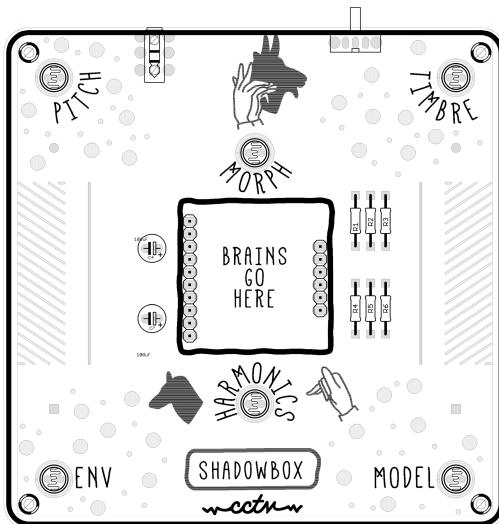


SHADOWBOX

BUILD GUIDE & USER MANUAL



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Cctv.fm

L i g h t a n d S h a d o w s S c u l p t Y o u r S o u n d

Shadowbox is an Open Source optically controlled digital drone synth where parameters are controlled by introducing or blocking light. Shadowbox is offered as a DIY kit, which requires soldering. The goal of this Build Guide is to make the assembly process as easy as possible and accessible to tinkerers of all skill and age levels.

Tools Required

- Soldering iron: Any will do, however a higher power (30W+) iron with a fine chisel or bevel tip will be easiest to use
- Side Cutters (also known as flush or diagonal cutters) to clip off excess leads
- 2.5mm Allen Key (or hex driver)

Consumables Required

- Rosin Core Solder, preferably 63/37 Lead/Tin composition
- Solder wick or desoldering pump in case of mistakes

What is Soldering and How Do I Get Really Good?

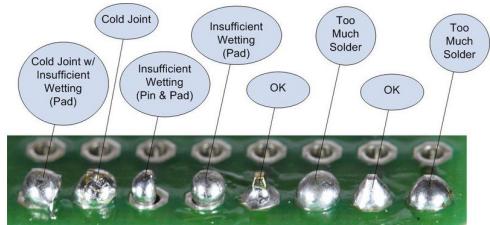
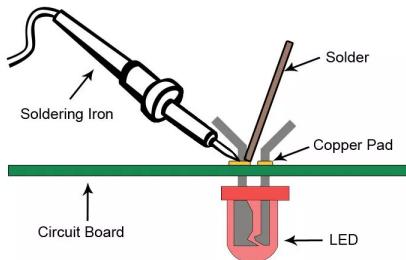
Soldering is the act of joining two metals using an intermediate metal to bridge the connection. We are soldering copper component legs to copper pads on a printed circuit board (PCB) using lead-based solder.

The most important tip to good solder joints is to first concentrate on heating up both pieces of metal first and then introduce the solder. You are not “painting” the molten solder onto the part, you are heating up the parts and then filling in the gaps with solder.

A good idea is to apply heat from the soldering iron first, count to 3 in your head, and then introduce a little bit of solder. Count to 3 again in your head and finally remove the soldering iron.

Once you complete your first solder joint, compare your results with this image and see where you stand.

How To Solder



What you're looking for is a *perfect little volcano* - a smooth transition from the tip of the component leg to the ring of the pad.

Bill of Materials

A Bill of Materials (or BOM for short) is a table that matches each part number with its value or part type. BOMs are used in DIY builds, as well as mass assembly as a means of describing what parts are placed on a PCB, and where to find them.

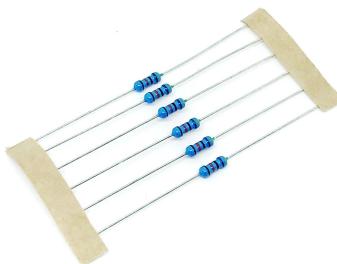
To save on space, part numbers are printed on the PCB rather than their values. For instance, a resistor will be labelled as 'R12' instead of '200 Ohms'. The BOM will tell you what value 'R12' is and what type of part it is. Resistors are conventionally referred to as 'R*', capacitors as 'C*', and integrated circuits as 'IC*' or 'U*'

The Bill of Materials is your best friend and is found on the back of this manual.

A good idea is to mark off the components you've already soldered on the BOM with a high-lighter or pencil. This keeps you on track in the event you take a break or get distracted.

1. Resistors

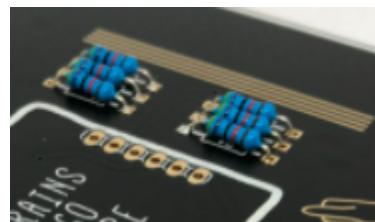
Always start with resistors. They come in a strip and they look like this:



Resistors impede the flow of current and have a variety of uses in electrical circuits. In the SHADOW BOX they are used to create voltage dividers to convert the resistance of the LDRs to a variable voltage that can be measured by the Brain module.

Resistor leads need to be bent and inserted into the PCB. Resistors do not have a polarity, and can be installed either way around.

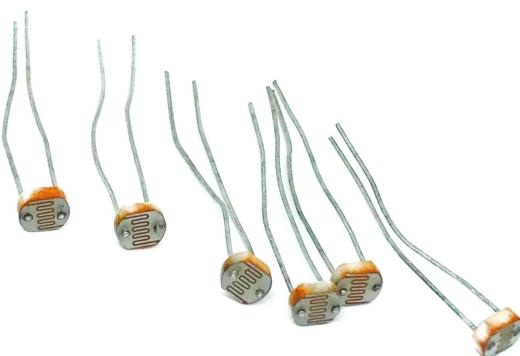
Once you have bent the leads on the resistor and inserted it into the PCB board, you will need to flip the PCB over and solder the leads in the way described in the earlier sections. Once you have both leads properly soldered, you can go ahead and trim the leads using the side cutters.





Congratulations! You've soldered perfect resistors. Great job!

2. LDRs (Light-Dependant Resistors)



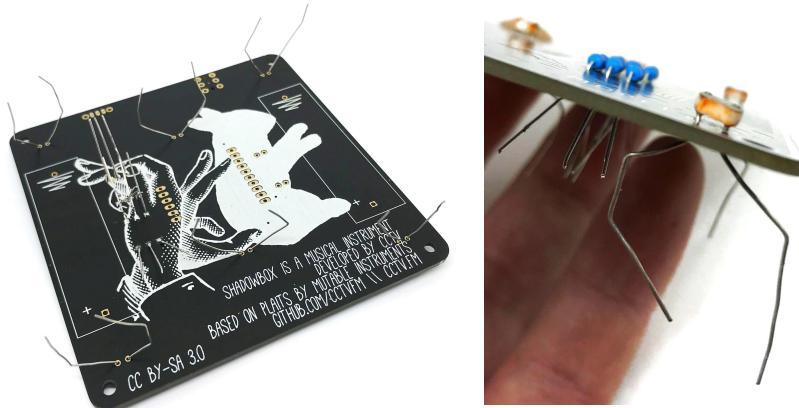
The order for soldering PCBs is always flattest to tallest - this is so it's easier to flip the board over and have the desk supporting the components. If you do taller ones first, then the shorter components will drop down when you flip the PCB over.

Let's solder the LDR's next.

These are light-dependent resistors, allowing current to flow based on how much light the component observes.

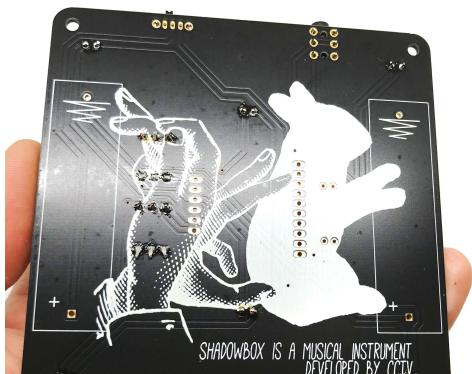
Once you have pushed the leads of the LDRs through the PCB, you will need to flip the PCB over, bend them at an angle to hold them in place, and solder the leads in the way described in the earlier sections. It may be tricky to get them

perfectly flush to the PCB, so a little room between the component and the PCB is ok.



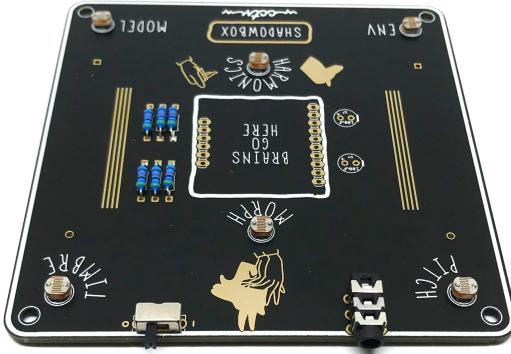
Once you have both leads properly soldered, you can go ahead and trim the leads using the side cutters.

3. Switch and Headphone Jack



SHADOW BOX has an ON/OFF switch, so you do not drain the batteries while the synth is not being used, as well as a combo headphone/line out jack. Since both components are similarly tall, we will solder these next.

Place the components onto the PCB.

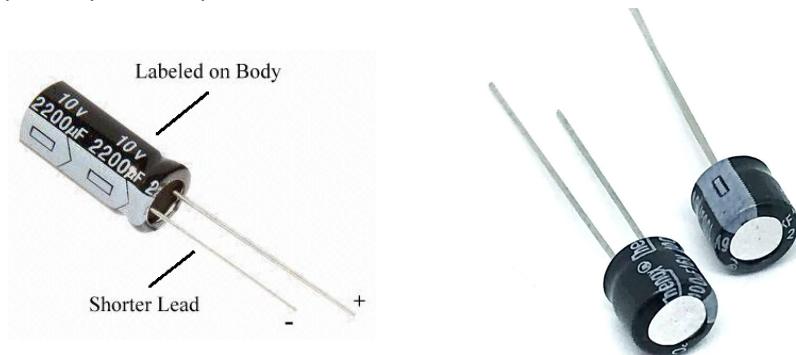


Flip the board over, and solder only one lead of each component. You can then hold the PCB in your hand, push on the component with a free finger, and bring the soldering iron tip to the soldered lead a second time. This is to make sure the component is flush against the PCB. Once this is done and the components are flush, you can solder the rest of the pins.



4. Electrolytic Capacitors

SHADOW BOX only uses one type of capacitor, so no need to tell them apart. They are called electrolytic capacitors. Electrolytics are very cheap for high capacities, and are excellent at storing large amounts of energy. These are used to filter out switching noise in the power supply section.
Electrolytics DO HAVE POLARITY AND YOU MUST MAKE SURE TO INSTALL THEM CORRECTLY. If they are installed backwards they will short out and possibly even explode.



The PCB has a marking showing '+' and a white stripe for the negative pole, and these correspond to the longer and shorter lead, respectively. Similarly, the large white stripe of the capacitor corresponds to the white stripe on the footprint of the component, so getting the polarity right is only a matter of lining these up correctly.



At this point, your board should look like this. Hooray!

5. The Brains!

Shadowbox's synth engines and functions are hosted on a microcontroller, which is conveniently pre-soldered using surface-mount devices (SMD), to simplify the complexity of this build.

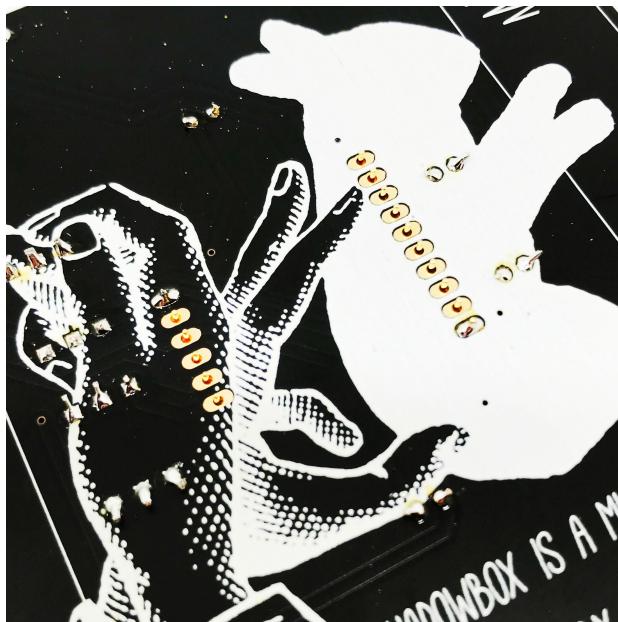
This *submodule* contains the STM32 processor - an ARM M0 running code brilliantly written by Emilie Gillet. Also on this board is a PCM5100 DAC - a Digital to Analog Converter - which receives digital audio data (I2S) from the STM32 and outputs analog audio waves that we can listen to. This DAC is quite full featured since it also contains a charge pump to generate the negative voltages we need to directly drive headphones and supply a signal with a high headroom.

There are some auxiliary components on this submodule as well - a boost converter to generate 3.3V from 1.5-3.0V input voltage, an orange LED to show you Shadow Box is turned on, a programming port, and resistors and capacitors needed by all these sub circuits. There's a lot going on here.

The Brain module fits into the middle of the PCB, where it says "BRAINS GO HERE". The Brain module only fits onto the PCB in one orientation, so it is impossible to get it wrong. Drop it in so it looks like this:



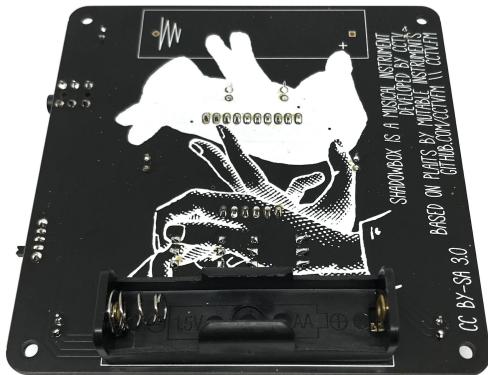
Next, you'll flip the board over, while making sure the pins are still through the PCB. Solder only one corner pin. After this, push on the Brain and re-solder this same pin, to make sure the Brain's headers are flush with the PCB. Once complete, solder the opposite corner's pin.



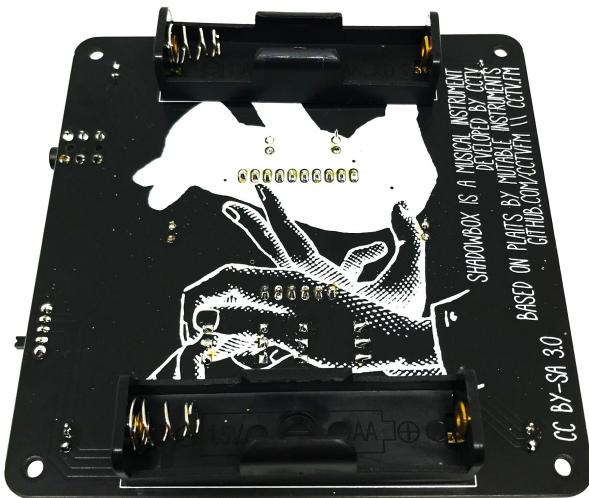
Alternate which corners you solder, moving towards the middle pins. This is to ensure that one side of the Brain module does not flex more than the other, and so it sits straight.

6. AA Battery Holders

SHADOW BOX draws power from two AA batteries. You will now solder the two battery holders onto the back of the PCB. Place them into position, where the spring aligns with the squiggly line on the footprint, and so the '+' symbol in the battery holder aligns with the '+' footprint symbol. These are the only two components soldered on the **back** of the board.



Flip the board over, and make sure the battery holders are flush with the PCB by pushing on it while soldering one pin of the battery holder, as you've done many times now. Solder the other pins.



At this point, it's time to do a test. Put batteries into their holders, plug in a pair of headphones or connect an amplifier, turn on the unit using the ON/OFF switch, and make sure your SHADOW BOX drones in all of its mysterious and confusing glory. If something's not right, check for solder bridges or missed solder joints, and double check that your capacitors are installed correctly.

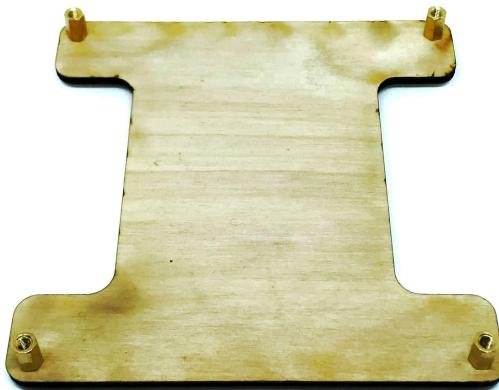
7. Back Plate

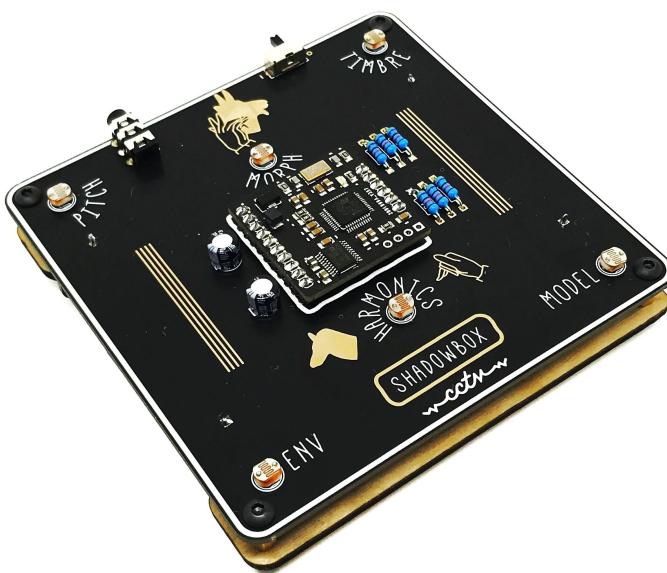
SHADOW BOX comes with a laser cut Russian birch back plate to hide the solder joints from the world, so you don't accidentally short components if something happens to be beneath your SHADOW BOX. It also looks handsome and hides potentially ugly solder joints.

To connect the back plate to the PCB, you'll need to push your M3 screws through the corner holes of the back plate, and thread them to the 8mm standoffs using a 2.5mm Allen key or driver. It's easiest to do this one at a time.



When these are all done, line up the stand offs with the corner holes of the PCB. Make sure the logo on the back plate is facing the correct way, since it fits both ways. Thread the last of the M3 screws through the PCB corner holes to the standoffs.

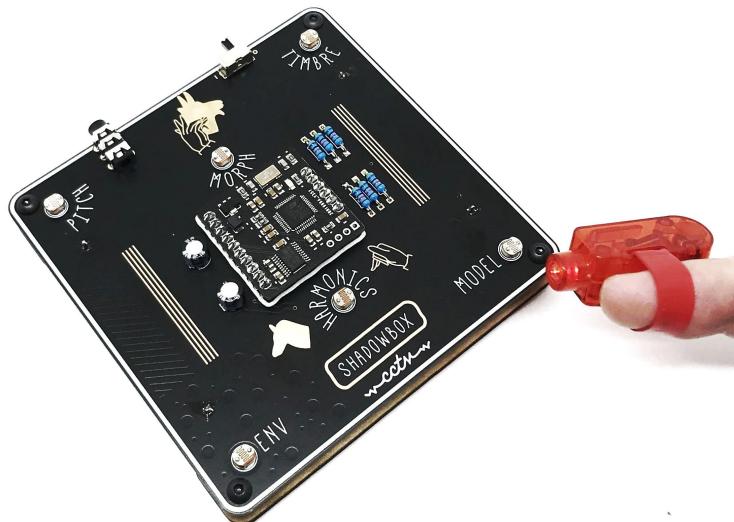




8. Usage

To play Shadowbox, use your hands to block ambient light from getting to the LDRs, or use the finger light to really hit the LDRs with a dose of light. Experiment with which LDRs you cover with your hands, and which ones you blast with light. Using cloth as a filter can yield interesting results. I have found an effective method is to set up a desk lamp directly above Shadowbox and to use both hands to shape the light.

Pitch: controls the frequency of the output audio. No Light = low frequency.
Env: controls output volume with simulated LPG. No Light = low output volume
Mode: selects a synthesis engine.
Timbre, Morph, Harmonics: Controls 3 parameters of the selected synthesis engine.



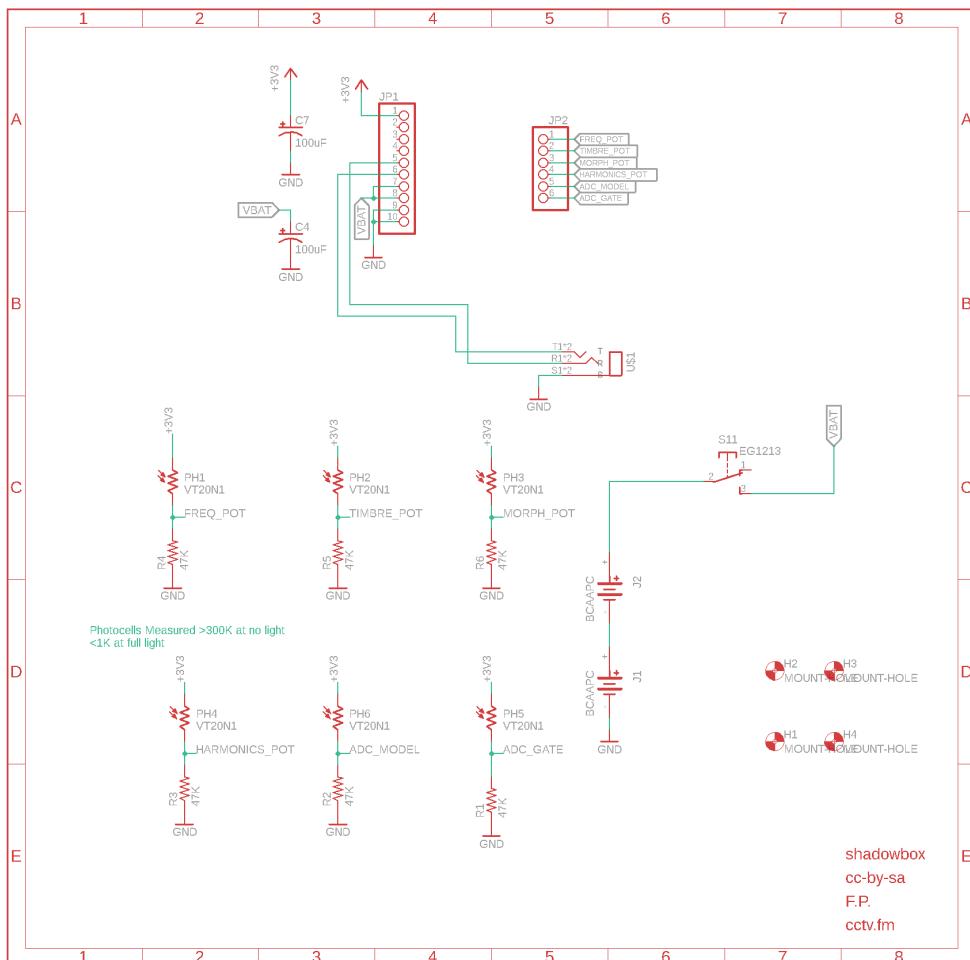
Documentation

Power Input: 120 mA, 3.3V Max

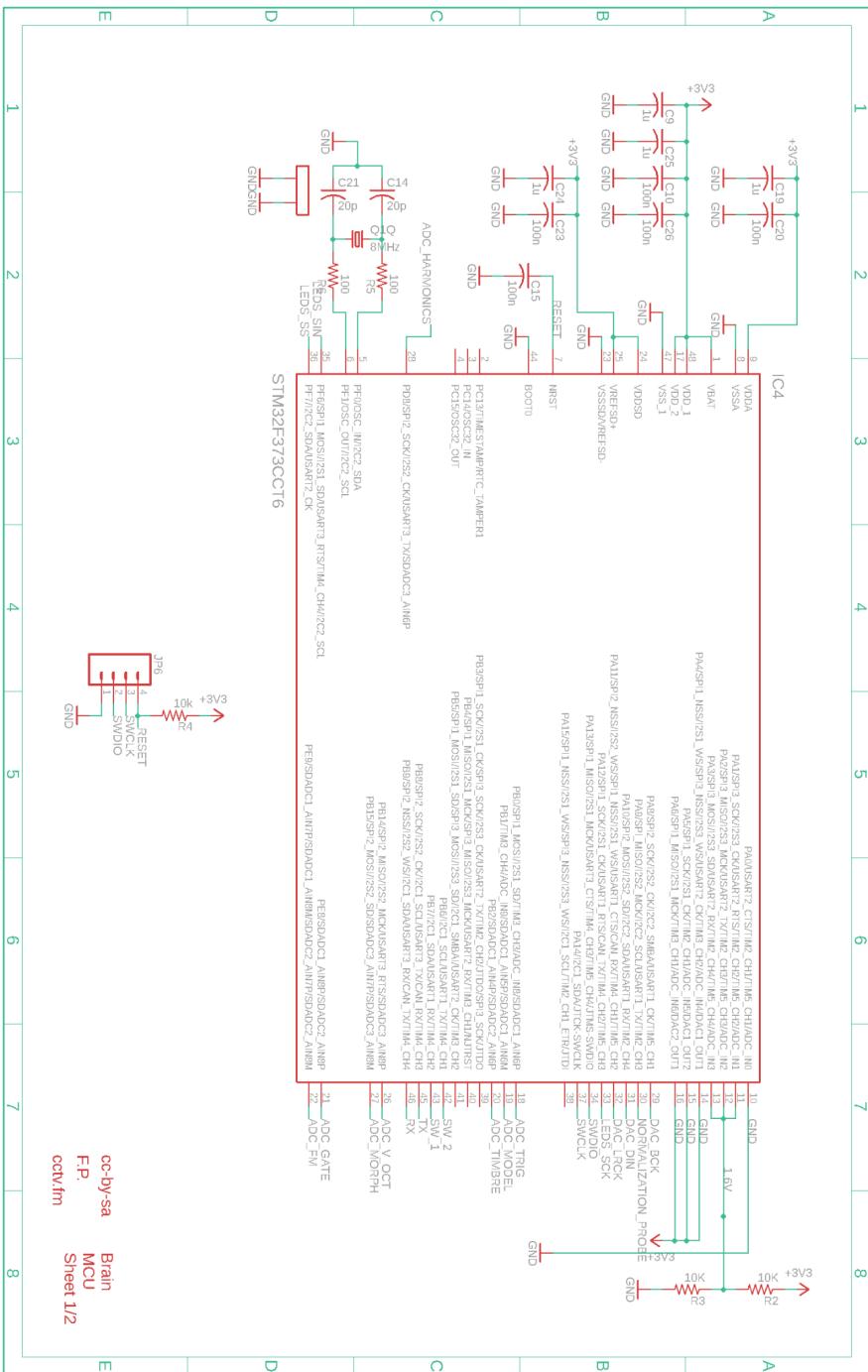
Run Time: ~10 Hours with line out, ~2 Hours with Headphones

Output: Stereo

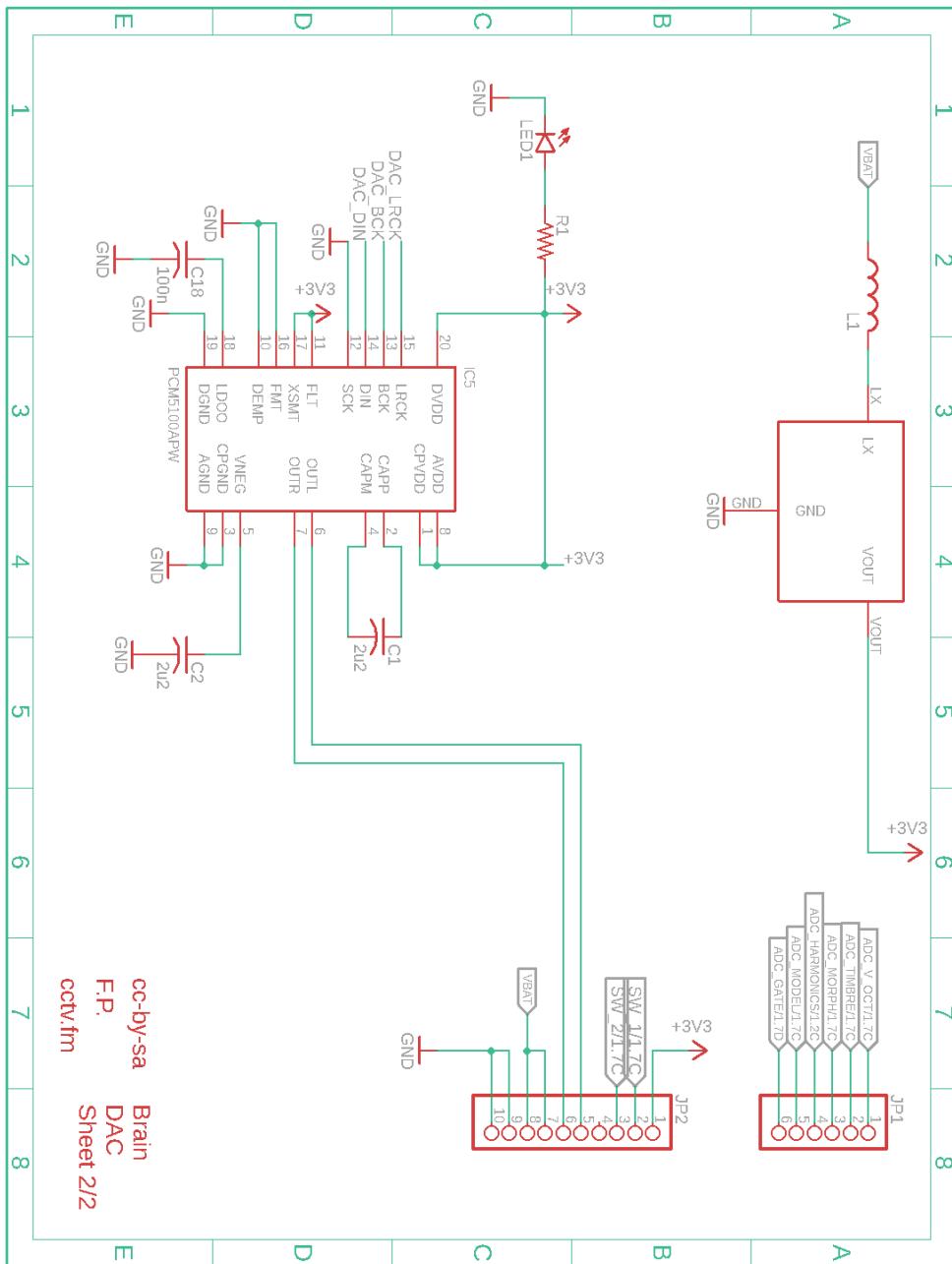
Note: If a mono cable is used, the left channel is shorted out and Shadowbox will not work properly



Main PCB Schematic



Brain PCB. Two sheets, #1 - MCU circuit, #2 - Power and DAC



cc-by-sa
F.P.
cctvfm
Brain
DAC
Sheet 2/2

1 2 3 4 5 6 7 8

E

D

C

B

A

Bill of Materials

BOM				
Electronic				
Qty	Value	Device	Parts	Description
6	47K	Resistor	R1, R2, R3, R4, R5, R6	
2	100uF	Capacitor	C4, C7	Electrolytic Capacitor
2	BCAAPC	Battery	J1, J2	Holder Battery AA
1	EG1213	Switch	S1	E-Switch right-angle slide SPDT Part
1	PJ-3136-B	Jack	U\$1	Stereo 1/8" Jack
6	VT20N1	LDR	PH1, PH2, PH3, PH4, PH5, PH6	Photoconductive Cell VT200 Series
1		Brain	"Brains Go Here"	Submodule
Hardware				
4	8mm	Standoff		
8	6mm	M3 screw BHCS		
1		PCB		
1		Wood Back Panel		
1		Flashlight		
1		Manual		
1		Sticker		

github.com/cctvfm/shadowbox

cctv.fm/shadowbox

