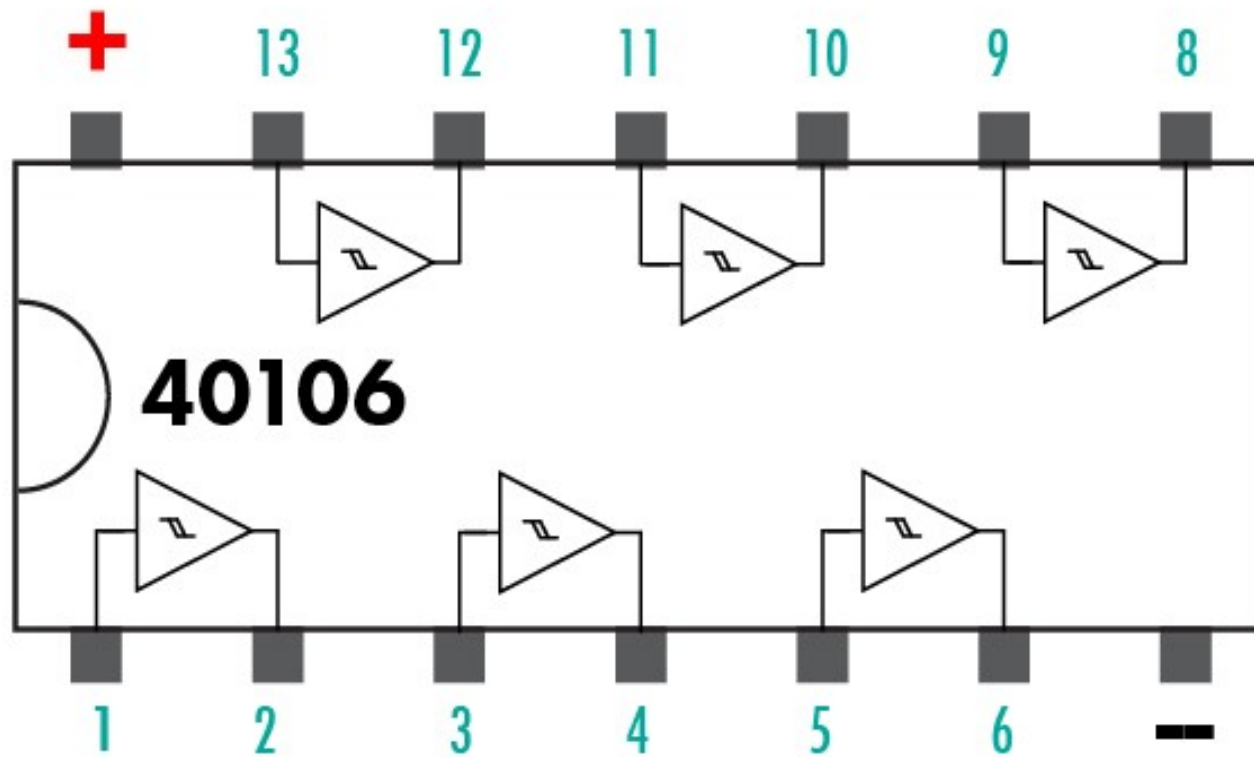




# The CD40106

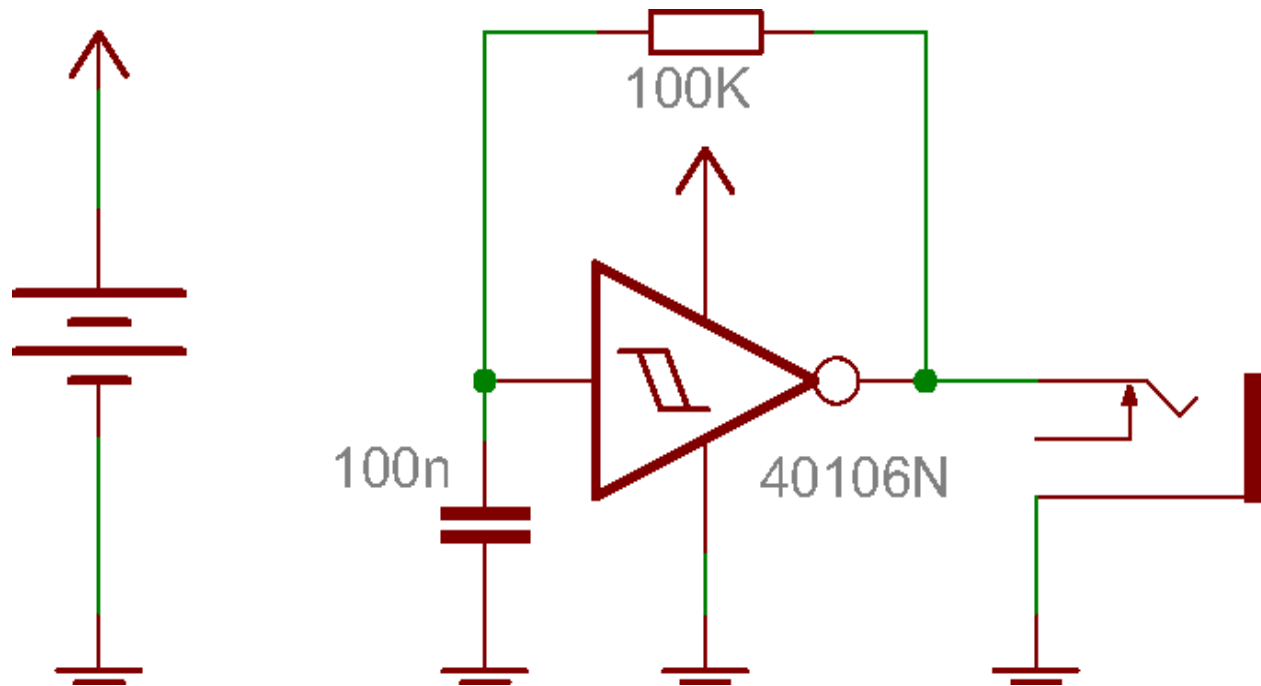
- There are complicated ready-made circuits inside
- pins lead to useful points in the circuit
- Search for the chip's **pinout** or **datasheet** to find out which pin does what!
- Chips visually look similar, except for the model name on top
- Pay attention to the dent! For DIP, pin 1 is **under** the dent when it's pointing to the **left**

# The CD40106



# Protoboard an oscillator

Use the 3.5mm jack to pin header adapter you made last time

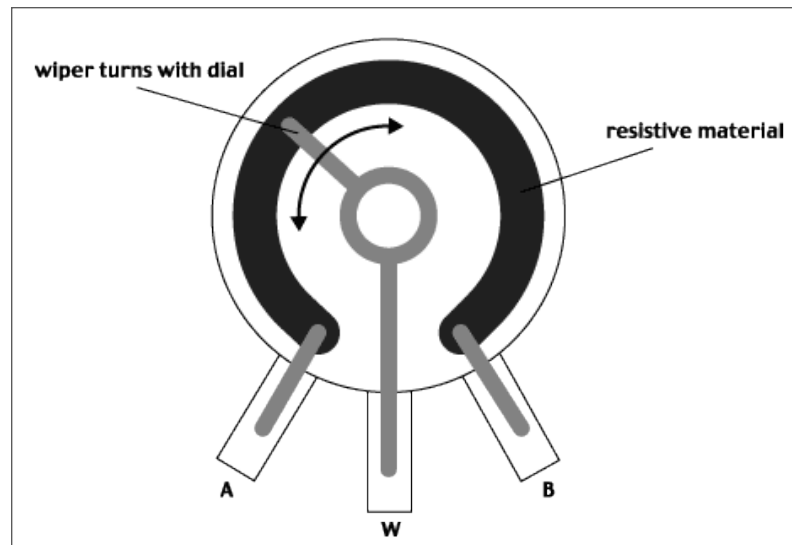


# Experiment with it

- Replace the 10K resistor with a 100K resistor
- Replace the 100n capacitor with a 47n capacitor

What changes?

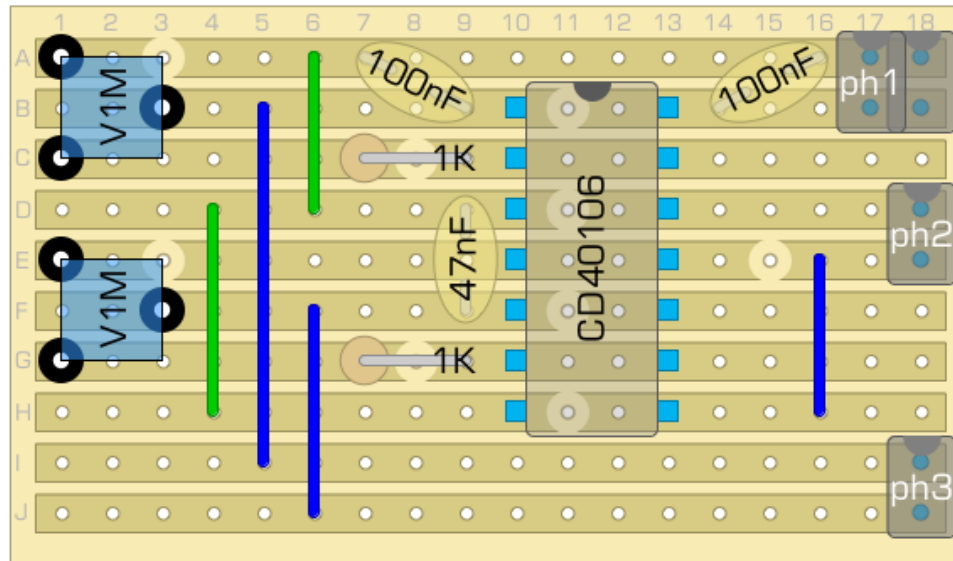
- Replace the fixed resistor with a variable one



# Build a minimodule

- Now, let's build 2 such oscillators as a hard-soldered minimodule to use with other stuff we made/will make
- We will add pin headers for easy connectivity, as well as a buffer (another Schmitt trigger) after each oscillating trigger to improve stability, etc
- Parts: 2x100n & 1x47n capacitors, 2x1K resistor, 2x1M variable resistor, 1xCD40106, 1xDIL14 IC socket, pin headers (two 2\*1, one 2\*2), bare wire

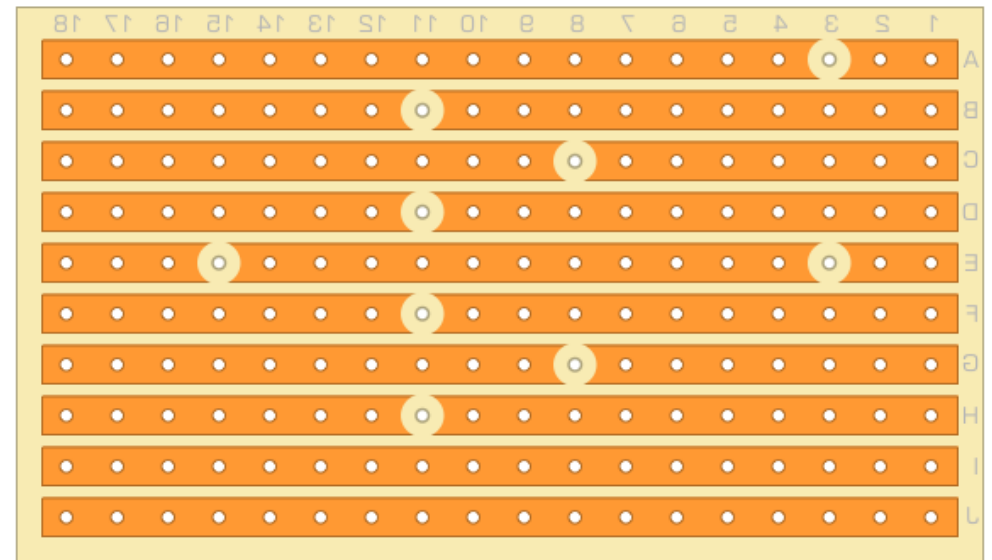
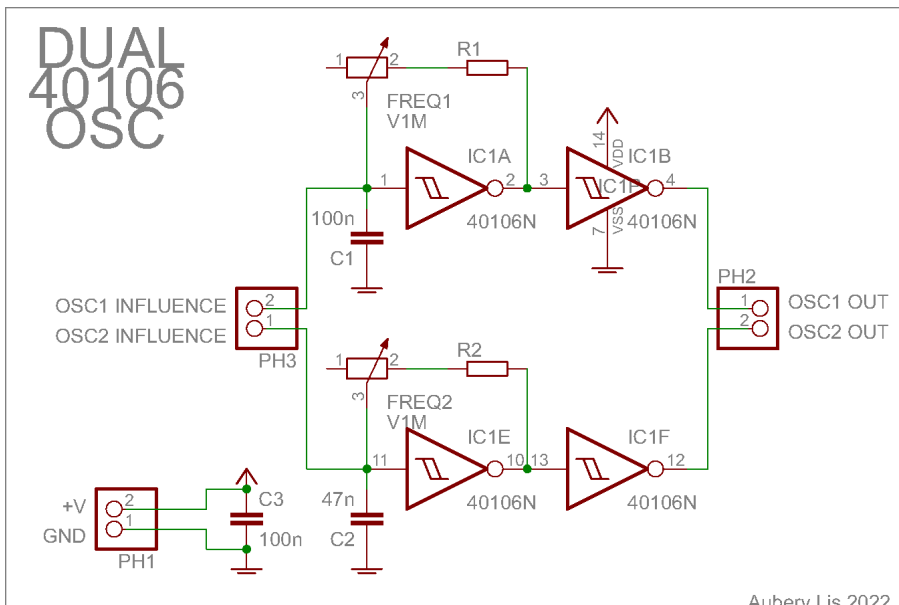
# Schematic and layout



GND  
+V

OSC1 out  
OSC2 out

OSC1 'influence'  
OSC2 'influence'





# Play around

Test each osc and make sure it works. Then, connect both oscillators to a protoboard with a plug-jack jumper wire and try various creative things, such as:

- Mixing them with diodes or 10K resistors
- Passing them through logic gates (e.g. CD4030)
- Passing one osc out to the other's 'influence' input through a diode