

40106 Hex Oscillator Workshop Instructions

bbob drake, aka fluxmonkey

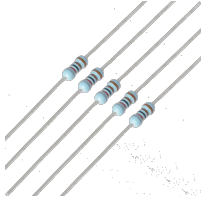
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Basic electronics using a few components

We'll be making some simple oscillators using just a handful of components:

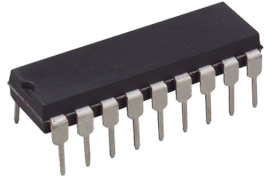
Resistors



Capacitors



Integrated Circuit



CDS Cell
(light-sensitive resistor)



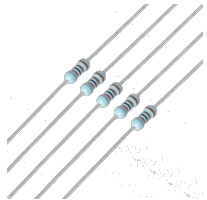
Diodes



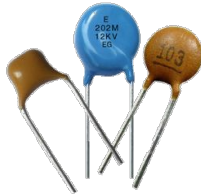
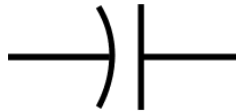
Schematic Symbols

Electronic components can all be represented by schematic symbols:

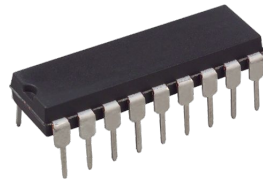
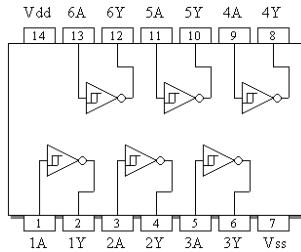
Resistors



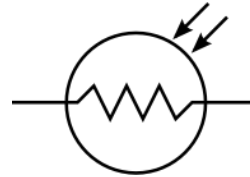
Capacitors



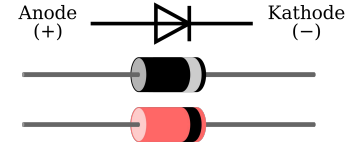
Integrated Circuit
(CD40106)



CDS Cell
(light-sensitive resistor)

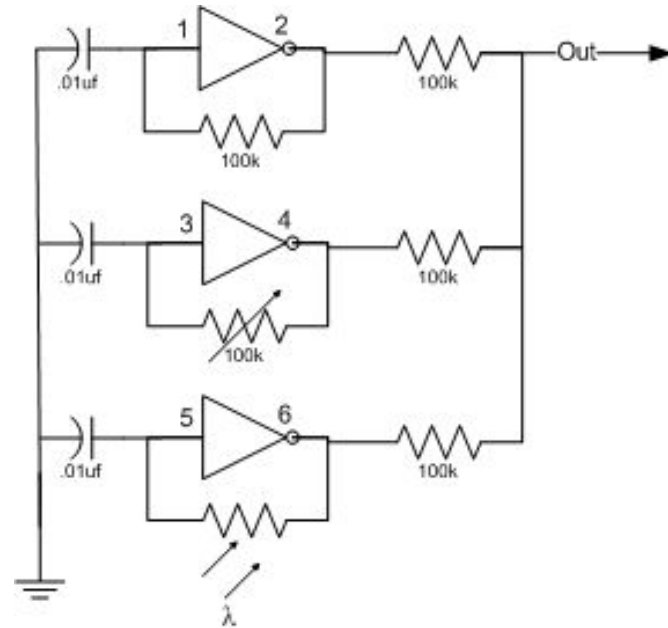
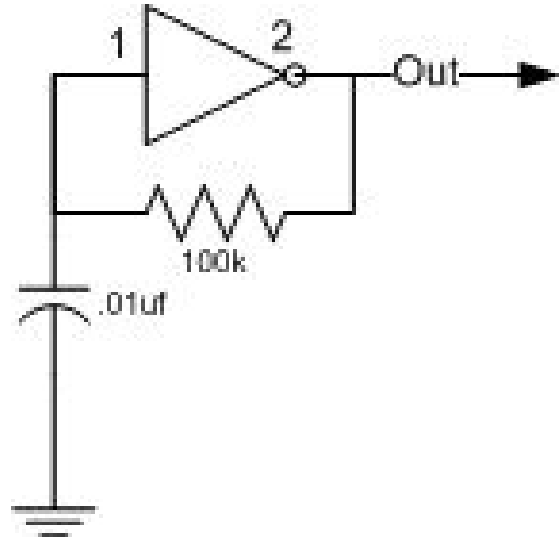


Diodes



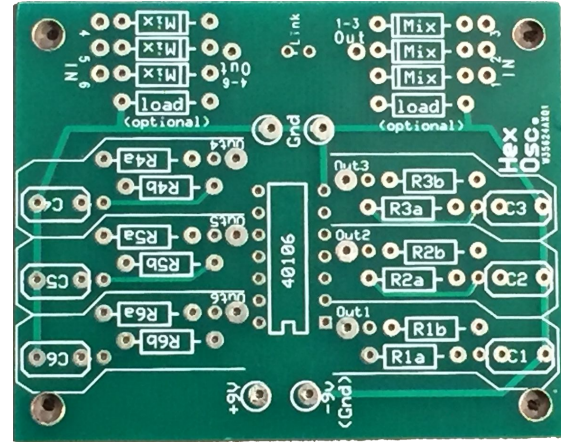
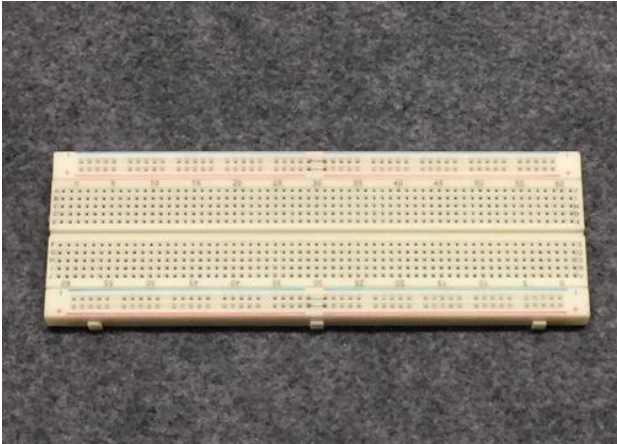
Schematic Diagrams

Schematics are used to diagram electrical circuits, showing how the components are inter-connected:



Building techniques

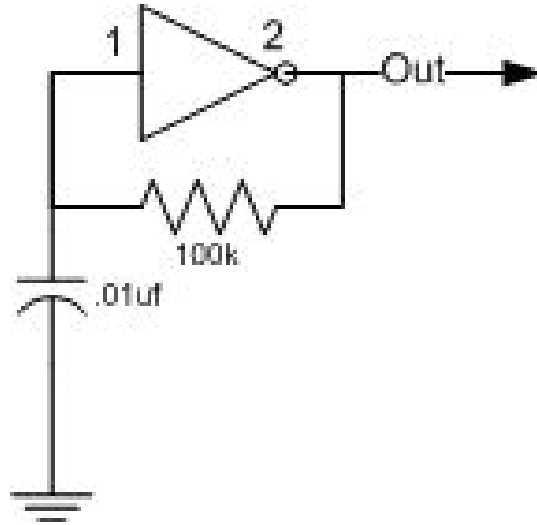
We'll use 2 different tools to build our projects today, a solderless breadboard, and a printed circuit board:



Each of these provide different ways to mount the components and connect them together.

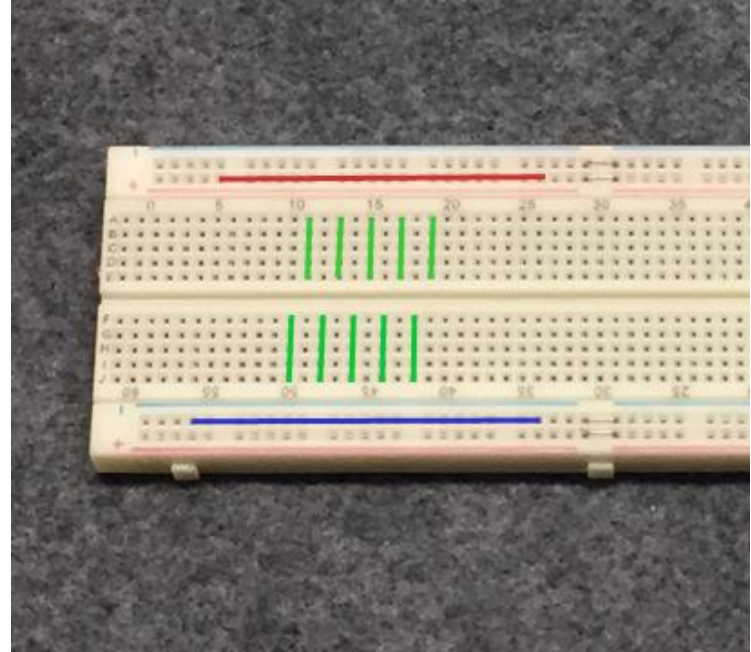
Simple CMOS Oscillator

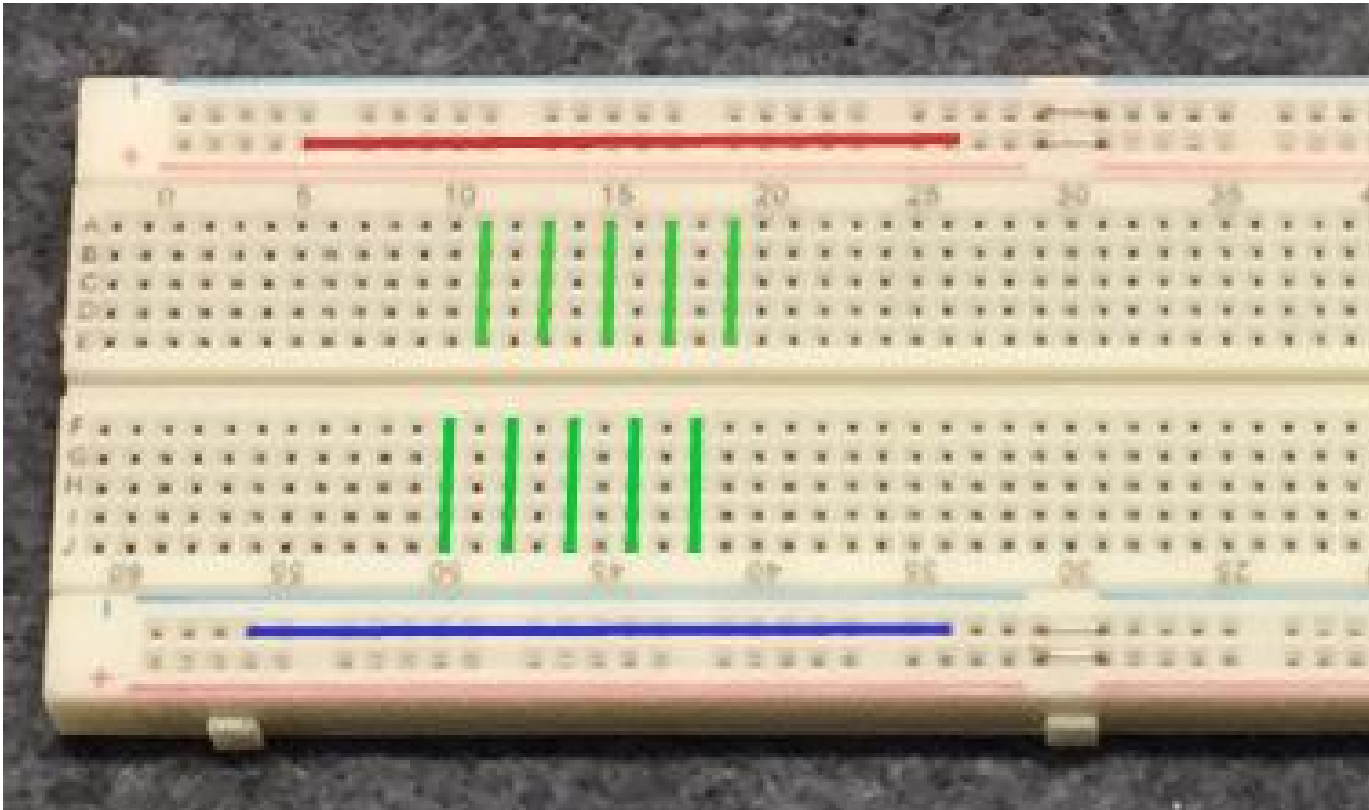
First we'll build a single oscillator on a breadboard, so you can see how it works. Here's the schematic: a capacitor, a resistor, and one section of an integrated circuit:



How breadboards work

- The breadboard has holes where you can insert component leads
- Sets of holes are interconnected, so component leads stuck in adjacent holes get connected
- It's easy to swap things around while prototyping, to test out ideas
- Components can get jostled and dislodged, so it's not great for final builds.

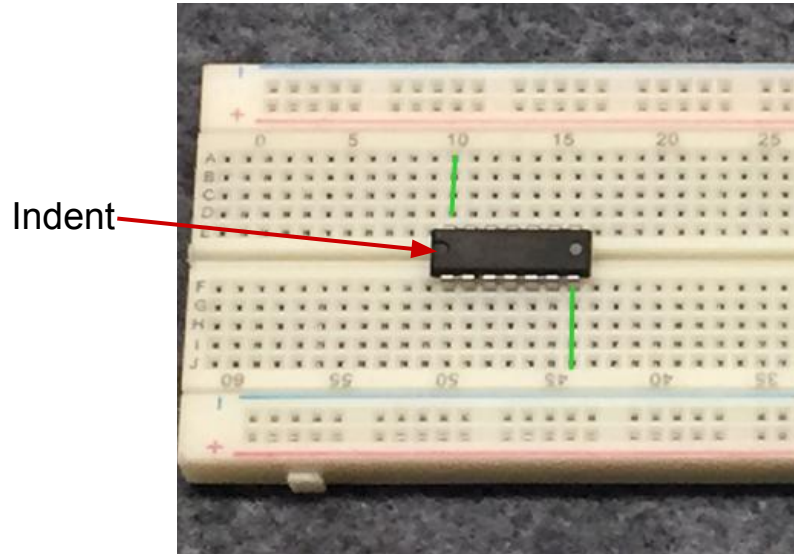




(lines indicate sets of holes that are connected together)

Simple CMOS Oscillator - Step 1

Insert the IC into the center of the board, straddling the gutter. Make sure the indented end is to your left.

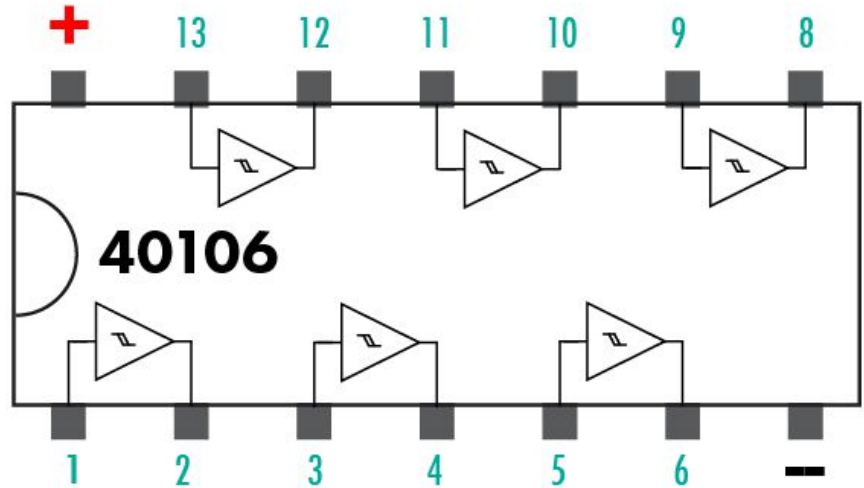


Simple CMOS Oscillator - Step 1.5

ICs provide circuitry building blocks in a small package. We're using a 40106 IC, which has 6 "inverters", represented by triangles in the diagram.

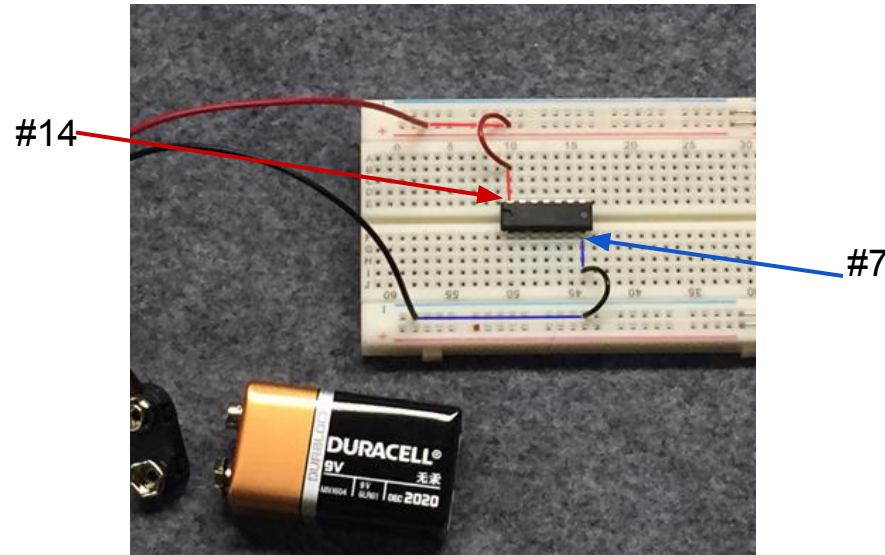
Connections are made to these inverters via the pins, or metal legs on the IC. They're numbered 1-14, counter-clockwise from the bottom left.

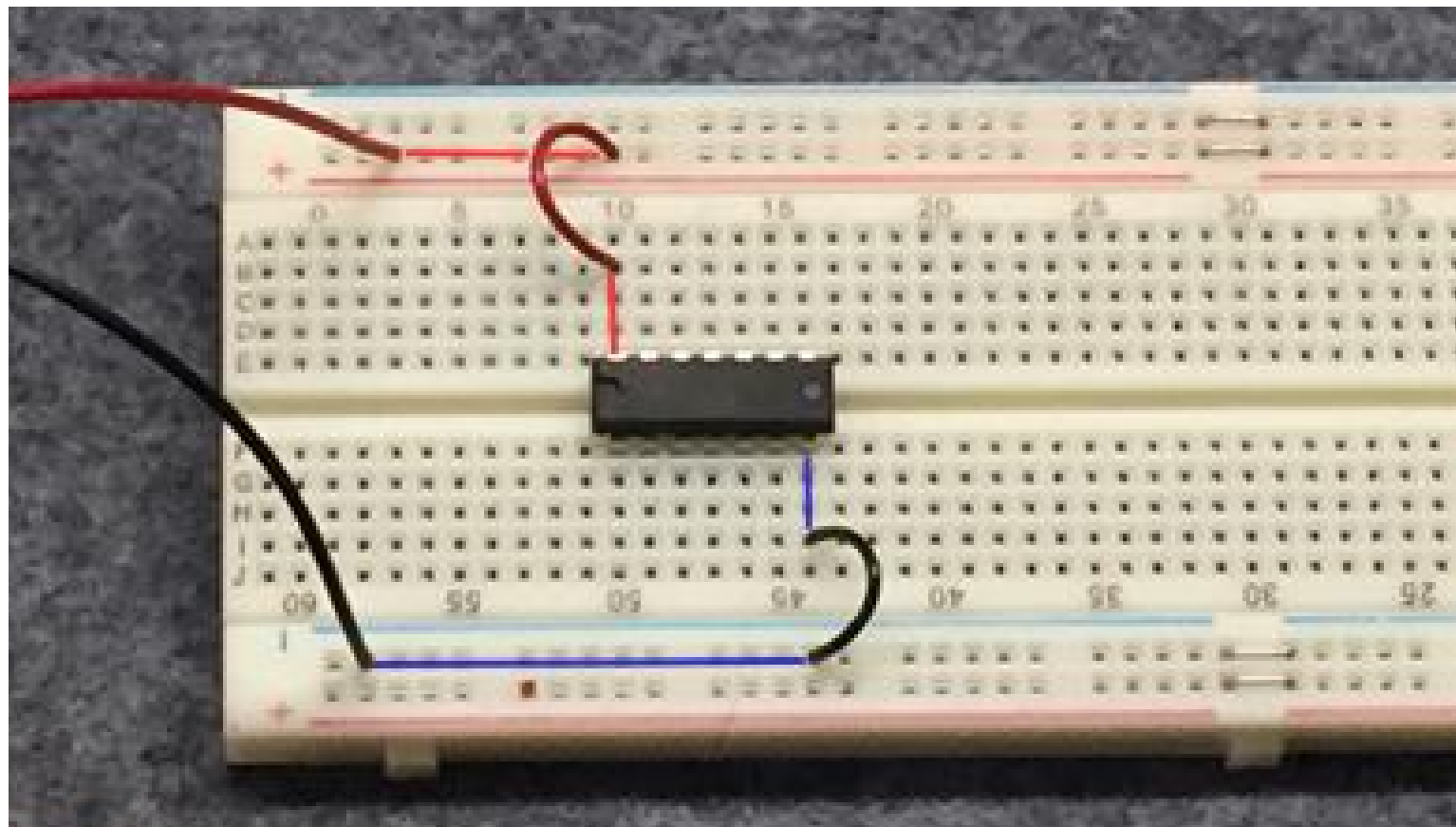
Power goes to pins 7 (negative, or ground) and 14 (positive).



Simple CMOS Oscillator - Step 2

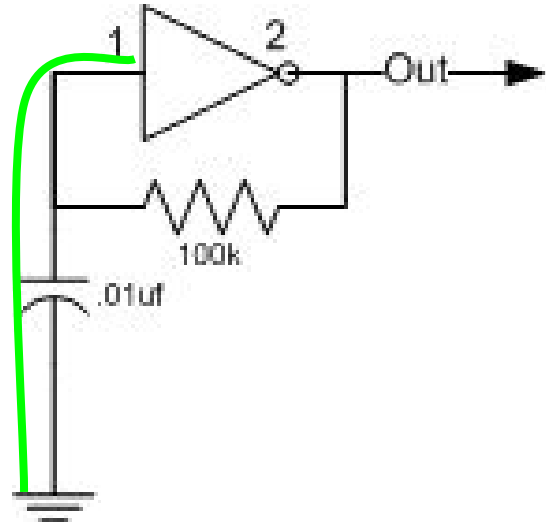
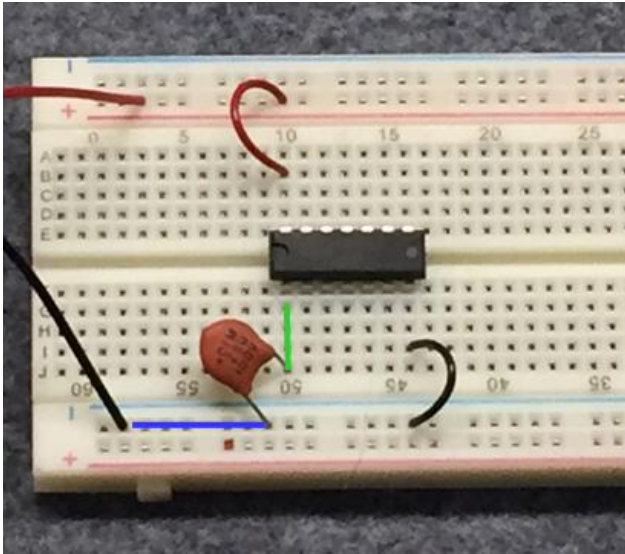
Connect power lines to the chip: short jumpers from the connection by the bottom blue line to IC pin #7, and from the connection by the top red line to IC pin #14.





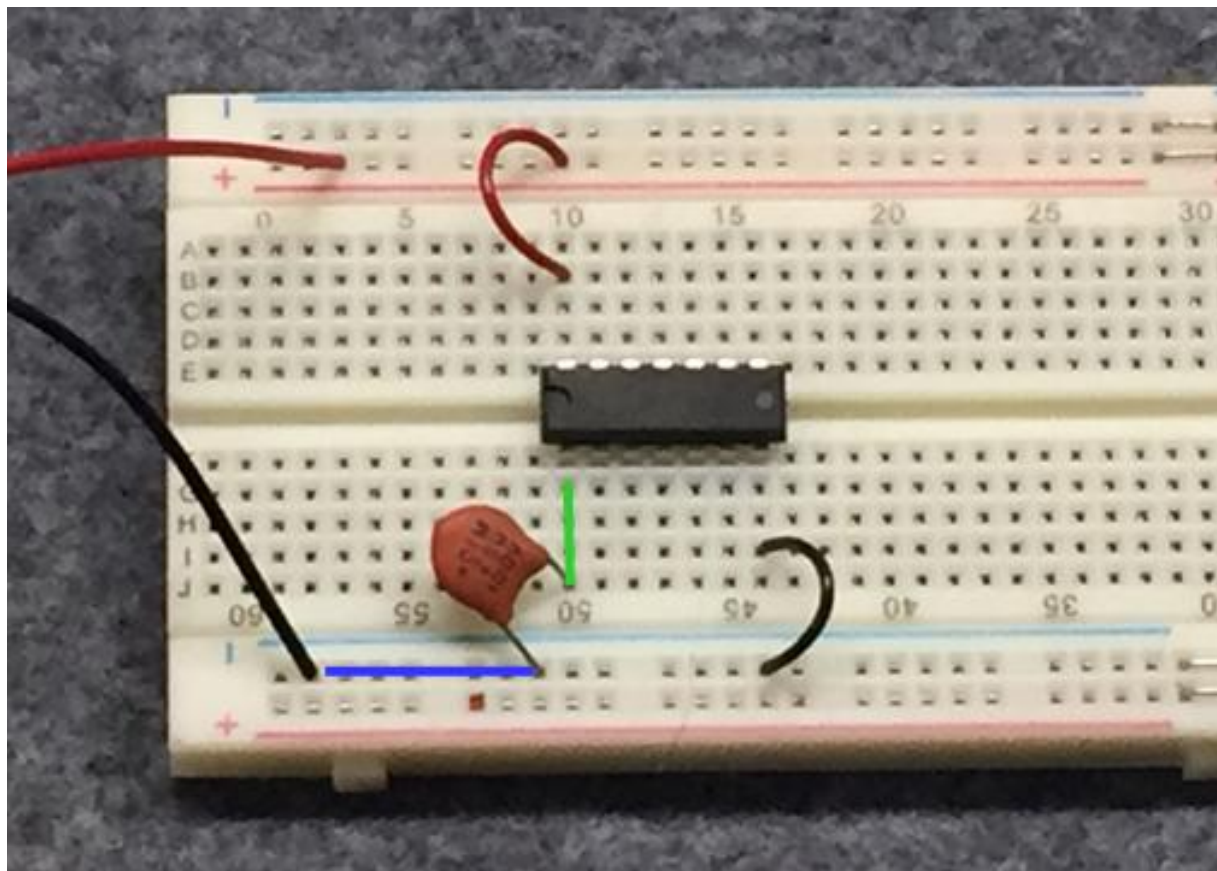
Simple CMOS Oscillator - Step 3

Connect a .01 uf (103) capacitor between the bottom blue (ground) line IC pin #1 .



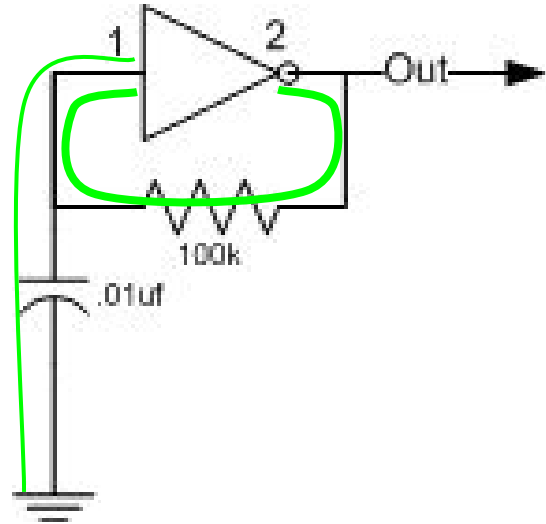
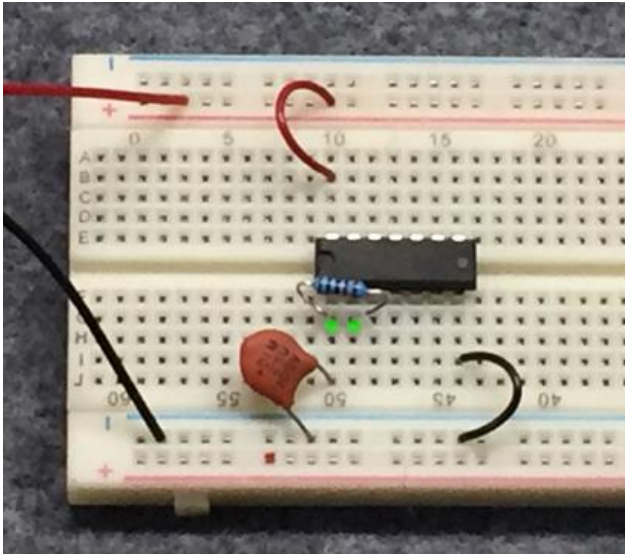
Simple CMOS Oscillator - Step 3.5

[add content: explanation of capacitor function, units of capacitance (farads), and marking conventions]



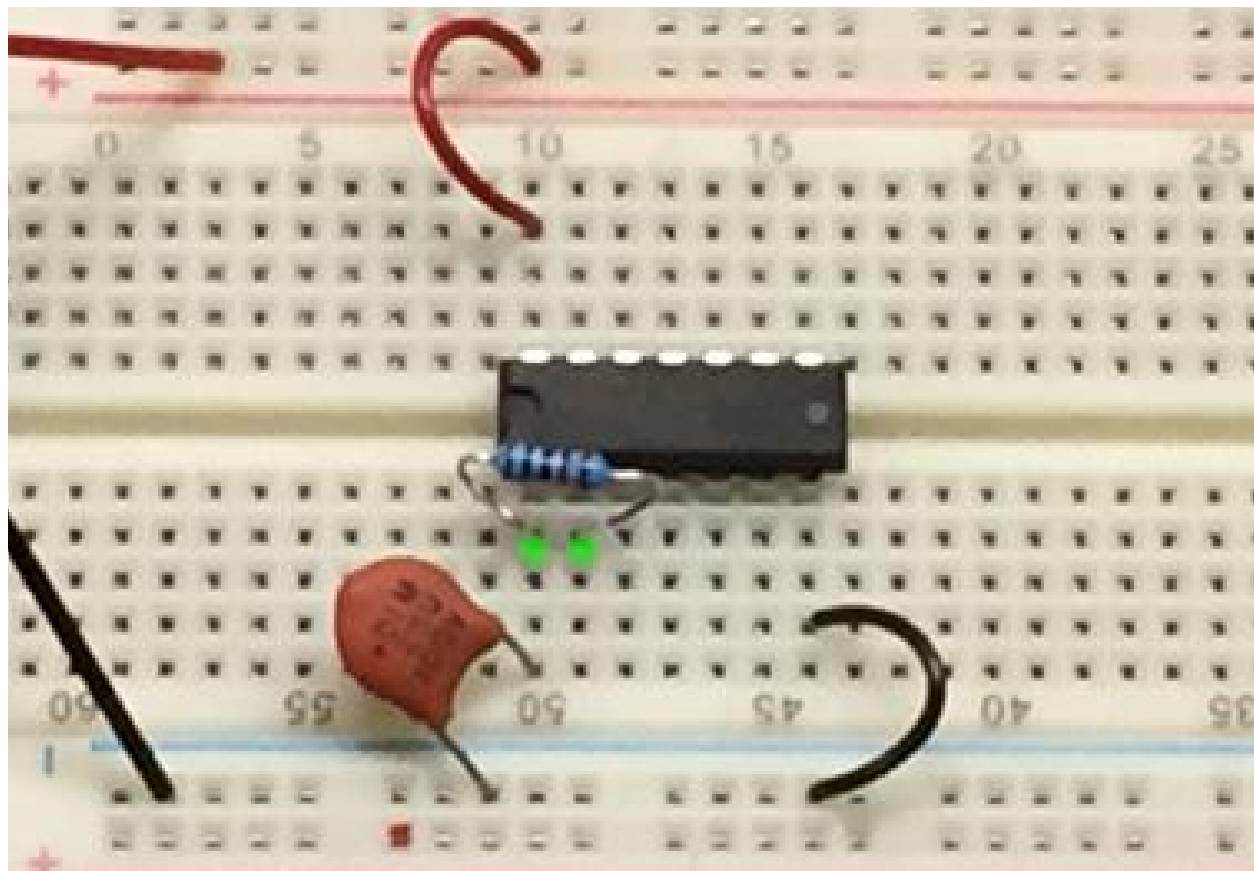
Simple CMOS Oscillator - Step 4

Connect a 100k (brown-black-black-orange bands) resistor between IC pin #1 and pin #2.



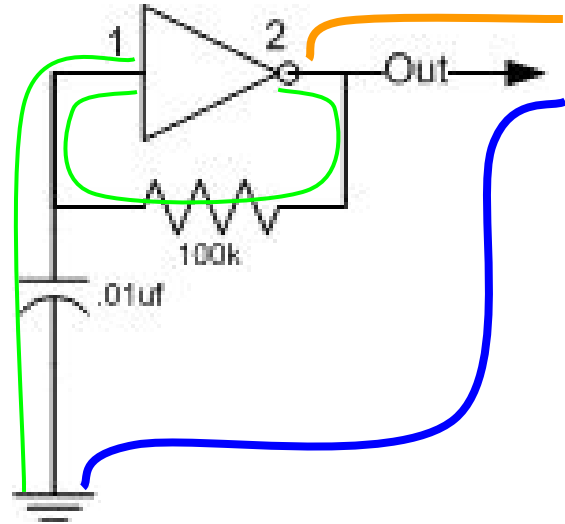
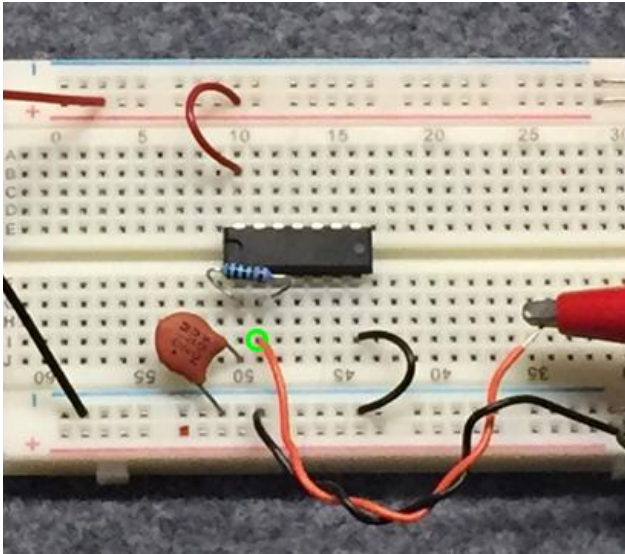
Simple CMOS Oscillator - Step 4.5

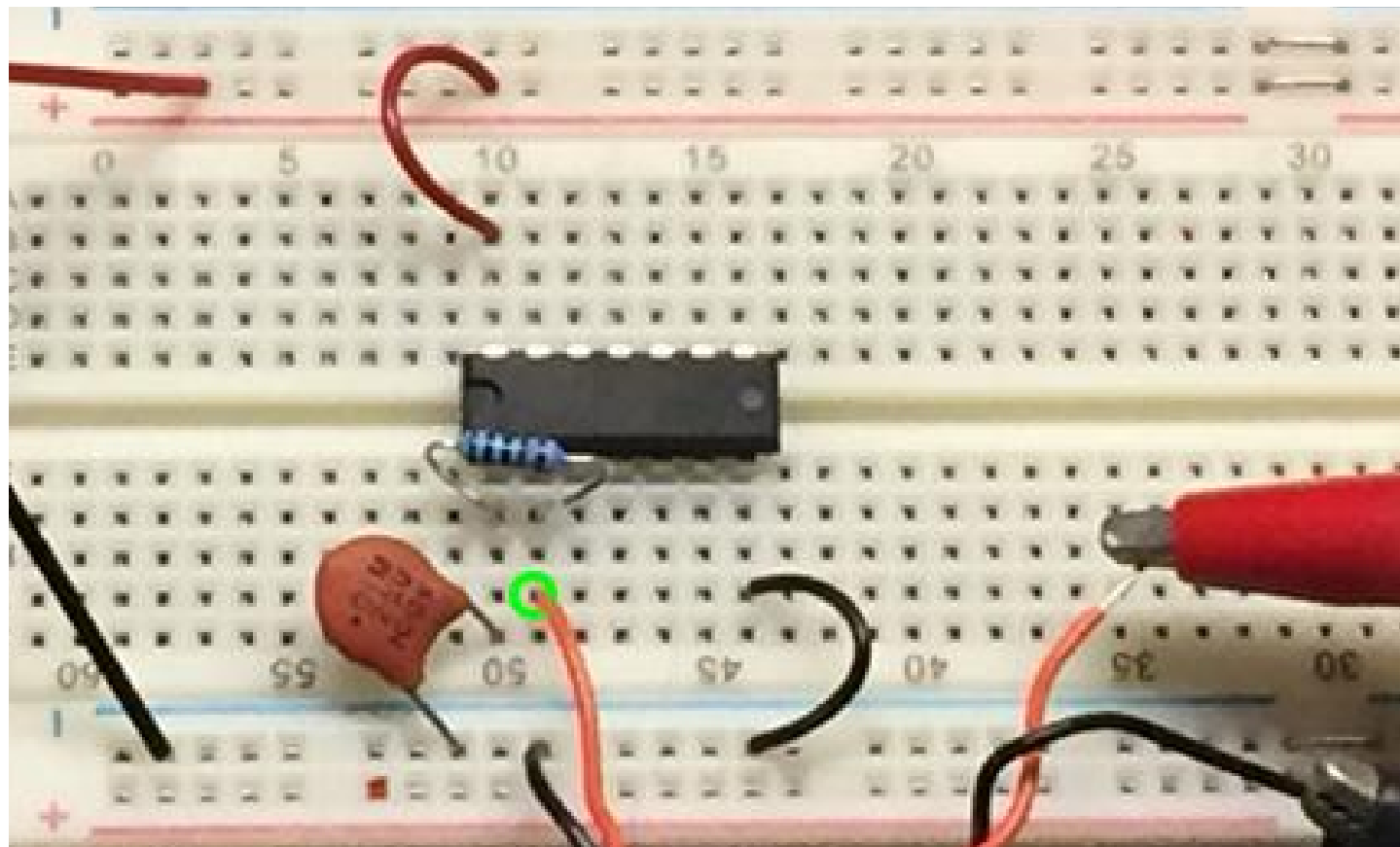
[add content: explanation of resistor function, units of resistance (ohms), and resistor color codes]



Simple CMOS Oscillator - Step 5

Connect one wire to IC pin #2, and another to ground (negative), then use alligator clips to connect to a speaker/amplifier.



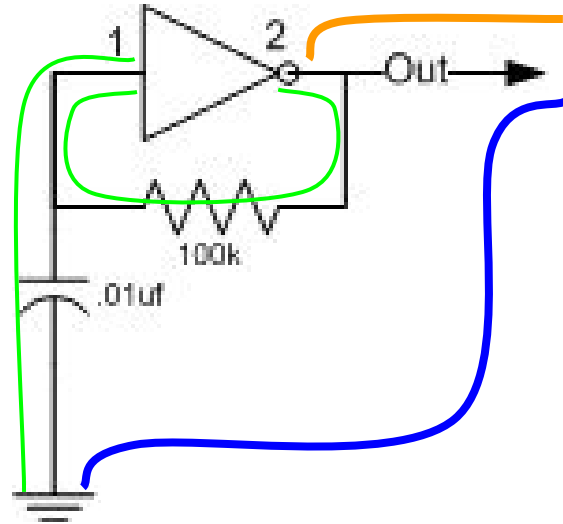


Simple CMOS Oscillator - Step 6

Connect a battery to the red and blue buss lines (red is +, black or blue is -) and turn on the speaker/amp to hear the oscillator!

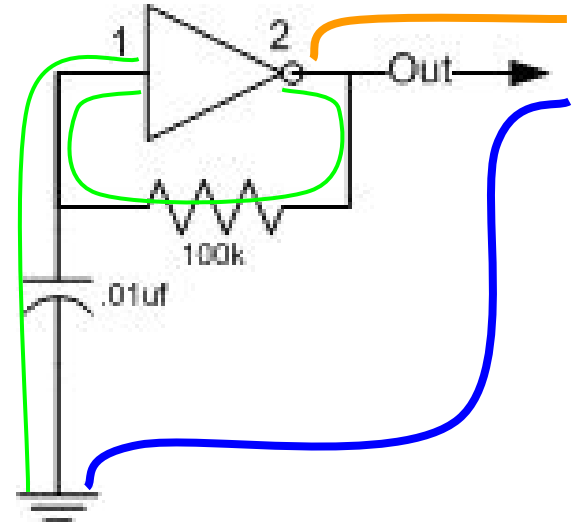
Try this out to get different sounds:

- Change the resistor to a different value
- Change the capacitor to a different value
- Put a photoresistor or potentiometer in place of the resistor



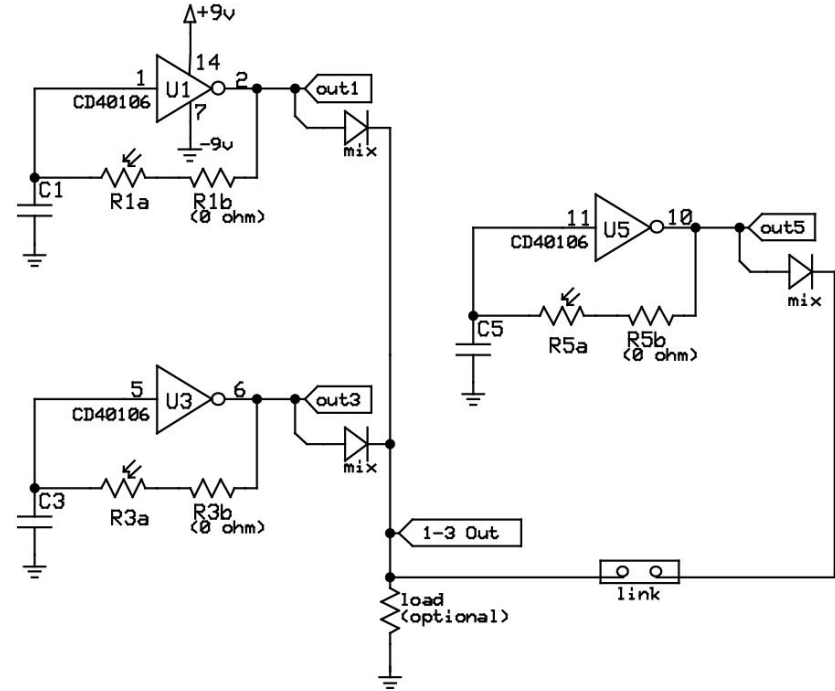
Simple CMOS Oscillator - What's going on?

- In this circuit, the resistor and capacitor form an “R/C” network.
- The capacitor stores up electricity (the larger the value, the more it can store)
- At a point determined by the value of the resistor, the capacitor discharges through the IC logic gate, releasing the stored up electricity.
- Then the cycle starts over again
- The repeated build up and release of electricity, when amplified, is what we hear as “oscillation”
- Changing the value of either the capacitor or resistor changes how fast that oscillation occurs, changing the pitch of the sound we hear



Triple CMOS Oscillator

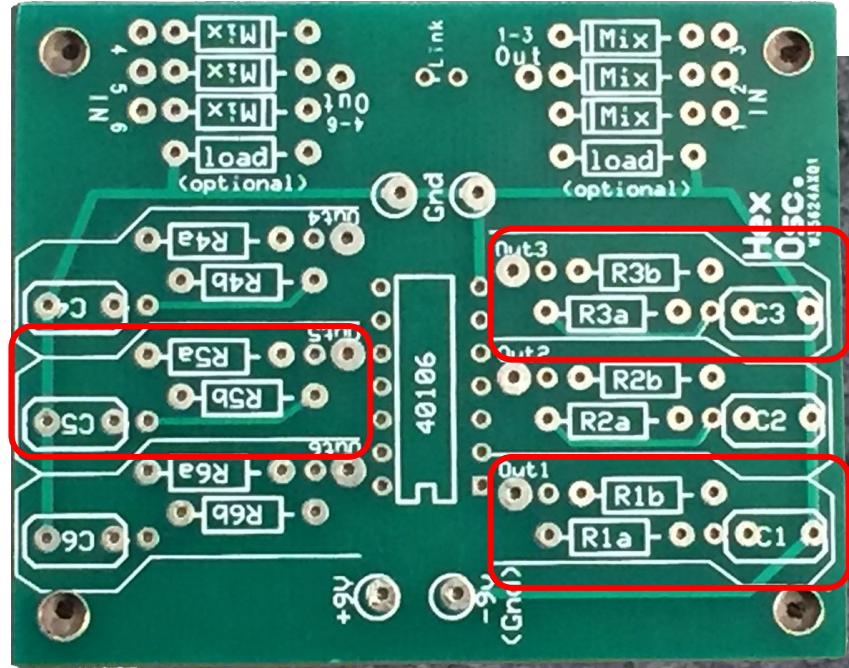
Now we'll build a circuit that has 3 oscillators, each controlled by a photocell.



Triple CMOS Oscillator

We'll use a Printed Circuit Board, which has holes for all the components and metal traces (instead of wires) to make the connections.

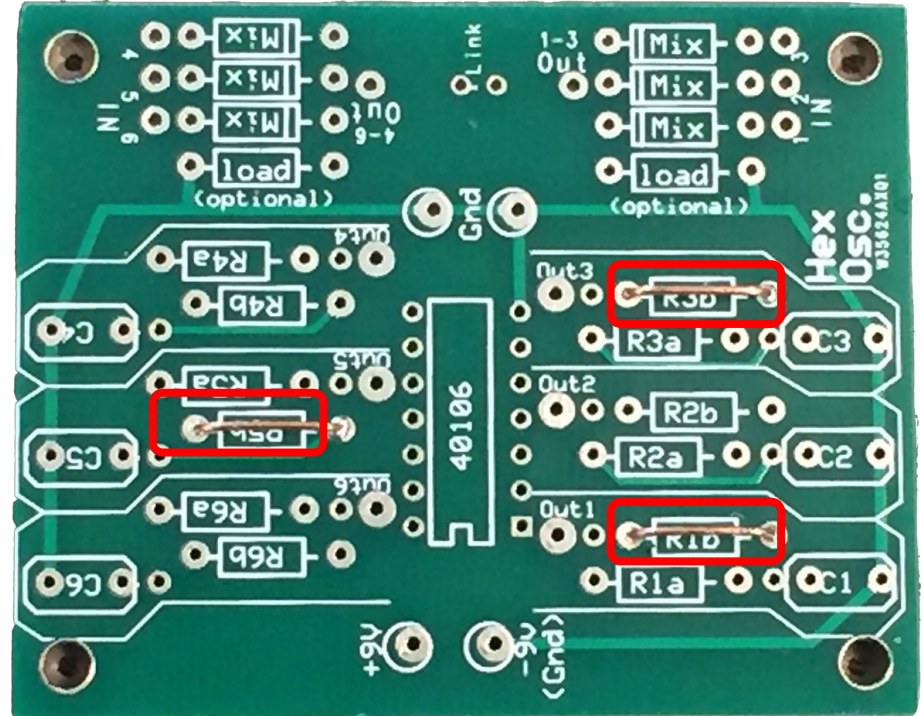
This particular board has room for 6 oscillators; we're going to build 3 (numbers 1, 3, and 5)



Triple CMOS Oscillator - Step 1

First we'll solder in 3 jumper wires across pads marked R1b, R3b, and R5b

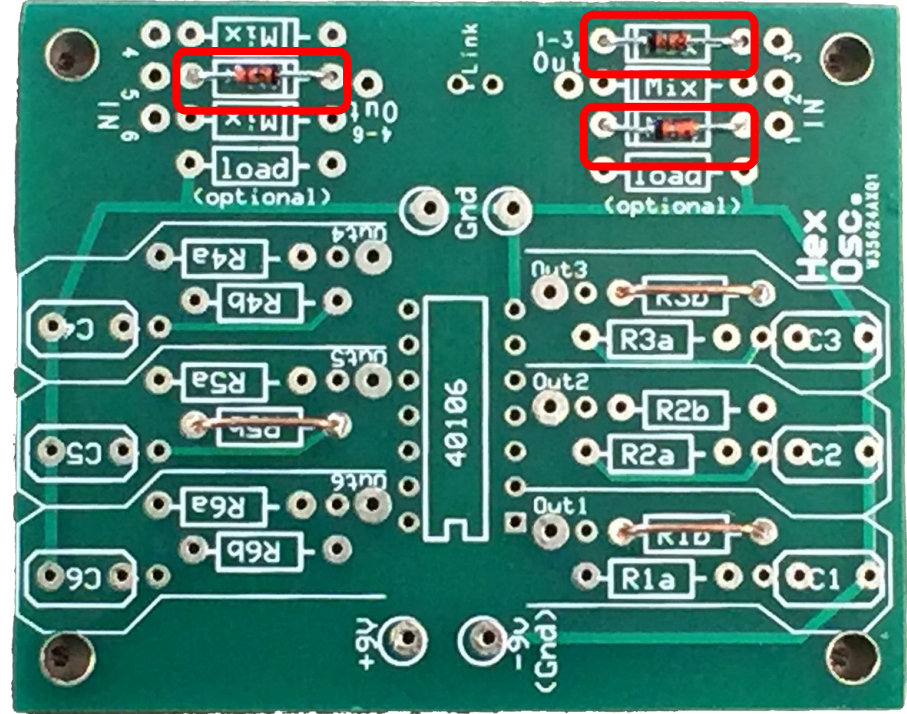
(the board has room for a pair of resistors for each oscillator, wired in series, labeled *a* and *b*. We're only going to be using one of them for this project; the wire replaces the one we're not using).



Triple CMOS Oscillator - Step 2

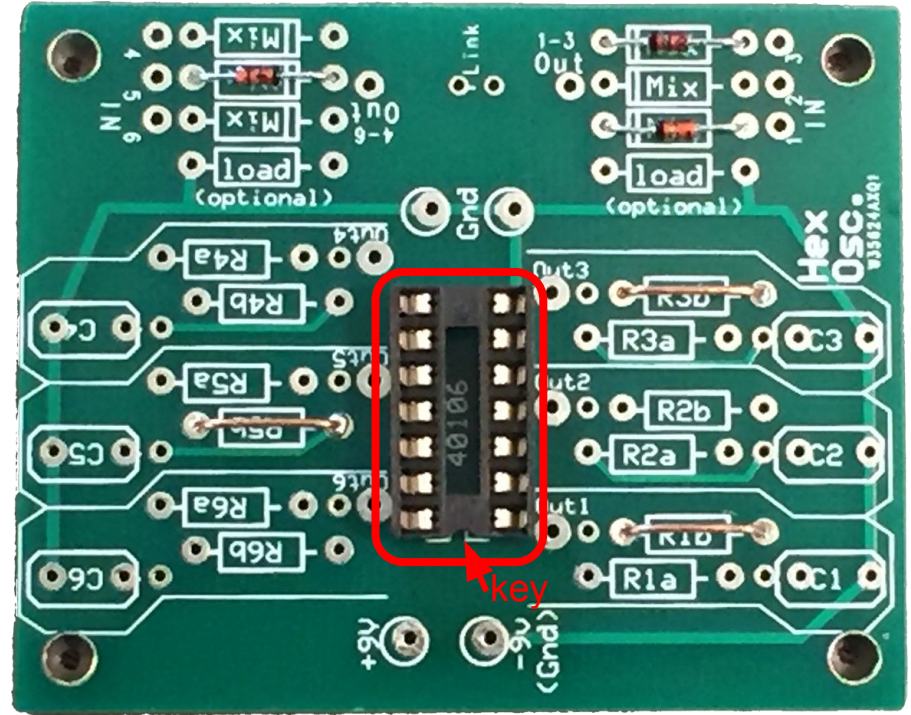
Next, insert & solder the 3 mixing diodes. They have a band on one end, make sure they line up with the bands on the PCB.

The PCB has metal traces from the outputs of each of the oscillators to one end of these diodes; the other ends are all connected together. The diodes lets us mix the 3 signals together without them interfering with each other



Triple CMOS Oscillator - Step 3

Next, insert and solder the socket for the IC. There's an indentation on one end, make sure it lines up with the picture on the PCB.

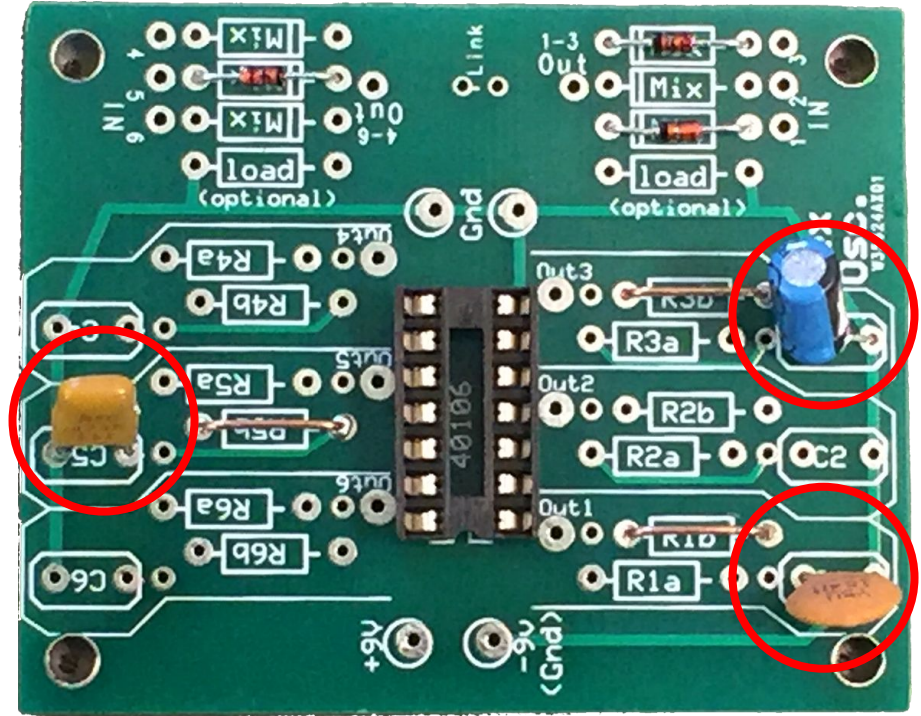


Triple CMOS Oscillator - Step 4

Next, insert the 3 capacitors. If you want to, just lightly solder one side of each capacitor, in case you decide to swap out different values later.

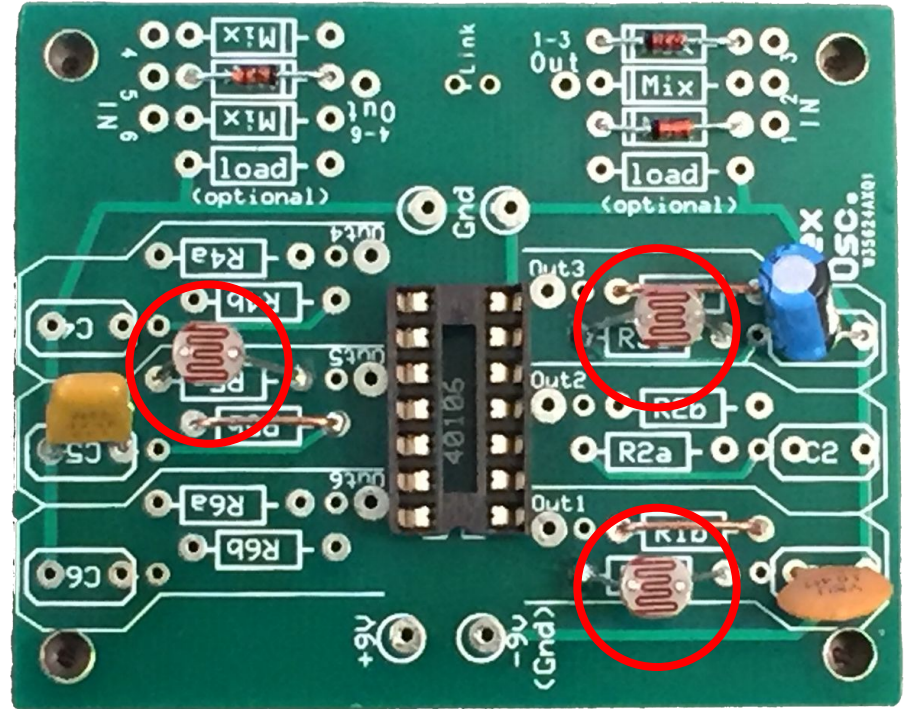
Lower capacitor values (.001-.1 uf) will make higher tones; higher values (.1-10uf) will make lower tones, or rhythmic pulses.

If you use electrolytic capacitors (like the blue one), make sure the negative/banded side is toward the *outside* of the board.



Triple CMOS Oscillator - Step 5

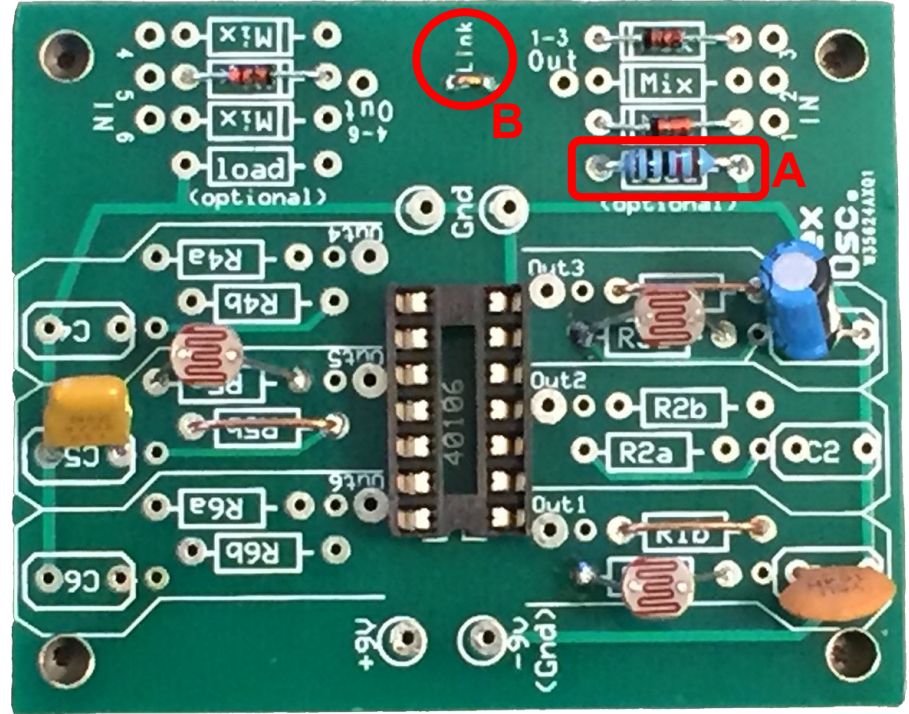
Next, insert and solder the photo-resistors across pads marked R1a, R3a, and R5a.



Triple CMOS Oscillator - Step 6

Now, add a 10k (brown-black-black-red) load resistor in ONE of the spots marked “load /optional” (A). Either position will work.

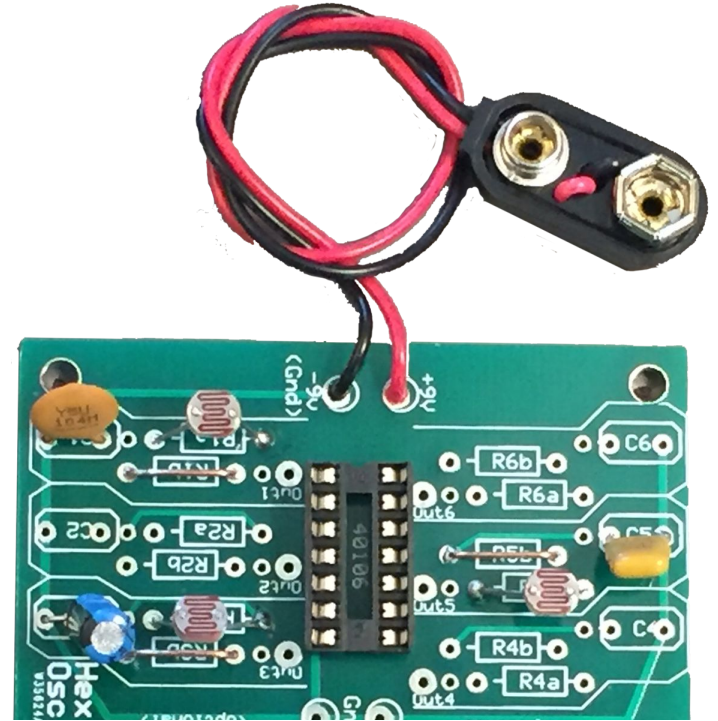
Also insert a short jumper wire across the 2 holes marked “link” (B) --this connects all outputs from both sides of the board (1, 3, and 5) together



Triple CMOS Oscillator - Step 7

Solder the battery clip to the power inputs (red is +; black is -).

If you wanted to add an on/off switch, you could do that here: solder the red wire from the battery clip to one side of the switch, and the other end of the switch to the +9v hole on the PCB.

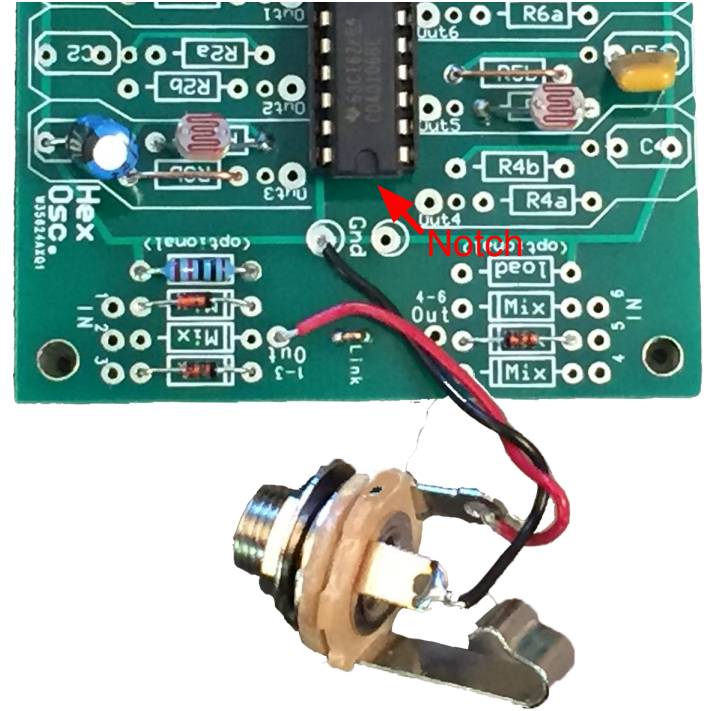


Triple CMOS Oscillator - Step 8

Finally, solder 2 output wires--one from the mixer “Out” pad (either one), and one from Ground. Connect those to an audio jack--wiring is done!

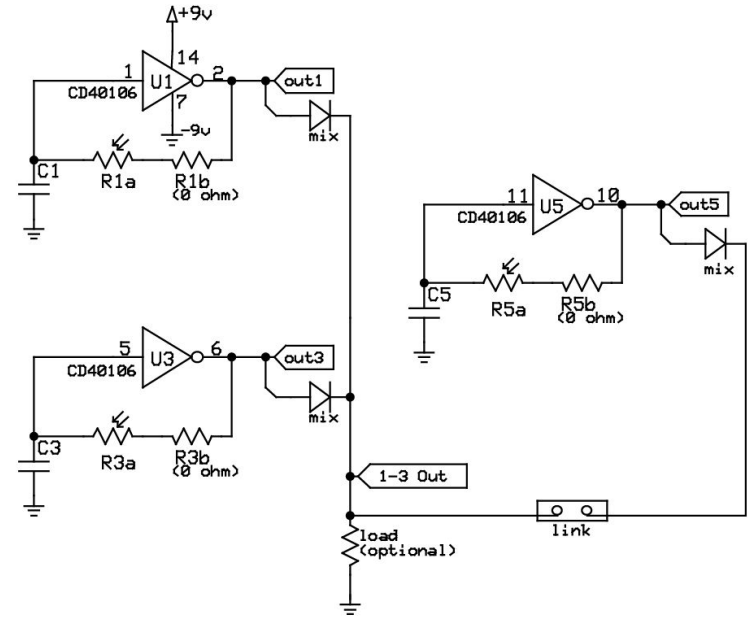
Insert a chip into the socket--make sure the notch on the chip and the socket line up, and the legs all go into the socket.

Now connect your battery, plug into an amplifier and wail! Careful with the volume control, it’s loud.



Triple CMOS Oscillator - What's going on?

- Each of the three oscillators has it's own photocell, so the pitch of each one varies independently...
- But since they are physically close to one another, you can change the pitch of all 3 at the same time using an open hand, or just one or two at a time using a finger
- If you used different capacitor values in each oscillator, each one will have a different range for more variety
- The outputs of all each oscillator goes through a diode or resistor before being tied together... this prevents the OUTput of one oscillator going IN to the output of another, which can cause problems.



Additional information on similar projects

- Electronoise Playshops:
 - <http://fluxmonkey.com/electronoise.htm>
 - <http://fluxplayshop.blogspot.com/>
 - http://fluxmonkey.com/fluxmerch_gear.htm (more PCBs for sale)
- Nick Collins: *Handmade Electronic Music; The Art of Hardware Hacking*
 - Book: <http://routledge-ny.com/books/Handmade-Electronic-Music-isbn9780415998734>
 - Early draft in PDF format: <http://www.nicolascollins.com/texts/originalhackingmanual.pdf>
- Lunetta forum on Electromusic.com:
 - <http://www.electro-music.com/forum/forum-160.html>
- Fun with Sea Moss:
 - http://milkcrate.com.au/_other/sea-moss/