

# *PhotoSynTheremin*

Build Sheet (08/28/2018)

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Thank you for purchasing the PhotoSynTheremin kit! If you're new to electronics or kit building, this is a great opportunity to experience the process of hand soldering a through-hole product. When you're done putting your kit together, you'll have gained the understanding and confidence that it takes to solder components to any PCB, and you'll end up with a world class musical instrument designed to annoy friends and family alike.

\*\*If you have never dealt with through hole components before, I highly recommend visiting [www.citruscircuits.io/instructions](http://www.citruscircuits.io/instructions) for detailed tips, tricks and a follow-along **video** assembly guide.

You should have received the following components with your kit:

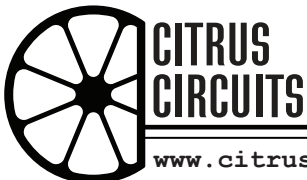
- a. Clear bag : circuit board and acrylic cover
- b. Clear bag : resistors and capacitors
- c. Clear bag : speaker, battery holder and switch
- d. Clear bag : screws and standoffs
- e. Antistatic bag : semiconductor devices

If there are issues with the contents of the shipment, please contact me through the website [www.citruscircuits.io/contact](http://www.citruscircuits.io/contact) and I will do my best to get in touch with you within 48 hours.

It is generally good practice when putting together a circuit board, to start with the lowest profile components first and then work your way up to the taller components so nothing gets in your way. Things will get tight as we move along, so a good assembly strategy will help us in the end.

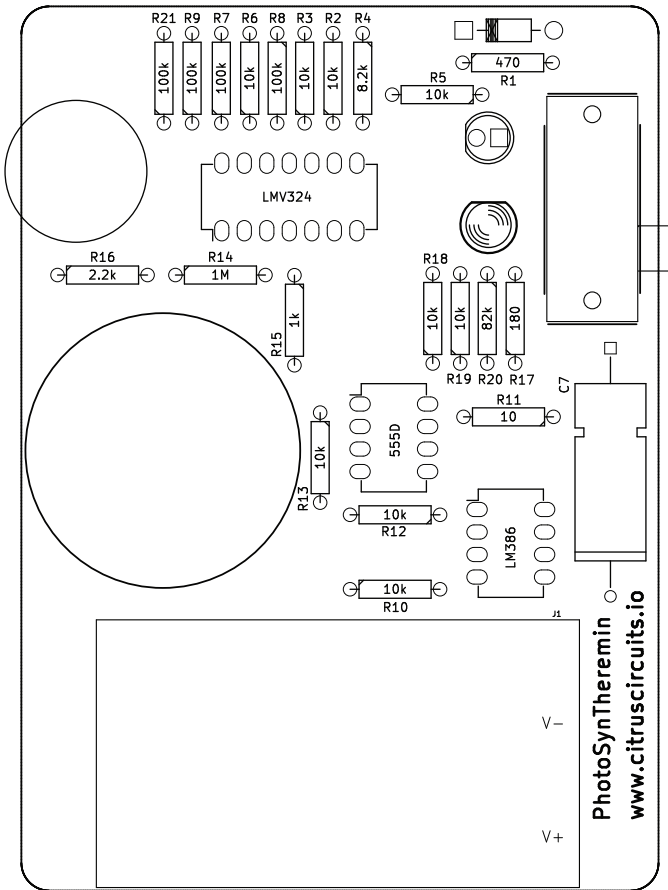
(Note: We are working with one component value at a time, by ease of access and not necessarily in numerical order).

Now let's get started!



# Assembly - Resistors

We'll start by soldering the resistors to the circuit board. Below is a checklist to help you keep track of your progress.



- |                              |                              |
|------------------------------|------------------------------|
| <u>100k</u>                  | <u>180 Ohm</u>               |
| <input type="checkbox"/> R21 | <input type="checkbox"/> R17 |
| <input type="checkbox"/> R9  | <u>10 Ohm</u>                |
| <input type="checkbox"/> R7  | <input type="checkbox"/> R11 |
| <input type="checkbox"/> R8  |                              |
| <u>10k</u>                   | <u>470 Ohm</u>               |
| <input type="checkbox"/> R6  | <input type="checkbox"/> R1  |
| <input type="checkbox"/> R3  | <u>2.2k</u>                  |
| <input type="checkbox"/> R2  | <input type="checkbox"/> R16 |
| <input type="checkbox"/> R5  | <u>1k</u>                    |
| <input type="checkbox"/> R18 | <input type="checkbox"/> R15 |
| <input type="checkbox"/> R19 | <u>1M</u>                    |
| <input type="checkbox"/> R13 | <input type="checkbox"/> R14 |
| <input type="checkbox"/> R12 |                              |
| <input type="checkbox"/> R10 |                              |
| <u>8.2k</u>                  | <u>82k</u>                   |
| <input type="checkbox"/> R4  | <input type="checkbox"/> R20 |

## Resistor Color Code



Color	1st	2nd	Mult	Tolerance
Black	0	0	x1	Gold 5%
Brown	1	1	x10	Silver 10%
Red	2	2	x100	None 20%
Orange	3	3	x1k	
Yellow	4	4	x10k	
Green	5	5	x100k	
Blue	6	6	x1M	
Violet	7	7	x10M	
Grey	8	8	x100M	
White	9	9	x1G	

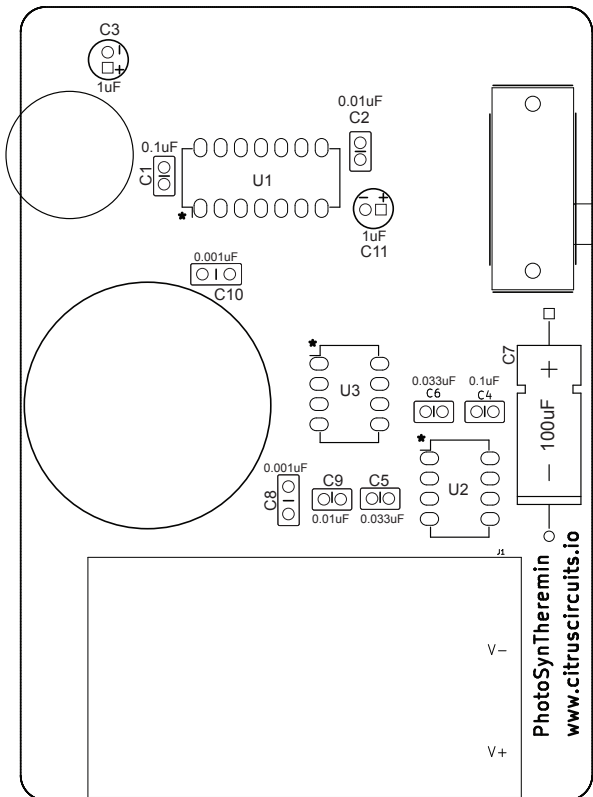
## Reading the Color Code

Example: Yellow, Violet, Red, Gold

- Yel. = 4, Violet = 7, Orange = x1k so,
- R = 47,000 Ohms, or 47k Ohms
- Gold = 5% tolerance or  
 $22,000 \times 0.05 = 2,350$  therefore  
R can be  $(47,000 - 2,350) = 44.65k$   
up to  $(47,000 + 2,350) = 49.35k$

# Assembly - Capacitors

It is important that polarized capacitors be installed properly or they could self-destruct. In this kit, the electrolytic capacitors which require attention to polarization are C3, C7 and C11. Small non-polarized capacitors can be installed in either orientation.



## CAPACITORS

<u>0.1uF</u>	<u>0.033uF</u>
<input type="checkbox"/> C1	<input type="checkbox"/> C6
<input type="checkbox"/> C4	<input type="checkbox"/> C5
<u>0.01uF</u>	<u>1uF</u> *
<input type="checkbox"/> C2	<input type="checkbox"/> C3
<input type="checkbox"/> C9	<input type="checkbox"/> C11
<u>0.001uF</u>	<u>100uF</u> *
<input type="checkbox"/> C10	<input type="checkbox"/> C7
<input type="checkbox"/> C8	

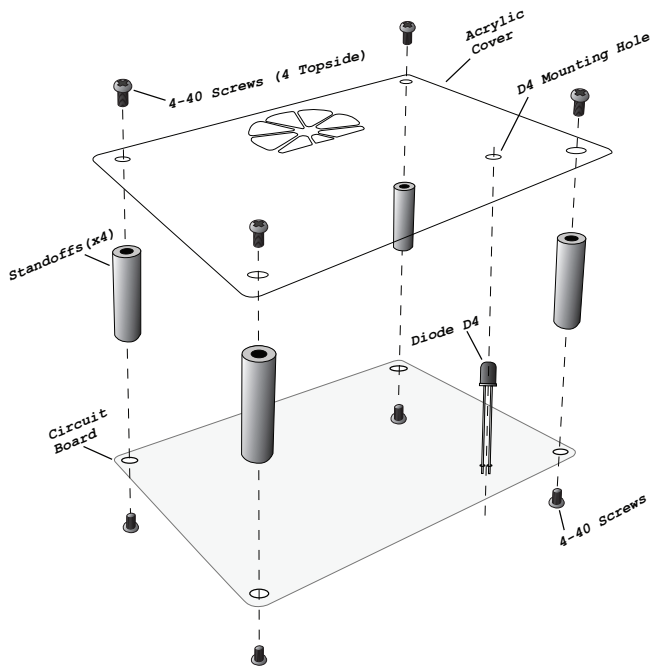
\* Electrolytic Capacitors

Value:uF	Value:pF	Marking
0.0001uF	100pF	101
0.001uF	1000pF	102
0.01uF	10000pF	103
0.1uF	100000pF	104
1.0uF	1000000pF	105

Here's a little cheat-table to help identify the smaller yellow MLCC capacitor's values. It'll be stamped on the side - hopefully your eyesight is better than mine!

# Assembly - Semiconductor Devices

This step requires that we take note of the components' polarity indicator during installation. Most semiconductor devices have a polarity mark such as a stripe on a diode or a "flat" in the case of a photodiode or LED (note D3 & D4). Integrated circuits also convey proper orientation, usually with a dot, denoting pin-1. For IC's, I've marked pin-1 with an asterisk on the PCB.



## LED EMITTER INSTALLATION

D4 (Tiny 3mm black LED)

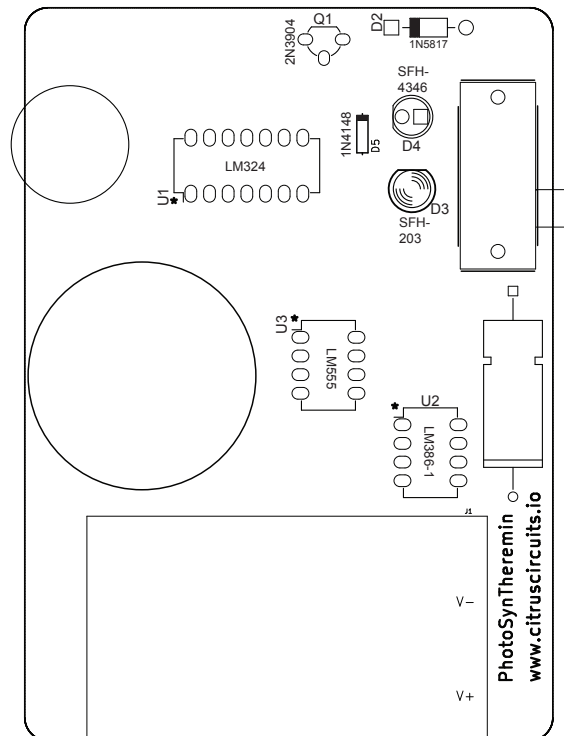
To install D4, we need to first insert D4 (noting the correct polarity) into the pcb \*do not solder at this time. Then temporarily install all 4 standoffs using (8) 4-40 screws. Push the LED up and into the acrylic cover. Flip the assembly over and now solder D4's pins to the circuit board. Now remove the screws, acrylic cover and standoffs.

## DISCRETE SEMICONDUCTORS

- D2 (1N5817)
- D5 (1N4148)
- D3 (Flat 5mm black photodiode)
- Q1 (2N3904 NPN Transistor)

## INTEGRATED CIRCUITS

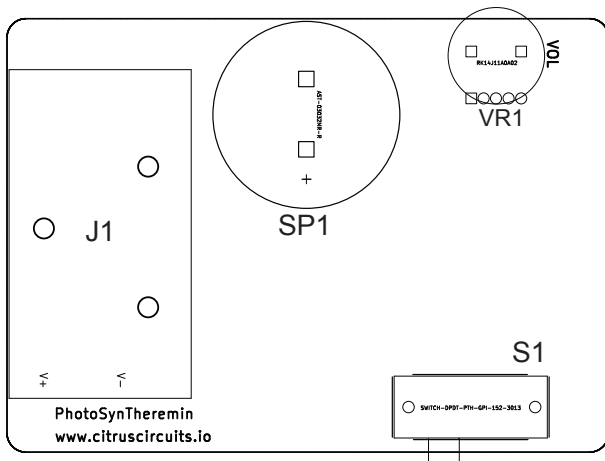
- U1 (LM324)
- U2 (LM386-1)
- U3 (LM555)



# Assembly - Electromechanical

The location of remaining electromechanical components are fairly obvious, though there is still the remaining surface mount LED to be installed on the rear of the PCB - we'll get to that.

First, install the 9-volt battery clip by inserting leads through PCB and aligning J1's mounting holes with the holes in the circuit board. Insert the (3) 1-72 screws through the battery clip to the backside of the PCB, tightening the (3) 1-72 nuts at the rear of the PCB. After aligning and tightening the battery clip, you may now solder the leads to the PCB. Lastly, you may install the switch, thumbwheel & speaker.

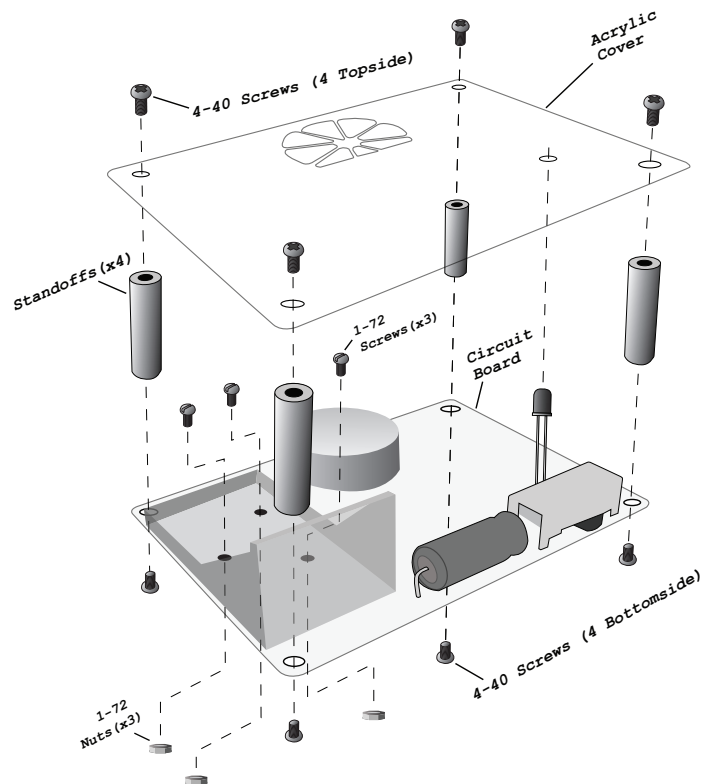


Let's install the standoffs and acrylic cover. Locate the 4 metal standoffs and (8) 4-40 metal screws. Install the standoffs on the topside of the PCB, screwing (4) 4-40 screws through the rear of the PCB. Mount the acrylic cover to the topside of the standoffs and secure it with the remaining (4) 4-40 screws - being careful not to overtighten as we don't want to crack the cover.

## ELECTROMECHANICAL COMPONENTS

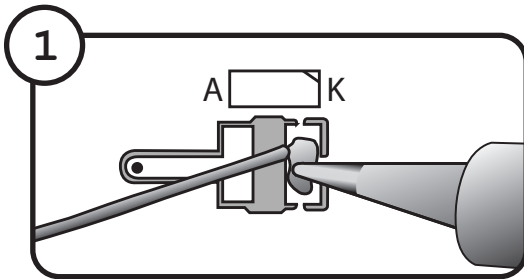
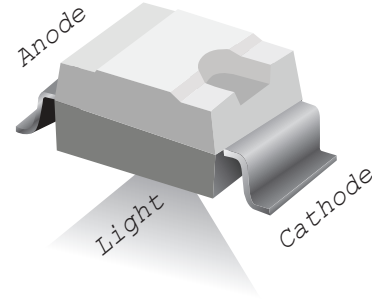
- J1 (9V Battery Clip)
- S1 (Switch)
- VR1 (Thumbwheel Potentiometer)
- SP1 (PCB Mount Speaker)

We can now install the 9V battery, switch the unit on, **adjust volume to midpoint** and test it by placing your hand over the circuit board. You should hear a (subjectively) pleasant squealing sound.

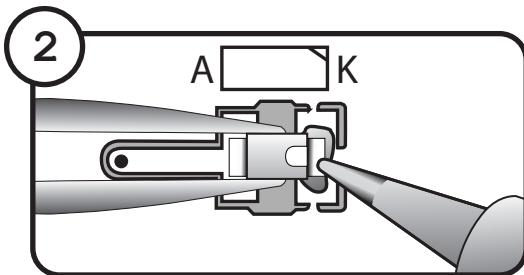


## Assembly - Rear Surface Mount LED

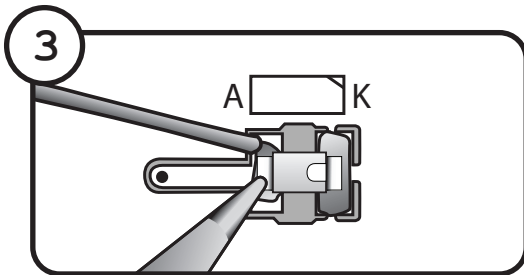
Flip the board over to the backside. You'll see a small silkscreened rectangle above two exposed pads. This is where we'll install the surface mount LED. Note that the LED is mounted face-down so it shines through the PCB substrate.



Melt a *small* bit of solder to the 'K', cathode pad. Do not put any solder on the 'A', anode pad yet. The goal is to adhere one side of the LED at a time. This ensures that the LED lays flat against the PCB. Let cool.  
Tip: A thin layer of solder is best.



Grab the LED with a pair of tweezers. Align the LED with the pads (making sure the cathode marking rests on the 'K' pad). Reflow the solder blob from step 1, then let it cool. The LED is now firmly held in place by a single pad.



Now all that is left to do is melt solder to the LED's anode and the 'A' pad.

If everything went well, upon turning on power switch S1, you should see the beautiful *Citrus Circuits* orange shining brightly on the frontside of the PCB.

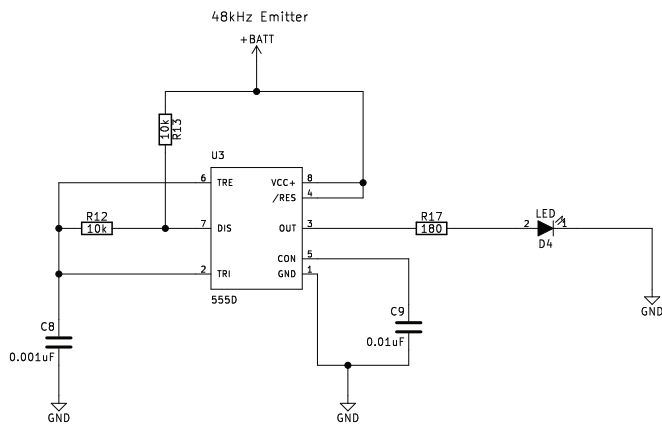
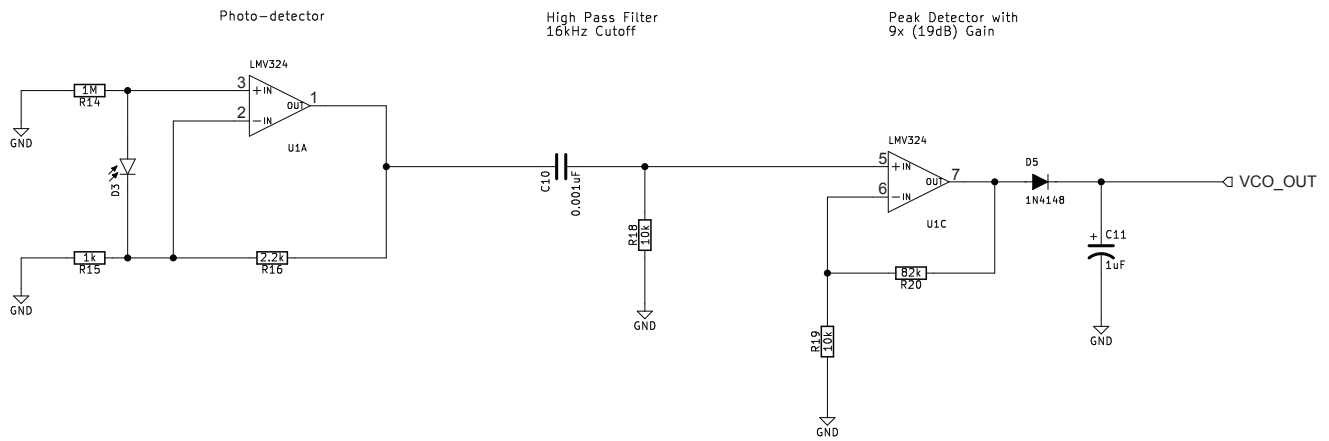
***Congratulations! You have now completed your PhotoSynTheremin kit.***

### *Hackable Hints:*

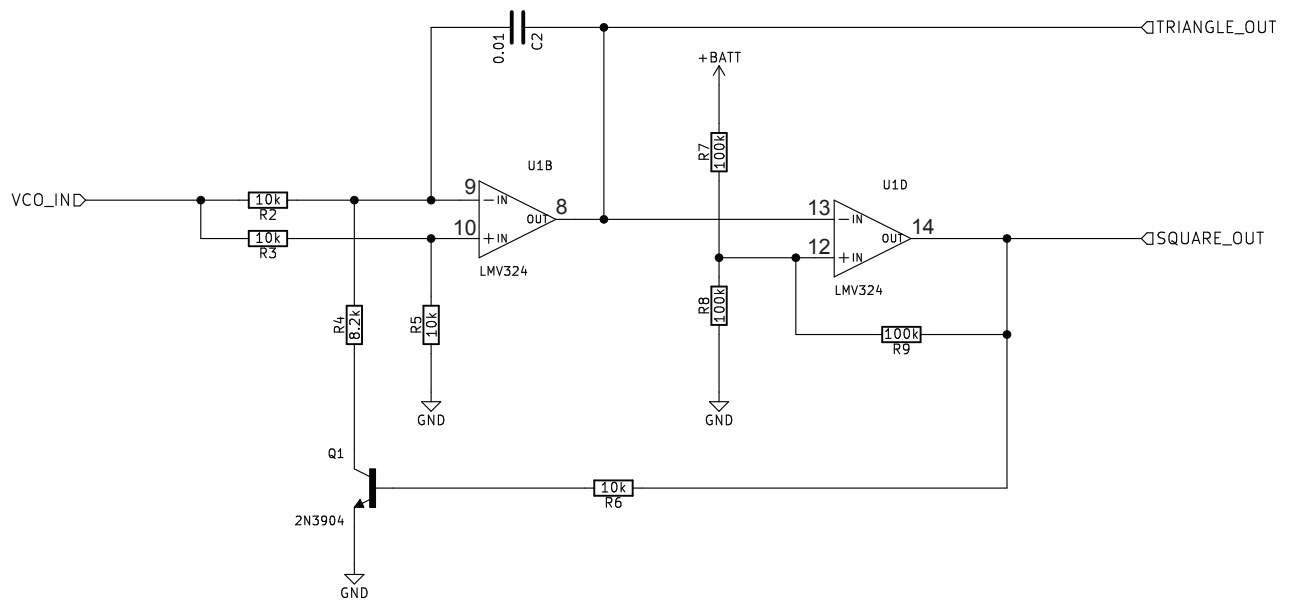
- a) You can get a different tone - think "area under the curve". You may need to perform surgery via a cut trace and bodge wire.
- b) An IR LED mounted to a pair of longer wires can make for an interesting two-handed musical experience.
- c) Are there any other modulated IR LED sources you can think of?  
*Shine some light on it!*



# IR Detector / Emitter

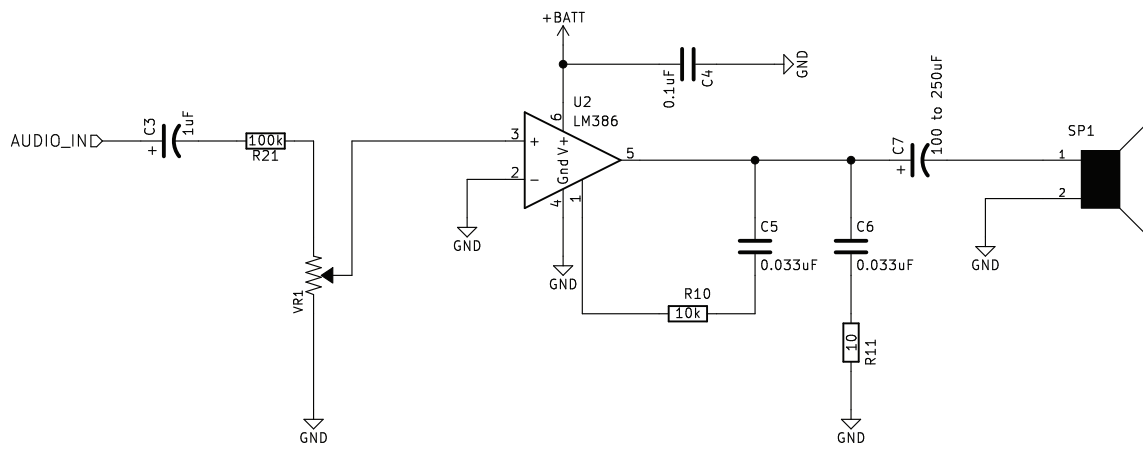


# Audio Signal Generator





# Audio Amplifier



# Power Section

