KITE'S SUPER AIO CONSTRUCTION GUIDE V1.1

Hardware V0.5E1 Edition

Last Updated: 12th March 2017

WARNING: This guide is for reference only. It does not guarantee success. Proceed at your own risk, and if in doubt contact someone with experience. This guide and author do not accept responsibility for damage or injury caused. This is a DIY project and will most likely take longer than a weekend. Do not rush it, take it slowly, and ask questions.

Table of Contents

1 INTRODUCTION

1.1 Foreword

Massive thanks for trying out my Super AIO board ☺ I hope you enjoy the project!

This guide contains a slight update on the 'prototype V1.0' version. The steps do not have major changes, but it is worthwhile following this guide in its entirety and ignore the old one (it was released to help prepare people for the steps to come).

1.2 Soldering Video Guide

It is recommended that you watch this YouTube video: https://www.youtube.com/watch?v=Bqzf31Nla5c

1.3 Overview

This guide will help you in building your own gaming system using a SUPER AIO board! This guide is technically more of a build log, however it will point out a number of hints and tips to make your build go smoothly! There is no guarantee of success, this is a DIY electronics project and things can and will go wrong. Use common sense and work out why you are doing things (or being told to do something) in a certain way, as there is always a logical reason.

The guide will be broken down into a number of sections. It is important that you read through everything before undertaking any work, because it is always good to know what the next step is to hopefully prevent modifications that later on aren't compatible (e.g. "I don't need this part, I'll just throw it away" … followed by a step requiring said part!). It's your project, make all the decisions yourself. Use this guide as inspiration and for tips.

1.4 Parts Required

The following list details all the parts used in this guide:

- Kite's SUPER AIO board.
  - This includes the LCD, back board, cables, USB port, tactile button, power switch, LEDs.
- Plastic console case including screws and power switch plastic.
- Additional X Y buttons for case.
- Additional button membranes for case (the rubber bits).
- Button wells.
  - 3D printed or from SNES controller.
- Back buttons.
- 2000-3000mAh LiPo battery.
- 30/32mm speaker 4 or 8 ohm (thinner the better).
- Pi Zero.
- Micro SD card (8GB or larger).
- Screen surround.
- Micro magnets (3x1mm).
- M2 Bolt (~20mm) + Nuts (2x).

1.5 Tools Required

The following list details all the tools used in this guide:

- Adjustable temperature soldering iron.
- Quality solder.
  - 63/37 with flux.

- Flux pen.
- Rotary cutting tool with cutting disk.
- Hot glue gun.
- Scalpel.
- Utility knife (e.g. Stanley knife).
- Needle nosed tweezers.
- Needle nosed pliers + flat pliers.
- Sandpaper.
- Assorted small files.
- Small magnetic screwdriver.
- Step drill bit (3-12mm). MUST contain an '11mm' layer.
- Conductive fabric tape.
- Kapton tape.
- Kapton tape.
- Kapton tape.
- Kapton tape.

Seriously, the kapton tape is a requirement! Without it you risk bridging the USB pads and that will be hard to fix!

1.6 Skills Required

The following skills will prove very useful for completing this project, so either practice them yourself (e.g. soldering on a breadboard to gain soldering practice) or make friends with the right people!

- Soldering
    - The key to success is an adjustable temp iron and good solder. From experience any solder from a generic hardware shop will lead to disappointment. See tools list above for recommendations. There isn't too much soldering required here, but it can be tricky. USE HIGH QUALITY SOLDER NOT FROM A SHOP!! Solder makes all the difference. Use an adjustable temp iron. 250-270 degrees C is my ideal, do not go any higher.
- Cutting and carving
    - The plastic cases are very soft, and using a sharp knife to 'carve' or 'plane' the plastic smooth or to shape makes for a much better finish (a rotary cutting tool will melt everything, but is useful for removing big chunks, and files/sanding will leave a rough finish).
    - You need to be VERY careful if you are new to this, blades are sharp and if used with force they can slip and really hurt you.
- Gluing
    - Handling hot glue is an art, in this guide we will glue on the mounting posts. Getting a solid hold is key to keeping everything together! Tips are given during this step in the guide.

1.7 Build Steps Overview

The following steps are a generalised overview on the steps required and their approximate order. You can do them in whatever order you like but it is key to stress on testing often, especially with the electronic components! You don't want to have it all closed up and then it not turn on.. so test test test!

1. Test electronics:
    a. Solder mode button and switch to 4pin cable.
    b. Solder USB port to back board.
    c. Solder Pi Zero to main board.
    d. Test Pi booting/Buttons/Audio/WiFi/etc.

    e. Solder LEDs.
2. Prepare front half of case:
    a. Drill button holes.
    b. Glue button wells.
    c. Drill LED holes and fill with glue.
    d. Cut USB port hole.
    e. Fit speaker.
    f. Cut LCD hole.
        i. Cut posts as low as possible.
        ii. Cut out approx. screen area.
        iii. Use knife to trim and neaten up screen area.
    g. Fit LCD:
        i. Tack screen in place (don't glue too much just yet!).
3. Test electronics:
    a. Test fit main board in to front half of case.
    b. Test all electronics again.
4. Finish front half of case:
    a. Glue mounting posts.
        i. Check for fitment on EVERY post, one by one.
    b. Glue screen firmly.
5. Prepare back half of case:
    a. Cut out battery bay.
    b. Cut out L and R button holes.
    c. Fit power switch.
    d. Fit mode button.
    e. Fit back board.
    f. Test fitment of front half of case.
6. Prepare battery bay door (optional):
    a. Cut tab.
    b. Glue magnets.
7. Finalise:
    a. Test fit battery placement.
    b. Plan wire placement.
    c. Slowly close case.
    d. Test all functionality.
    e. Stick screen border.
    f. Screw case closed.

The table of contents at the start of this document contains more detail on the actual order of steps. The above list has been simplified.

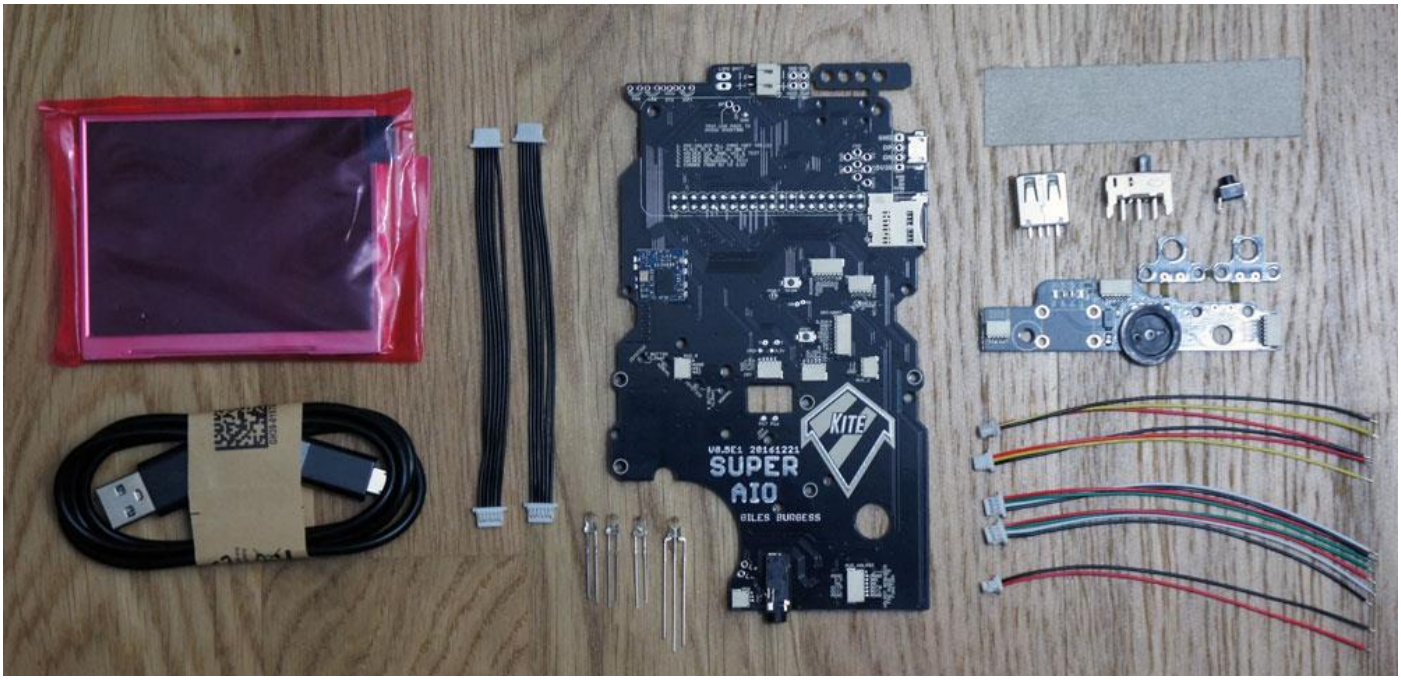
1.8 Software Required

The following software is required to complete this project:

- RetroPie image (pre-made image available here: https://github.com/geebles/Super-AIO/releases)
- Win32DiskImager (to burn the .img to the SD card)
- PuTTY (to ssh into the Pi)

2 Included Parts

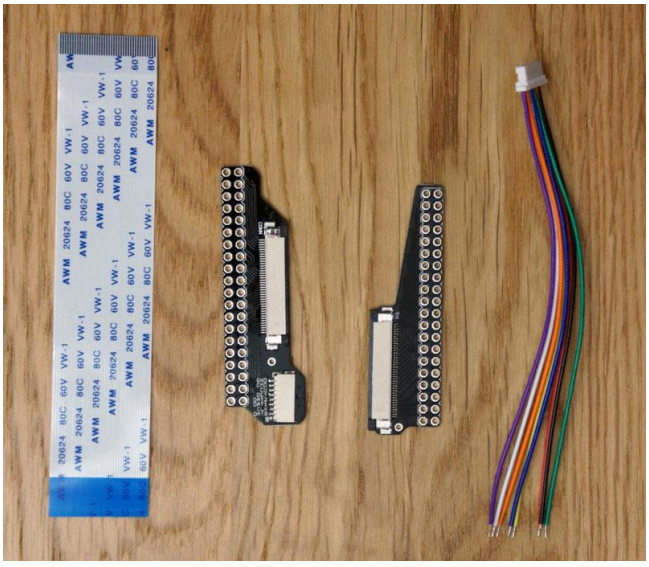
2.1 SAIOv1



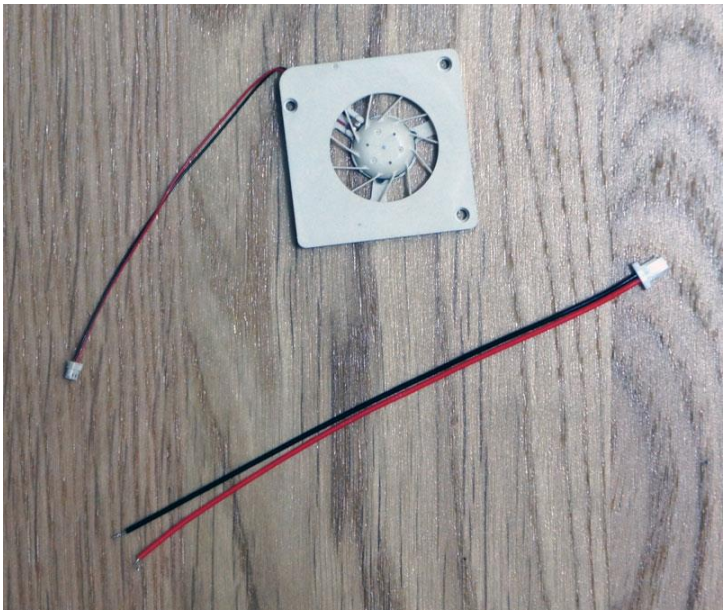
- 1x 3.5" LCD
- 1x extra-long connector micro USB cable
- 2x 6pin 1.00mm JST cables (linking main board to back board)
- 1x SAIO main board
- 1x 8cm strip of conductive fabric (to wrap around 6pin cable that contains USB to reduce interference)
- 1x USB, Power Switch, Button
- 1x SAIO back board
- 2x 3pin 1.00mm JST cables (for L and R buttons)
- 2x 4pin 1.00mm JST cables (for back board switch + button, and joystick/USB)
- 1x 2pin 1.00mm JST cable (for speaker)

2.2 Pi3EXT

- 1x 40pin ZIF cable
- 1x SAIO side PCB (with 2x connectors)
- 1x Pi side PCB (with 1x connector)
- 1x 8pin 1.00mm JST cable (for contrast SD card)

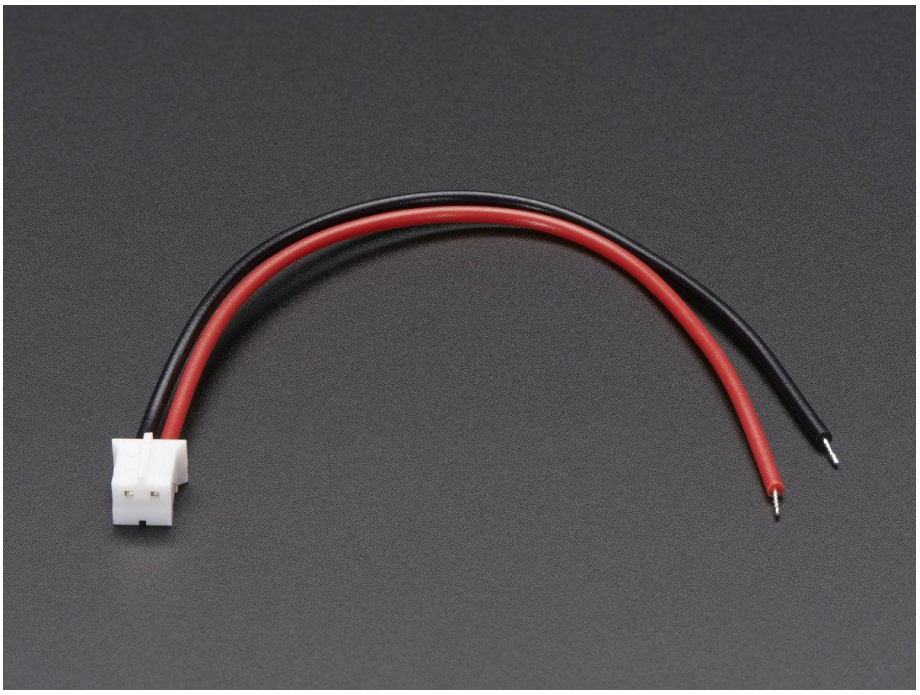


2.3 FAN



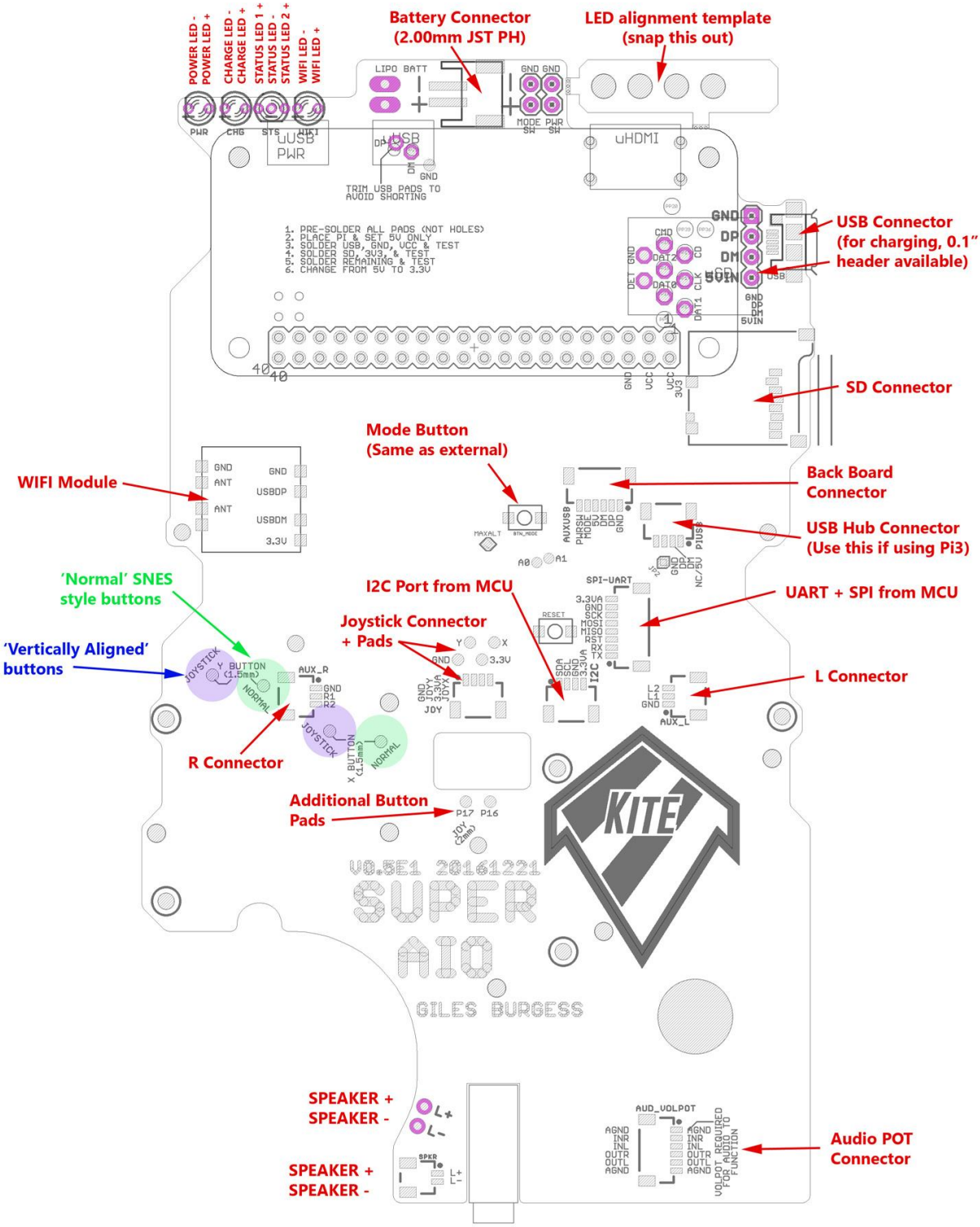
- 1x 30x30x3mm fan
- 1x 2pin 1.00mm JST cable

2.4 JSTPH

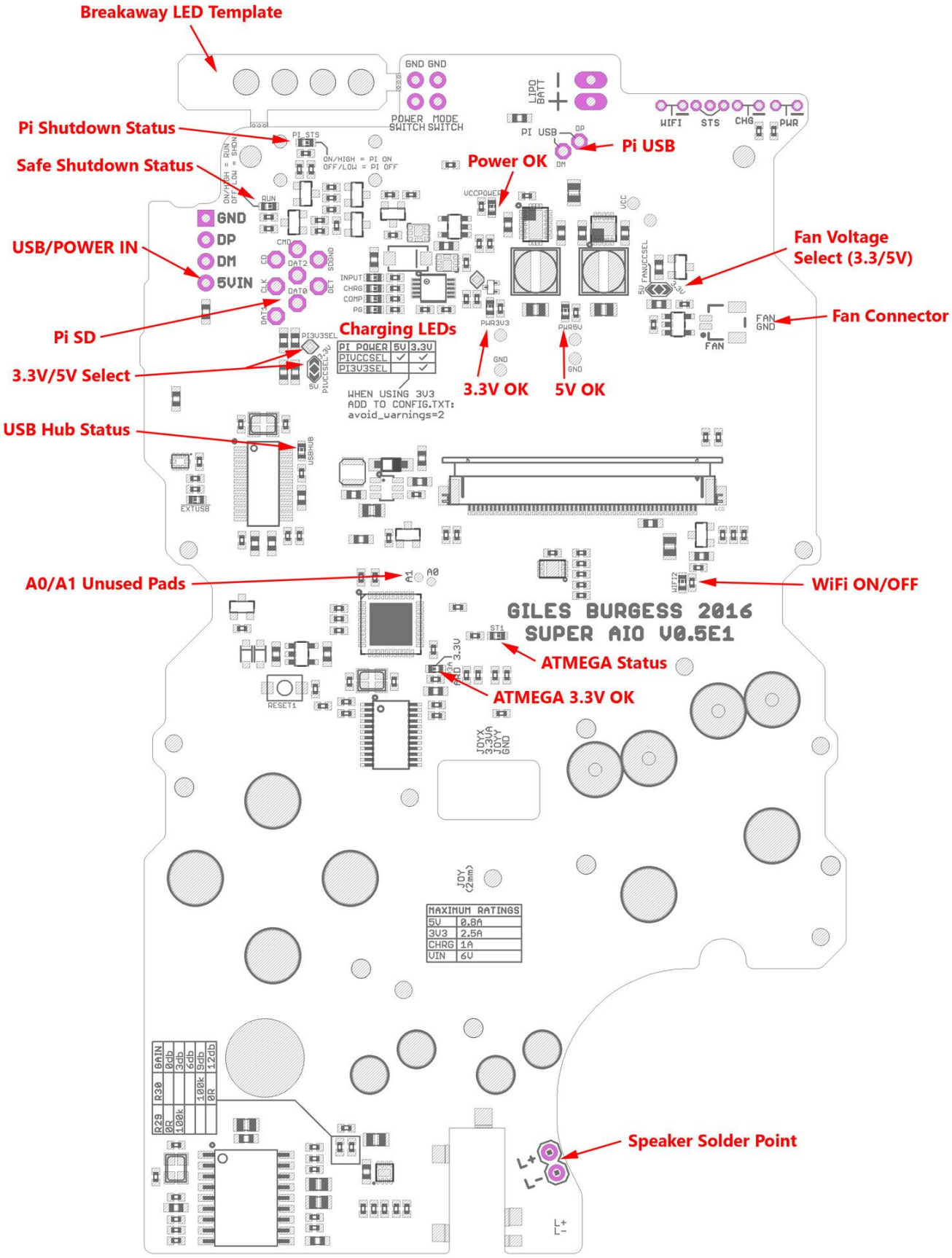


3 Super AIO Hardware Overview

3.1 TOP

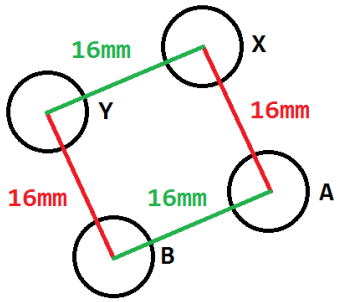


3.2 BOTTOM

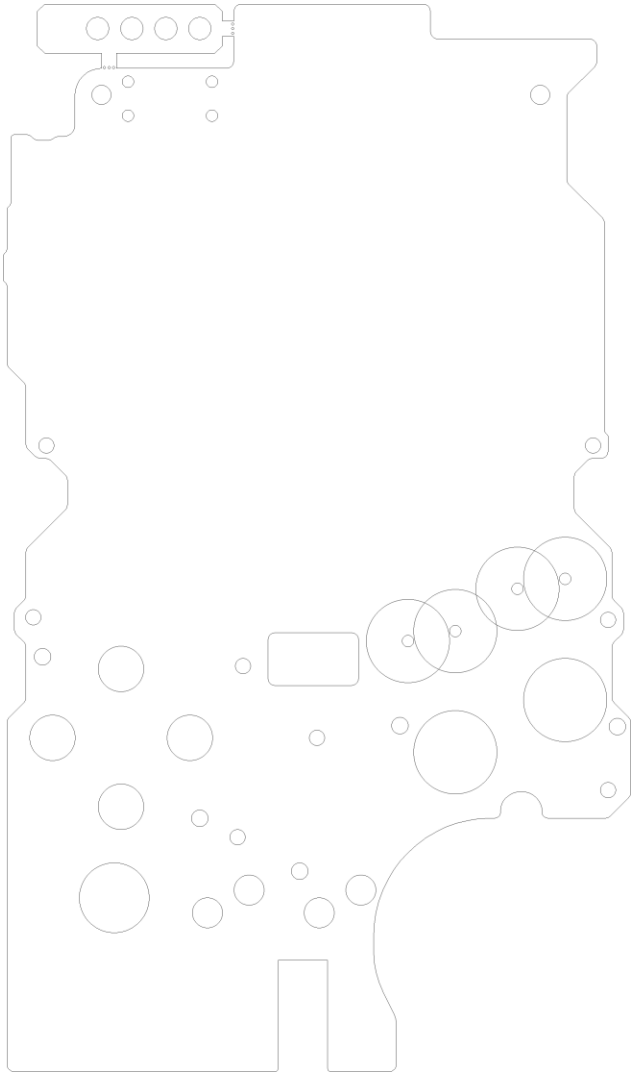

Breakaway LED Template
Pi Shutdown Status
Safe Shutdown Status
USB/POWER IN
Pi SD
3.3V/5V Select
USB Hub Status
A0/A1 Unused Pads
Power OK
Pi USB
Fan Voltage Select (3.3/5V)
Fan Connector
Charging LEDs
3.3V OK
5V OK
WiFi ON/OFF
ATMEGA Status
ATMEGA 3.3V OK
Speaker Solder Point
GILES BURGESS 2016
SUPER AIO V0.5E1
GND GND
POWER MODE SWITCH SWITCH
LIPO BATT
WIFI STS CHG PWR
PI STS
PI USB
GND
DP
DM
5VIN
RUN
CMD
DAT2
DAT0
DAT1
CD
CLK
DET
GDGND
INPUT
CHRG
COMP
PG
VCCPOWER
PWR3V3
PWR5V
VCC
FANVCCSEL
FAN
FAN GND
PI3V3SEL
PIVCCSEL
PI POWER 5V 3.3V
PIVCCSEL ✓ ✓
PI3V3SEL ✓ ✓
WHEN USING 3V3
ADD TO CONFIG.TXT:
avoid_warnings=2
USBHUB
EXTUSB
LCD
A1
A0
WIFI2
ST1
3.3V
RESET1
JOYX
3.3V
JOYY
GND
JOY (2mm)
MAXIMUM RATINGS
5V 0.8A
3V3 2.5A
CHRG 1A
VIN 6V
GAIN
0db
3db
6db
9db
12db
R30
R29
0R
100k
L+
L-

3.3 OUTLINE

The button holes are 16mm apart and 16mm from the other buttons:



If using this template to try and drill button holes, no responsibility is taken for accuracy as printers may print at different sizes. It is HIGHLY recommended to use the alignment holes on the SAIO board itself.



3.4 ATMEGA32u4 Pinouts

3.4.1 Functionality

The default firmware supports the following major actions:

Button Combo	Action
MODE + B	WIFI ON
MODE + A	WIFI OFF
MODE + X	AUDIO AMP OFF
MODE + Y	AUDIO AMP ON
MODE + START	'INFO' MODE ON (on OSD)
MODE + SELECT	'INFO' MODE OFF (on OSD)
MODE + UP	BACKLIGHT INCREASE BRIGHTNESS
MODE + DOWN	BACKLIGHT DECREASE BRIGHTNESS
START + POWER UP	Joystick calibration: rotate the joystick slowly 10 secs

3.4.2 Pinouts

The following table details the pins used on the ATMEGA32u4.

Pin	Alt	Group	Function	Location and Notes
D0		SERIAL	RX	SPI-UART Connector, can be used for anything
D1		SERIAL	TX	SPI-UART Connector, can be used for anything
D2		I2C	SDA	I2C Connector, must remain as I2C
D3		I2C	SCL	I2C Connector, must remain as I2C
D4	A6	GPIO	JOY_X	Joy Connector
D5		GPIO	SPI_CS	SPI-UART Connector, for future use on LCDs
D6		GPIO	LED_STS1	LED status for external
D7	A7	GPIO	TCA_INT	TCA Interrupt
D8	A8	GPIO	LED_STS2	LED status for external
D9	A9	GPIO	WIFI_EN	1 = ON, 0 = OFF
D10	A10	GPIO	BACKLIGHT	1 = ON, 0 = OFF, PWM this pin to dim backlight
D11		GPIO	AUDIO_!EN	NC = ON, 0 = OFF
D12	A11	GPIO	JOY_Y	Joy Connector
D13		GPIO	LCD_RESET	LCD, will reset the LCD controller
SCK		SPI	SCK	LCD / SPI-UART Connector, for future use on LCDs
MOSI		SPI	MOSI	LCD / SPI-UART Connector, for future use on LCDs
MISO		SPI	MISO	LCD / SPI-UART Connector, for future use on LCDs
A0		ANALOG	FREE	PAD
A1		ANALOG	FREE	PAD
A2		ANALOG	VOLTAGE	Battery Voltage, scaled to 3.3V
A3		ANALOG	CURRENT	Current (when IC installed), scaled to 3.3V
A4		ANALOG	PI_LOWBATT	Low batt trigger to Pi, tell the Pi the battery is low
A5		ANALOG	BTN_MODE	External MODE Button

3.4.3 How to Re-Program the ATMEGA32u4

The ATMEGA32u4 in the SAIO is the same as an Arduino Leonardo Micro. It comes PRE-PROGRAMMED with running firmware. If you wish to upload new firmware, please download the source from the following link:
https://github.com/geebles/Super-AIO

Uploading is as simple as installing the IDE, plugging in the USB port (with the main power switch OFF), installing the drivers, opening your sketch, and clicking 'upload'. A guide can be found here: https://www.arduino.cc/en/Guide/ArduinoLeonardoMicro

If all else fails, you can use an AVRISP (USBASP) on the programming connector which is called 'SPI-UART', this contains RESET, MOSI, MISO, and SCK.

ONLY feed the microcontroller with 3.3V. The IO are all 5V tolerant, and technically it is meant to run at 5V, however it has a dedicated regulator (3.3V) which should not be reverse fed 5V! 3.3V was chosen because the Pi can only tolerate 3.3V IO, therefore making the whole microcontroller 3.3V removes this need to level shift.

3.5 Raspberry Pi Pinouts

3.5.1 Pinouts

The following table details the pins used on the Pi. Any additional pins not mentioned can be used (e.g. camera connector).

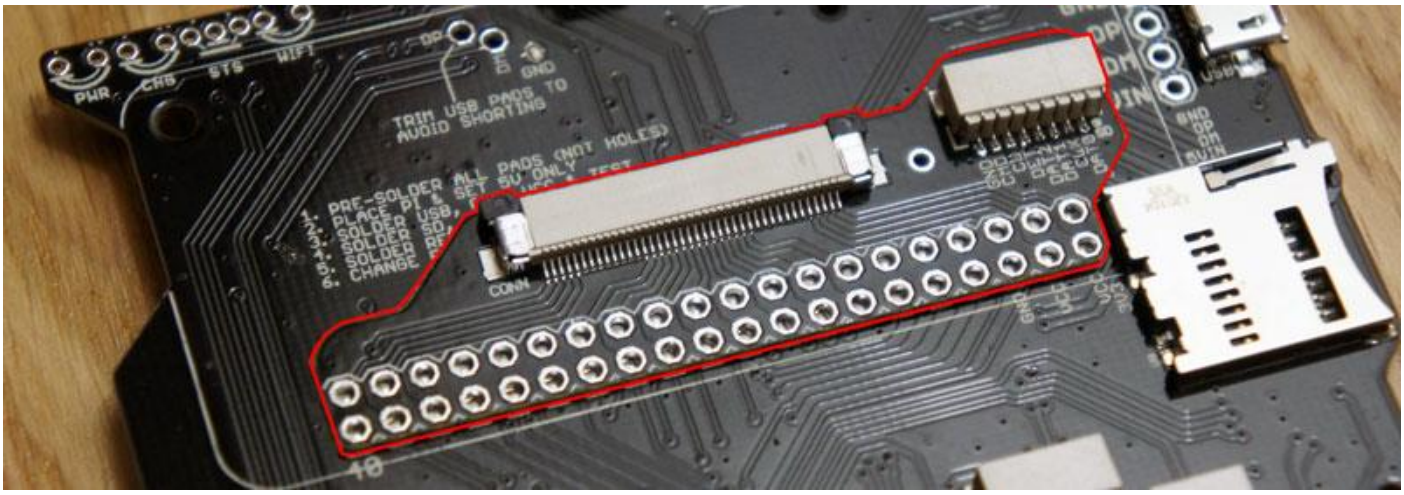
Pin	Group	Function	Notes
GPIO_00	DPI	DPI LCD	Cannot be used
GPIO_01	DPI	DPI LCD	Cannot be used
GPIO_02	DPI	DPI LCD	Cannot be used
GPIO_03	DPI	DPI LCD	Cannot be used
GPIO_04	DPI	DPI LCD	Cannot be used
GPIO_05	DPI	DPI LCD	Cannot be used
GPIO_06	DPI	DPI LCD	Cannot be used
GPIO_07	DPI	DPI LCD	Cannot be used
GPIO_08	DPI	DPI LCD	Cannot be used
GPIO_09	DPI	DPI LCD	Cannot be used
GPIO_10	DPI	DPI LCD	Cannot be used
GPIO_11	DPI	DPI LCD	Cannot be used
GPIO_12	DPI	DPI LCD	Cannot be used
GPIO_13	DPI	DPI LCD	Cannot be used
GPIO_14	DPI	DPI LCD	Cannot be used
GPIO_15	DPI	DPI LCD	Cannot be used
GPIO_16	DPI	DPI LCD	Cannot be used
GPIO_17	DPI	DPI LCD	Cannot be used
GPIO_18	DPI	DPI LCD	Cannot be used
GPIO_19	DPI	DPI LCD	Cannot be used
GPIO_20	DPI	DPI LCD	Cannot be used
GPIO_21	DPI	DPI LCD	Cannot be used
GPIO_22	GPIO	PI_PGOOD	Pi running status, driven by the Pi. 1 = Pi ON, 0 = Pi OFF. Prevents the regulators being switched off when the power switch is off. Set in config.txt
GPIO_23	GPIO	PI_LOWBATT	Connected to the ATMEGA32u4, the ATMEGA can warn the Pi that the battery is critical. Can be read by a script. Unused
GPIO_24	GPIO	FREE	Unused
GPIO_25	GPIO	FREE	Unused
GPIO_26	GPIO	FAN_EN	Turn on the fan. 1 = ON, 0 = OFF. Can be used to trigger the fan when a temperature threshold is reached from a script
GPIO_27	GPIO	PI_SHDN	Main power switch status, read only. 1 = ON, 0 = OFF. Shutdown script will read this value and trigger a shutdown when = 0

4 Pi3 Notes

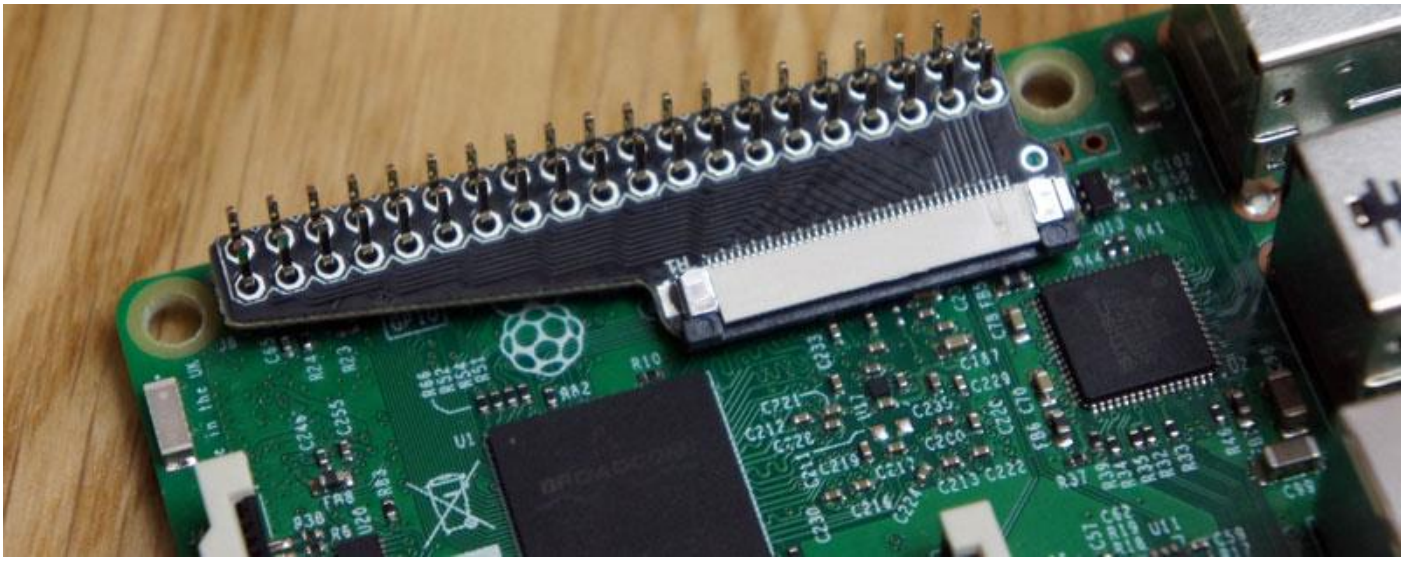
If using the Pi3 Extension adapter, the procedure is pretty much the same for the guide. The difference being that you solder the extension adapters to the SAIO and the Pi3, and then use the included ribbon cable to connect them together.

It is also advisable to run an additional 3.3V and GND wire from the SAIO to the Pi3 because the ribbon cable cannot fully supply the power to the Pi3.

The following image shows the Pi side board. Note that you should treat this just like the Pi Zero in the guide, including soldering the SD pins on the bottom of the adapter. The soldering procedure is identical.

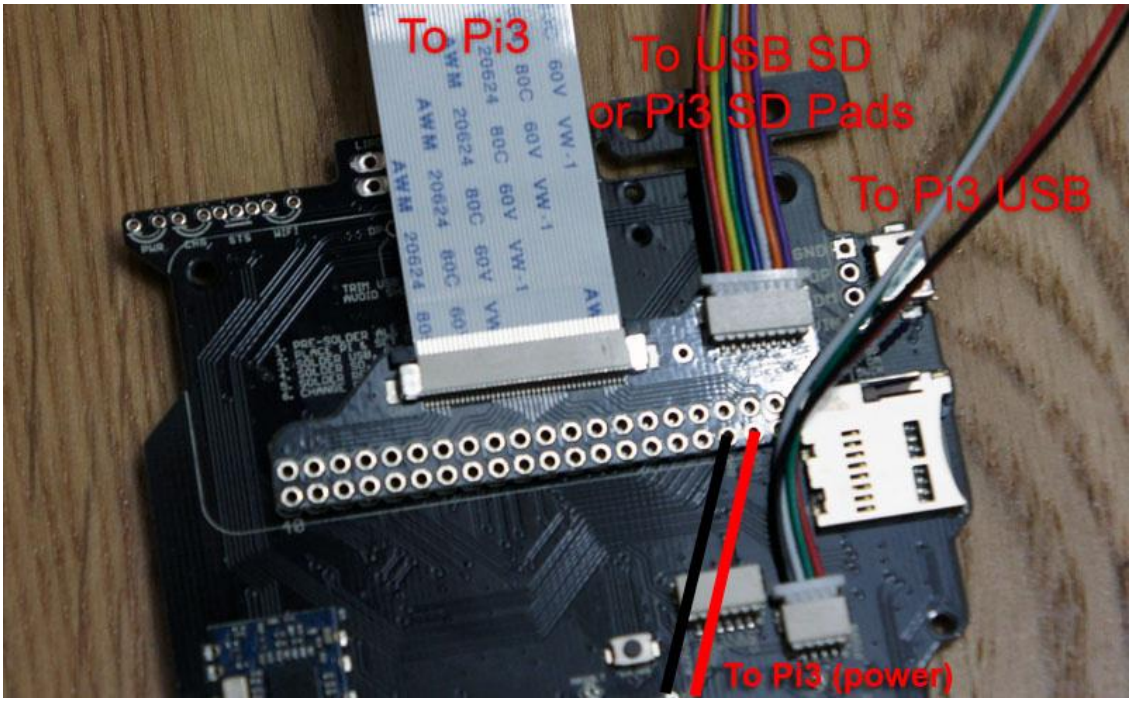


The following image show the Pi side adapter. Note that it MUST but the way round shown in the picture. You cannot rotate it at all in other directions. If you want to mount it to the other side of the pi, the connector must be facing the PCB (imagine you literally swap the Pi and the adapter over with each other).

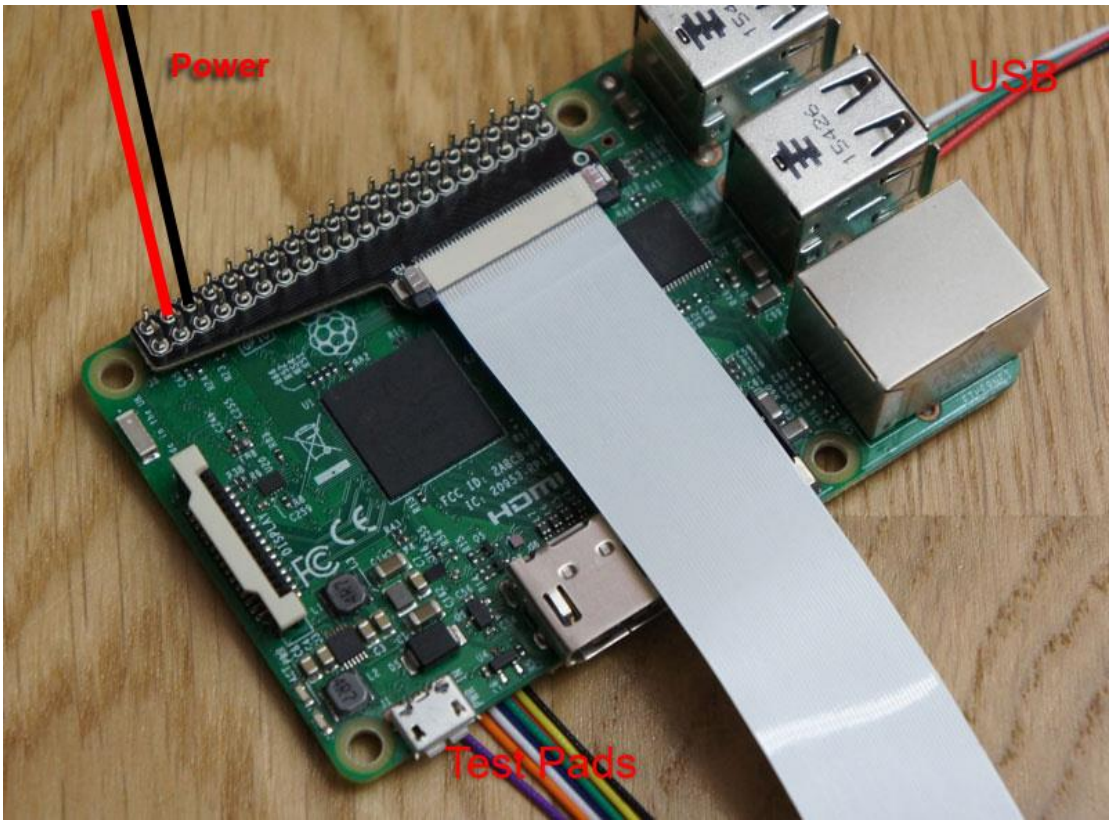


The following image shows how the cables are connected to the SAIO.

- The main ribbon connects to the Pi adapter.
- The 4pin USB cable must connect to a free USB port.
- Additional silicone cables are soldered to the power pins.
- (Optional) The 8pin cable can be connected to the Pi SD pins or a USB to SD adapter.



The following image shows the Pi side, with the USB connected to the USB pads/port, and the power pins connected as appropriate.



A pre-made image for the Pi3 is available (see links at the end of this guide).

Fitting the Pi3 is up to you, and it is even possible to use a sharp knife to cut lines in the ribbon cable (e.g. every 3 wires) to make it more flexible (wrap the strands in conductive fabric).

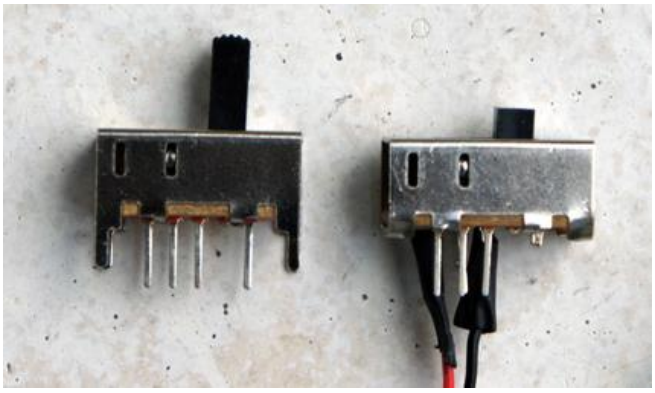
5 Phase 1 – Prepare and Test Boards

During this phase we will prepare and test the main PCB. The purpose is to prove that all the electronics work before fitting it. It is vital to do this as some stages may be hard to reverse.

5.1 Solder Mode Button and Switch to 4pin Cable.

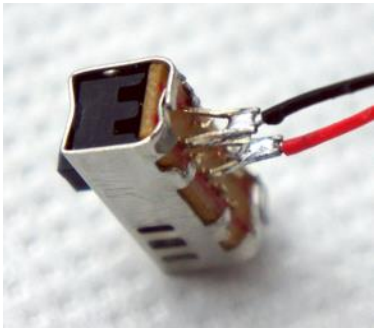
The main power switch and 'mode button' (which will go in the DC jack connector hole) need to be soldered to one of the 4pin cables (this can then easily plug in to the back board). Modifying switch not required but documented.

5.1.1 Prepare and Solder the Slide Switch

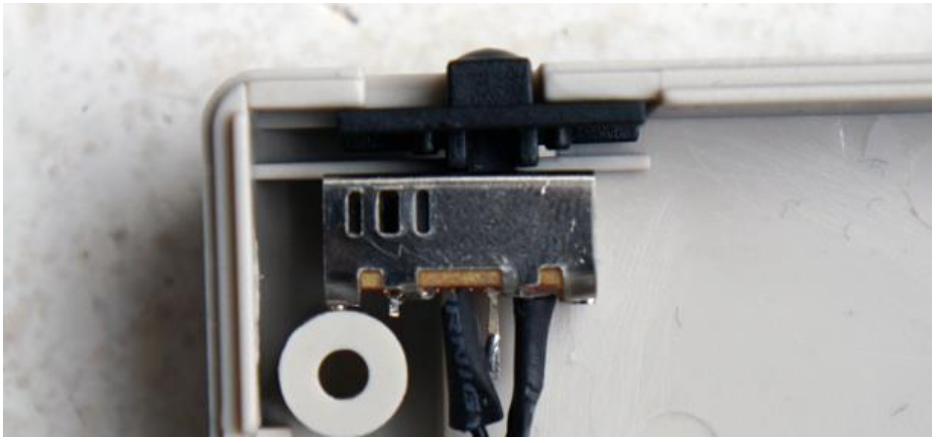


Trim the long switch (use a very sharp knife, and cut slowly). The purpose of this is so that the 'original slide switch plastic' will fit into the new switch. The 'original slide switch plastic' will go flush against the metal switch part.

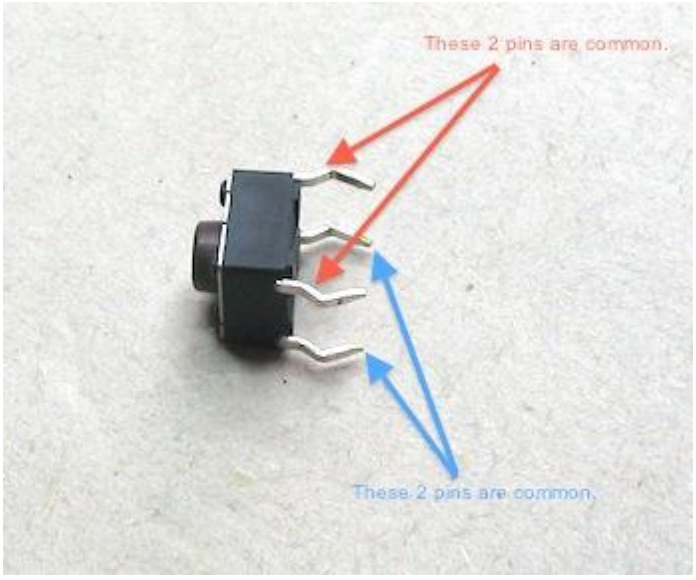
You will need to use the CENTER and EDGE pins, and solder the ones parallel to it (remove all others). See image below for an example.



When bending the edge legs, do so very carefully making sure not to 'squash' the main shape. The brown bit of PCB inside the switch should not be moved, and it will move if the outside metal is deformed, so be careful not to deform it. The END goal for the switch is show below (for fitment reference, don't glue it in just yet).

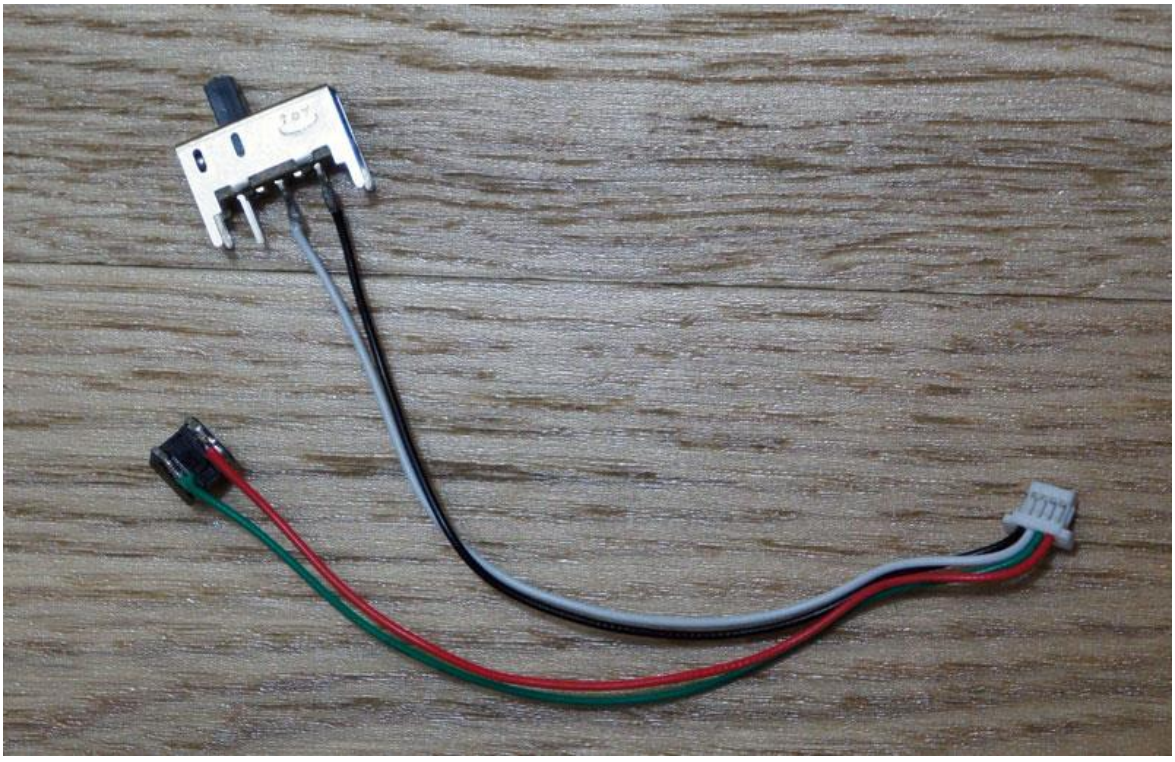


5.1.2 Prepare and Solder the Button



The diagram above shows which pins need soldering. Either bend them over and solder a wire to both, or solder to just the one set of legs. Test with a multimeter in continuity mode to make sure it's good!

5.1.3 Examine Finished Cable



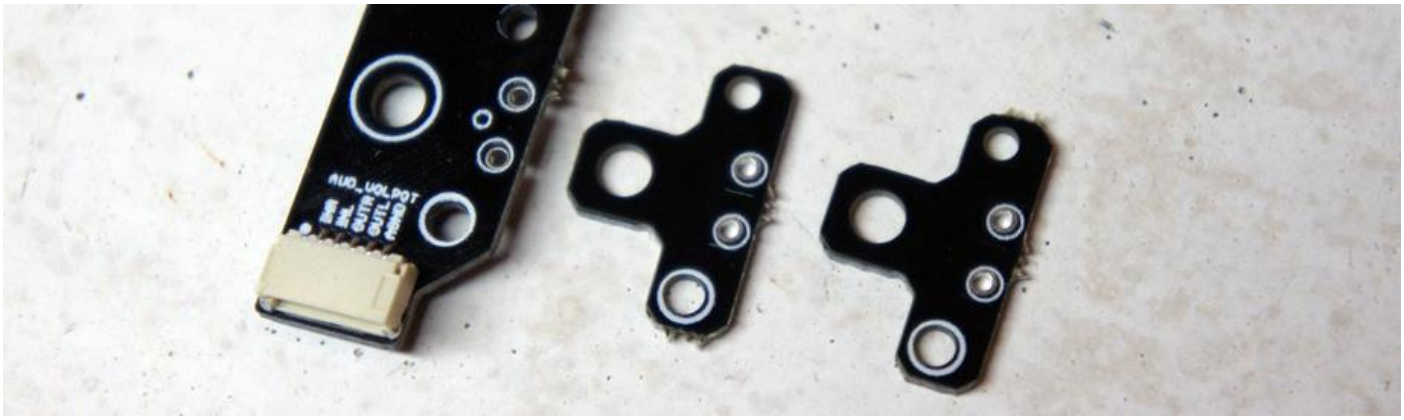
The image above shows the button and switch wired up. It does not matter which way round the cables go on the switch/button, just as long as they work as pairs on the connector. To make life easier, I bent the legs of the button over each other (in the way that they want to bend) and soldered them together, this makes a nice solid place to solder the wires to.

It is technically not necessary to modify the switch yet, as the boards can be tested without modification. You decide when to do this. It may be best to test without modification first in-case the switch or button is damaged.

5.2 Prepare Back Board Spacer

The original backboard of the DMG had a big plastic cartridge connector that acted as a spacer, without using a cartridge connector the board needs its own spacer. This is achieved by stacking the two included spacers and soldering them on to the board.

5.2.1 Break Out Tabs and Prepare Spacer 1

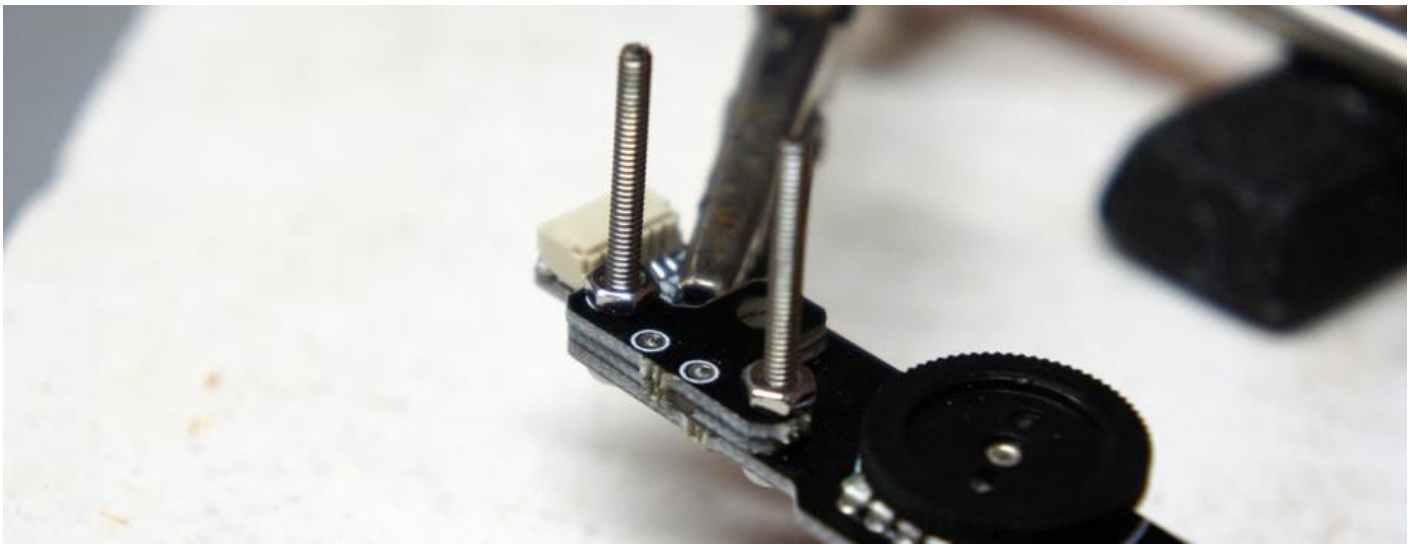


Using an M2 nut and bolt, attach 1x spacer. This makes sure that the holes line up.

Place solder into the white highlighted holes, keeping the soldering iron on the edge of each hole and slowly filling up with melted solder. Check on the other side and you will see that it will 'wick' to the other side of the board, affixing the two pieces together.

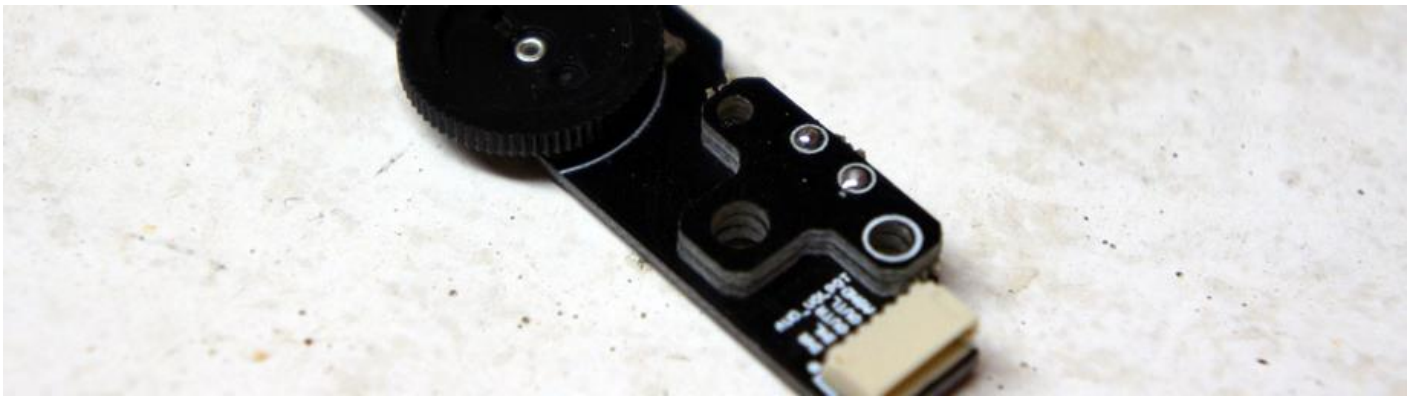
Make sure to leave the top of the soldered join as FLAT as possible to make attaching the second spacer easier (if it's lumpy and bumpy the next piece won't stack on top).

5.2.2 Prepare Spacer 2

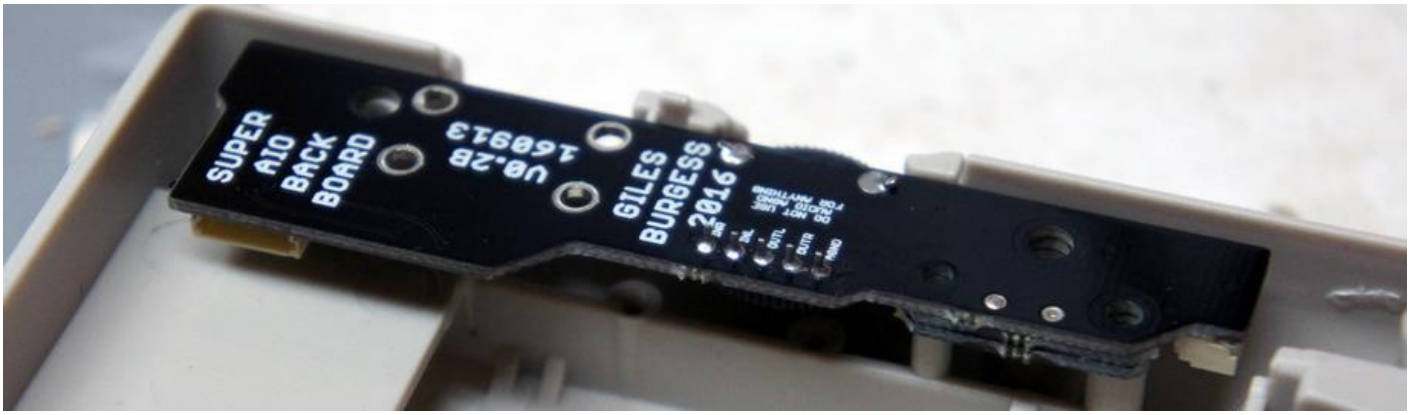


Remove the bolt and insert spacer 2, then put the bolt and nut back. Repeat the previous step to solder the second spacer to the board.

The end result should look like the following image:



5.2.3 Test for Fit

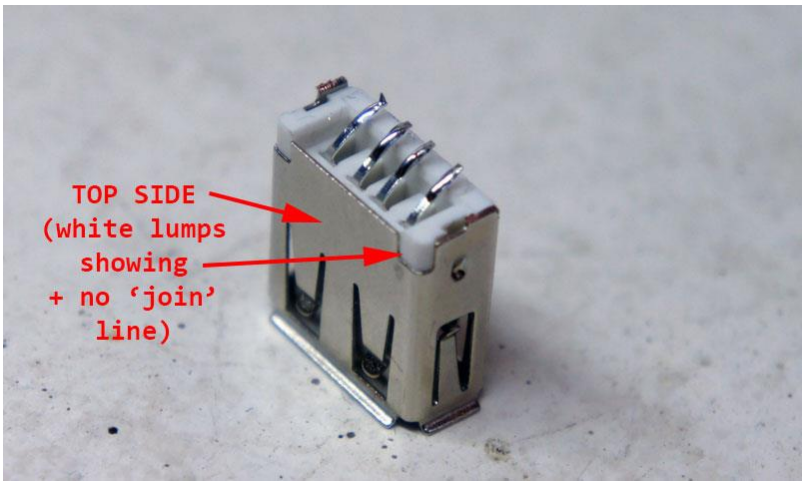


The holes should line up, and the board should fit nicely as shown above.

5.3 Solder USB Port to Back Board.

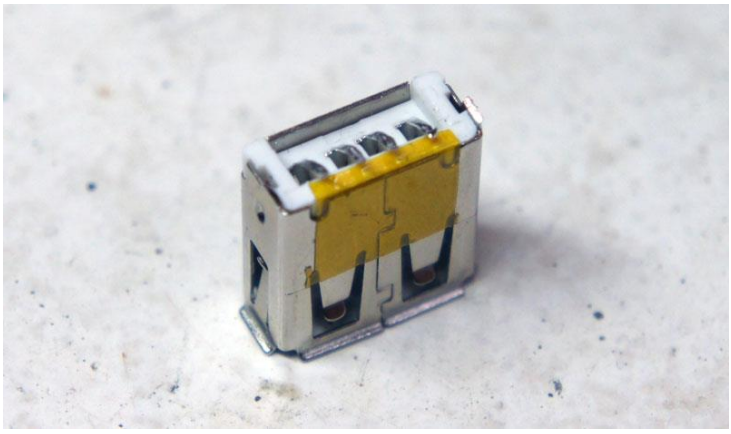
The USB port does not come soldered, and requires some careful alignment. With some preparation and following a process of 'temporarily solder' and 'test fit', it is not difficult to fit.

5.3.1 Determine 'correct' way up for USB Port



The image above shows the correct way up for the USB port. The top side is smooth, with white corners showing, the bottom side has a 'join' (see image below). The smooth side must face UP.

5.3.2 Bend USB Port Legs to meet PCB

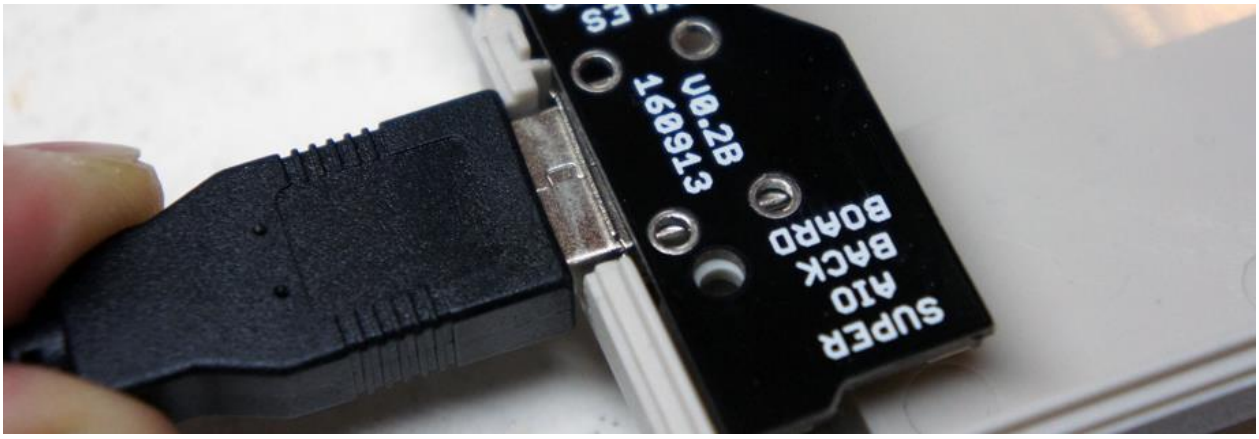


These USB ports are technically meant to be mounted vertically, but they are the only way to have a 'back board' with built in USB port being low profile (hence why they aren't populated already).

Bend the legs of the USB port towards the back, it is a good idea to put some kapton tape as pictured to avoid risk of shorting solder where you don't want it. Bend them back and use pliers where necessary to get them to bend over as much as possible.

Once bent, 'tin' the tips with solder.

5.3.3 Test Fit to Work Out Placement



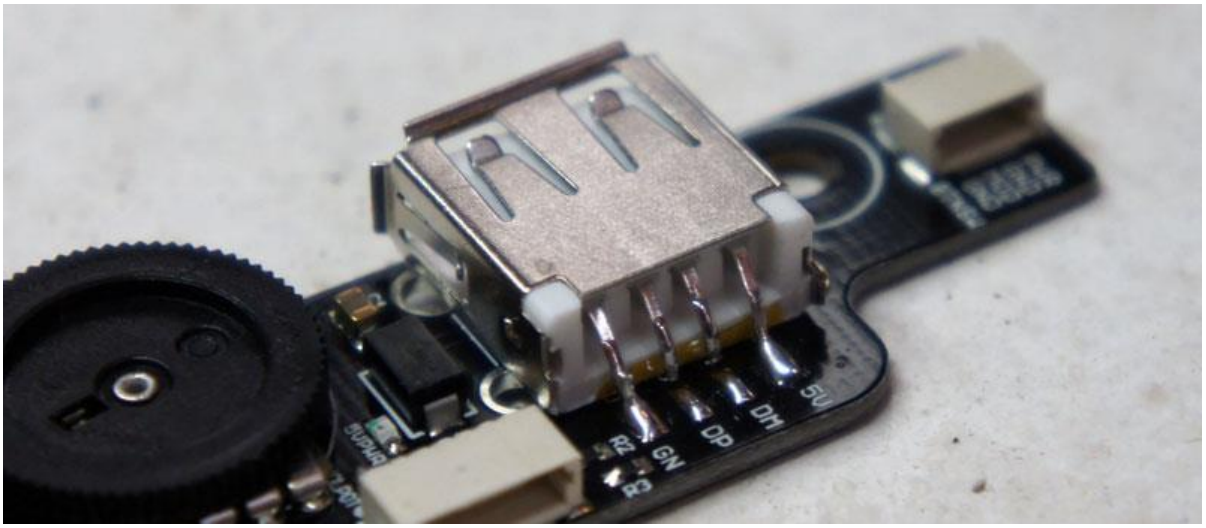
With a USB plug, offer up the port. The port works best as pictured above where the 'lip' of the USB connector is on the INSIDE of the case (rather than the 'lip' being on the outside, but it's up to you).

Using a marker, mark how far in the USB connector goes in (or just note it, in the picture above it is 1mm from PCB).

Remove the back board from case and solder ONE pin ONLY with the USB connector lined up to the line you just made.

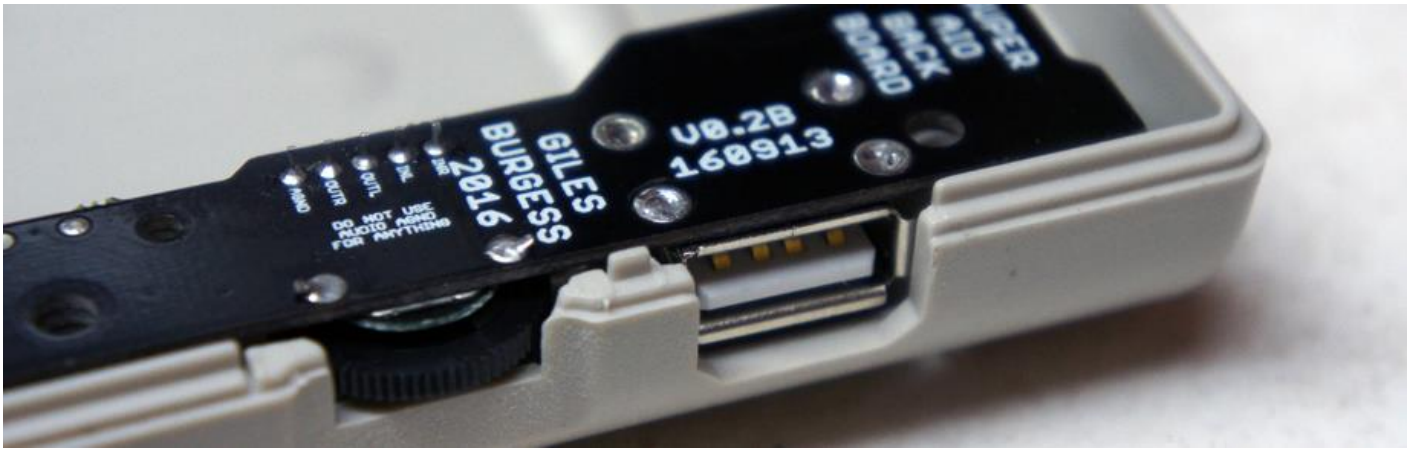
Then TEST FIT as is. If it doesn't fit, remove and adjust (by re-melting the solder and moving slightly). The benefit of only soldering ONE leg is that it is easy to move. Do not solder all the connectors unless you are 100% happy with the position (as it will be difficult to remove afterwards).

5.3.4 Solder All Connectors



When you are 100% happy with placement, solder the remaining 4 connectors on the back. Then solder the 4 large 'support' holes (these will be a bit harder to do, make sure to hold the iron on the connectors for a while (they will be very hot and will hold their heat!)). Picture above shows the two edge only soldered.

5.3.5 Final Test Fit



A final test fit and it should look like the above image. The metal can be filed if necessary.

5.3.6 Test Main Board before Soldering

Nearly everything is prepared for soldering the Pi zero to the main board, so now would be a good idea to test the board and the Pi separately before attaching. If anything doesn't work in this step then it most certainly won't work when attached!

Connect the back board connector, and switch/button connector to the backboard, and then plug in to USB power.

With the power switch OFF the following LEDs will be ON: INPUT, CHRG, COMP, PG, ARD 3.3V, ST1.

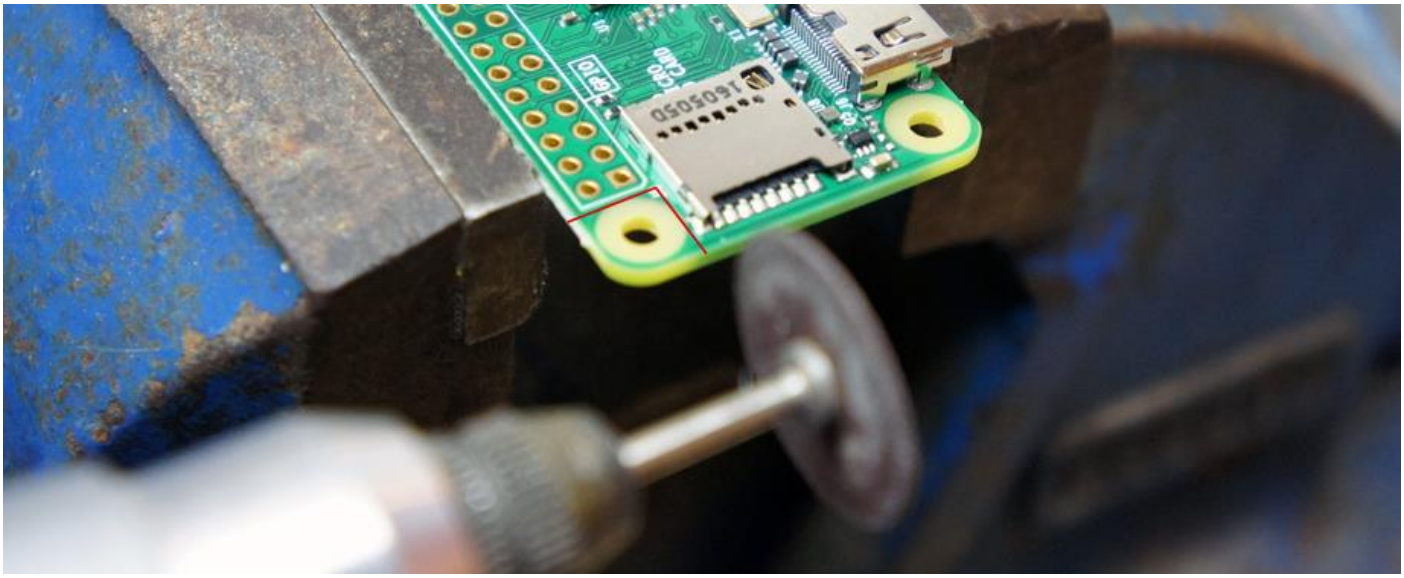
With the power switch ON the follow LEDs will be ON: INPUT, CHRG, COMP, PG, ARD 3.3V, ST1, VCC, PWR3V3, PWR5V.

If you plug USB and power switch is OFF, the ATMEGA32u4 will appear as a USB gamepad (open 'Set up USB game controllers' app from Windows Start menu) and will respond to buttons. It can also be re-programmed this way from the Arduino IDE.

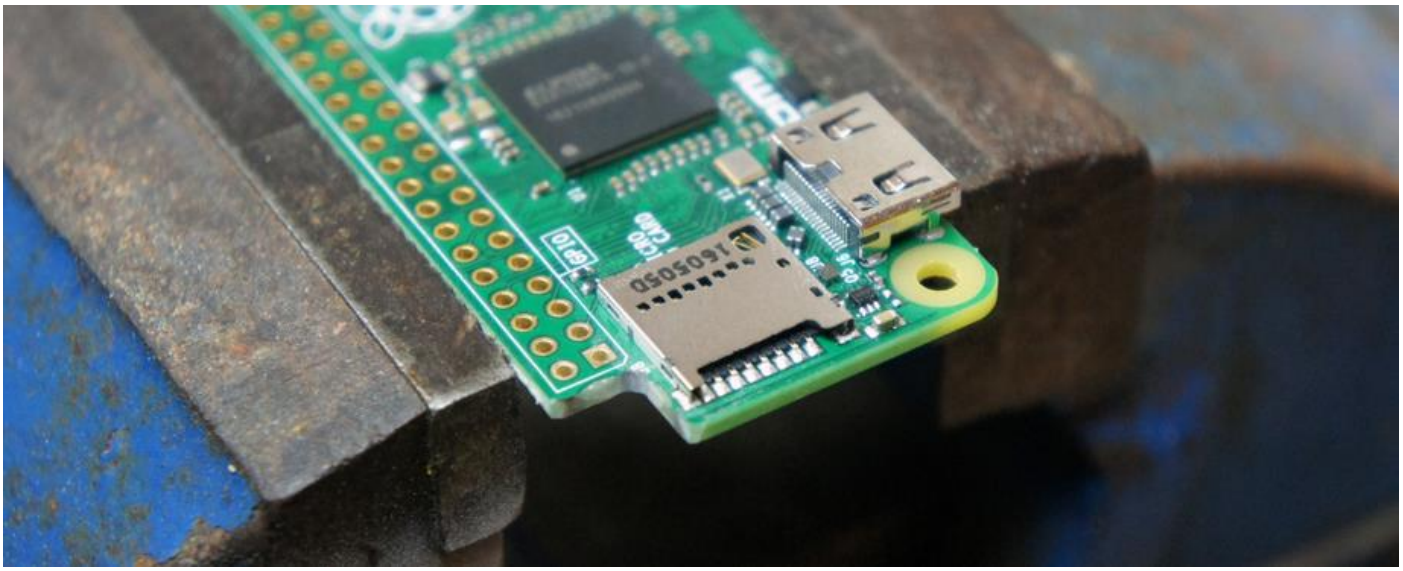
5.4 Prepare Raspberry Pi Zero

5.4.1 Cut the Pi

In order to mount the Pi Zero a small corner needs to be cut out.



The above image shows where to cut. The YELLOW area of the PCB is the only bit that needs cutting out.



Once cut, use a file and sandpaper to smooth down and neaten up. The end result should look like the above picture. Note that there are no traces or circuitry underneath the cut out area. Just be careful of the SD card connector.

5.4.2 Test Pi Zero

Make sure your Pi Zero works by putting the default RetroPie image (https://retropie.org.uk/download/) and plugging in HDMI and checking that it boots OK.

5.5 Solder Pi Zero to Main Board

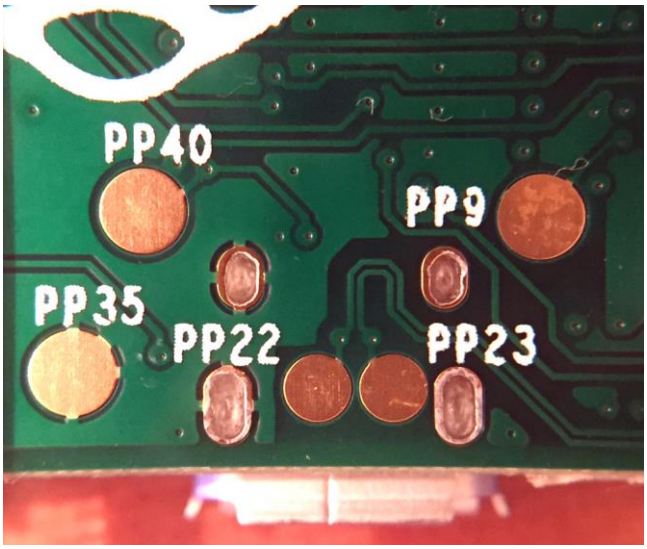
In this step the Pi Zero needs to be soldered to the main board. The entire GPIO connector, USB test pads, and SD card test pads are going to make a connection to the main board. This is done by filling the 'holes' with solder and having a mating solder surface on the other side. By melting the two sides they will form a connection. This process requires one side to have 'holes' and the other side to have 'pads'.

For the GPIO connector, the holes are on the Pi and the pads are on the main board.

For the USB and SD, the pads are on the Pi and the holes are on the main board.

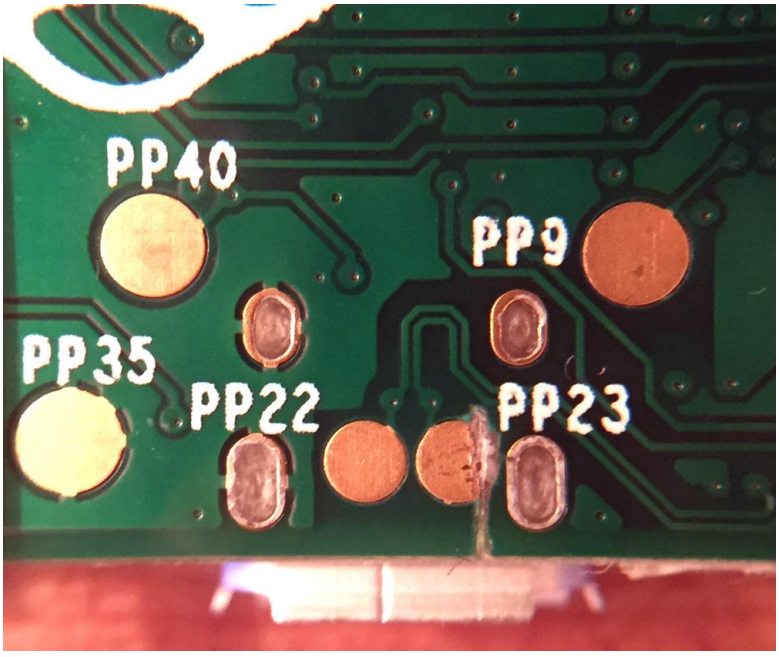
5.5.1 Preparing the USB Pads

One of the USB test pads on the bottom of the Pi is far too close to a ground pad, which if shorted with the USB pad will lead to no USB devices working. To avoid this we can use a sharp knife to 'cut' a slice out of pad as well as applying kapton tap to reduce the chance of shorting the pads.



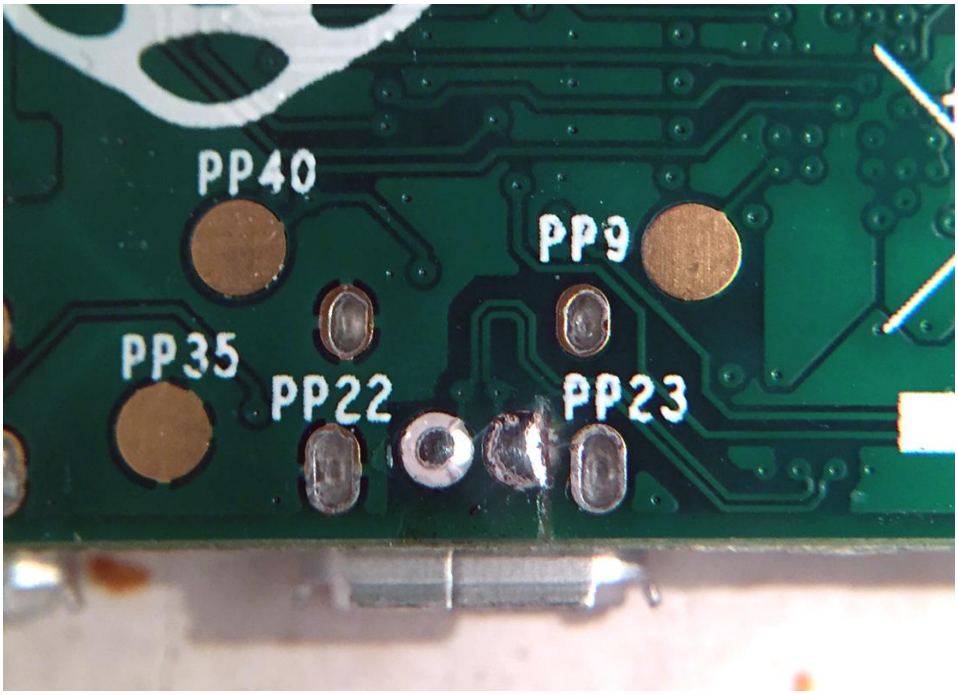
The above image shows the un-modified Pi with PP22 and PP23. Note that PP23 is VERY close to the exposed solder (this is the ground of the USB port).

A cut needs to be made to trim down the pad. Use a very sharp knife and gently but slowly cut. Using the edge of the blade, it is possible to lift up and remove the small bit of pad. Make the cut AWAY from the board.

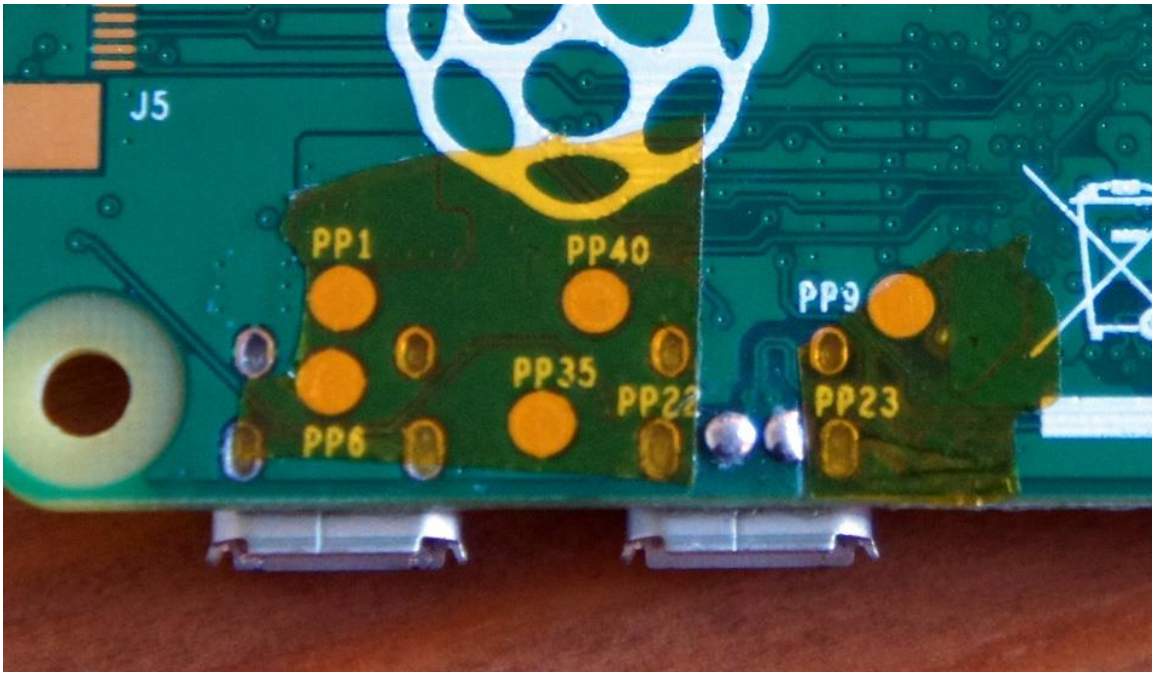


The above image shows that a cut has been made. It looks a little messy but from visual inspection it looks good.

Apply solder to the pads, they should look nice and clean like the image below.

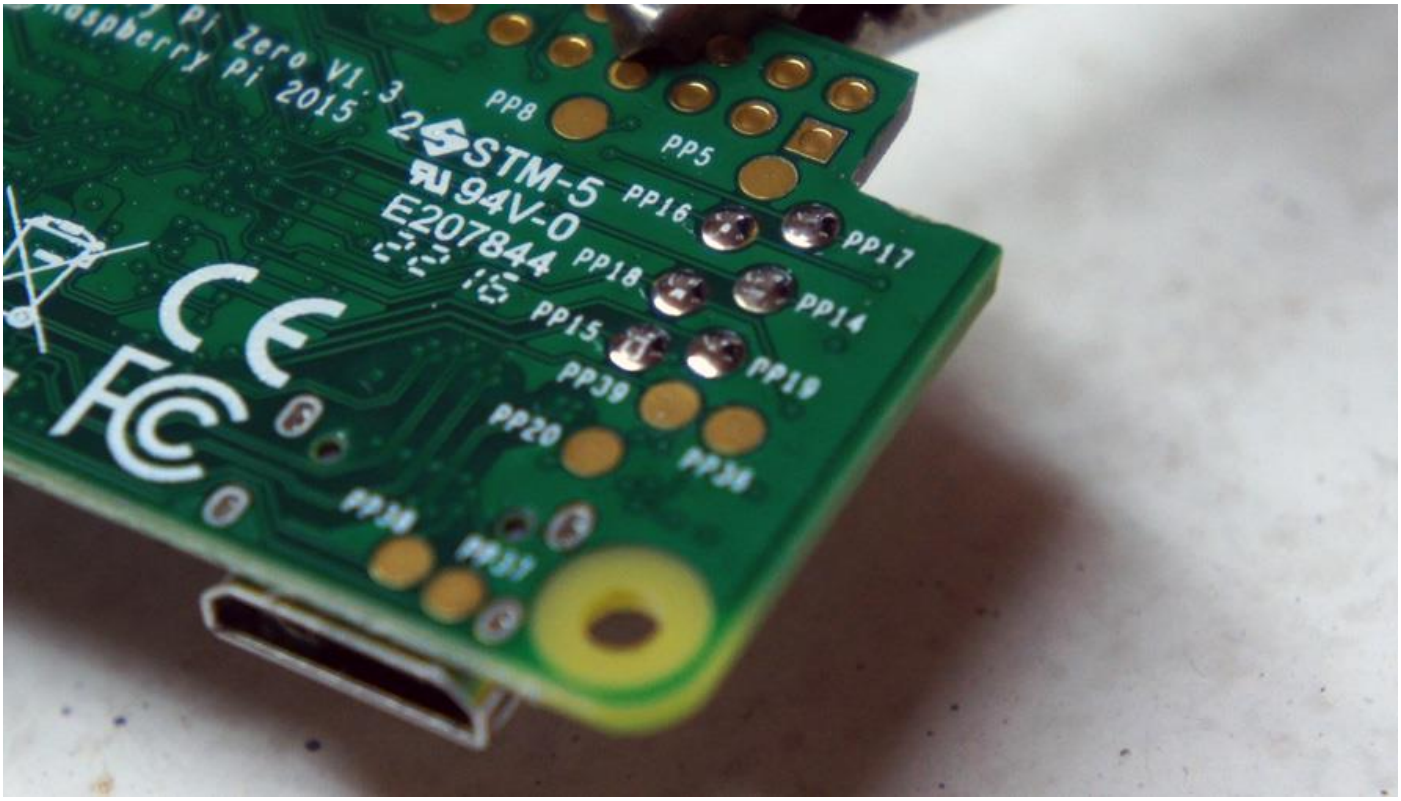


Cut two pieces of kapton tape and apply to the ground pads. See the following image:

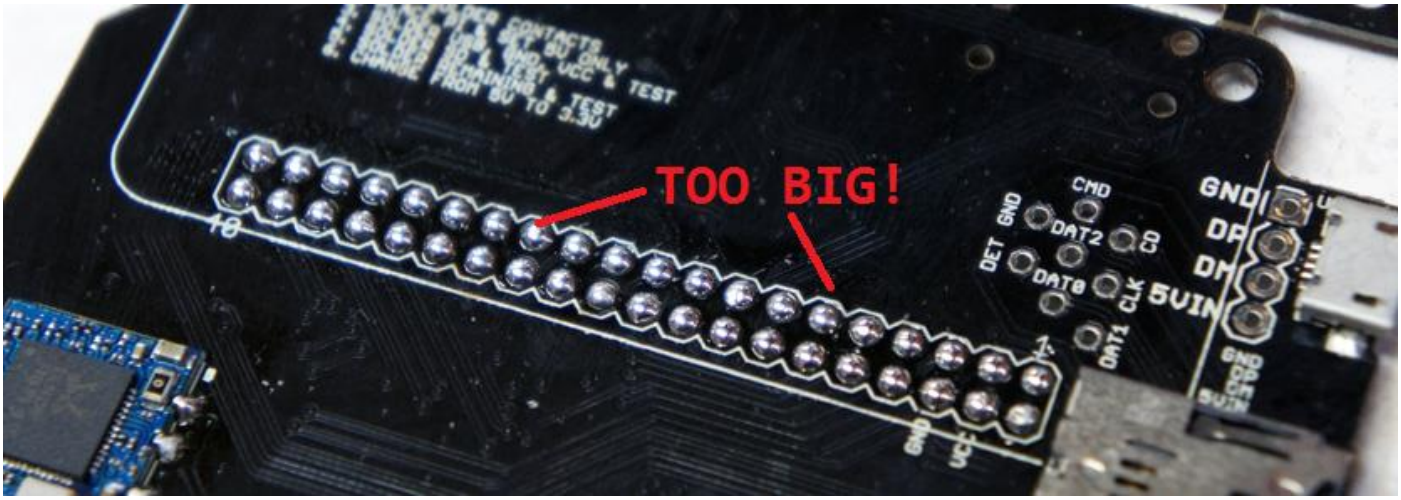


5.5.2 Prepare SD Pads

Apply a nice clean blob of solder to PP14, PP15, PP16, PP17,PP18, PP19 like the following image:



5.5.3 Prepare Main Board Pads



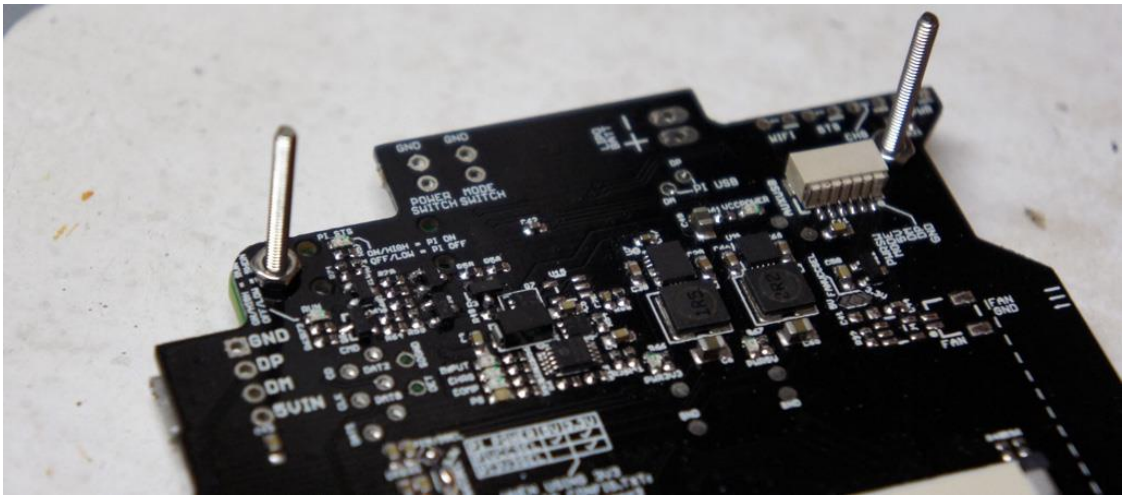
Solder a SMALL amount of solder onto each pad. It should look like the above image. The roundness is important, if your solder is messy it will be because you do not have enough flux in your solder, of you have tried to re-work the pads too much. Make sure that all the blobs are the SAME size. You don't want them too big. THE SMALLER THE BETTER. THE IMAGE ABOVE IS WAY TOO BIG!! YOU REALLY WANT THEM SMALL..

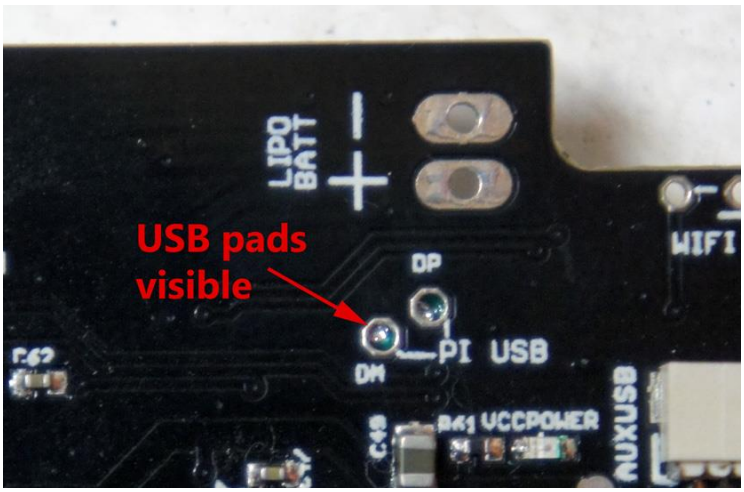
If you mess up, add MORE solder and wipe the excess away with an iron or solder sucker. Then apply FRESH solder.

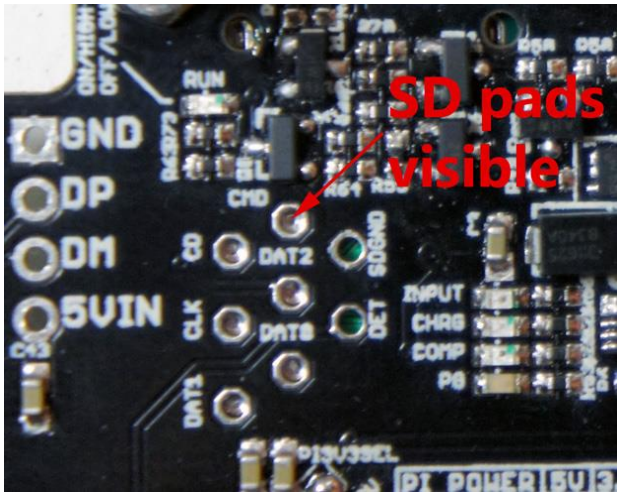
If you have a flux pad/brush, now would be a great time to brush every 'pad' and 'hole' that was soldered in this section.

5.5.4 Align USB, SD, and Power GPIO Pads of Pi

Mount the Pi in place and hold down with 2x M2 nuts and bolts. Take care to align the holes as best as possible. The most important are the USB pad holes as they are the smallest and closest together.





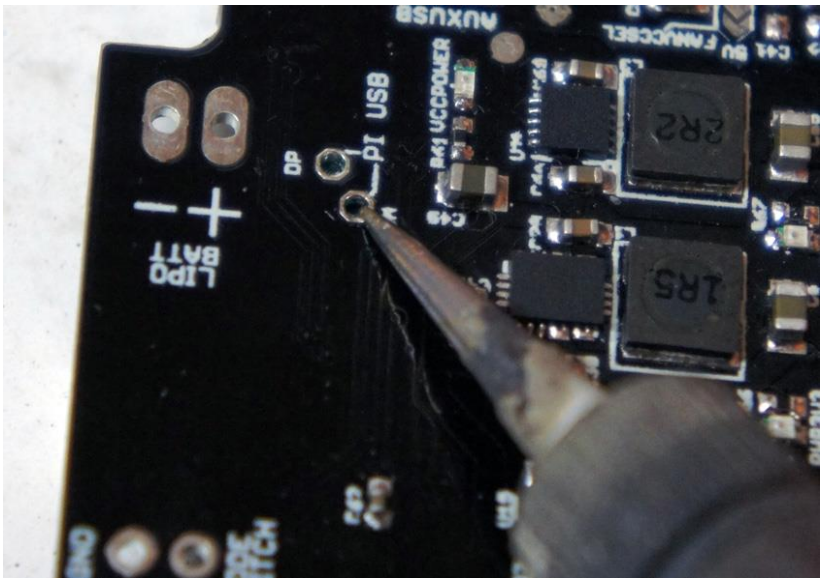


The above two images show how the pads will appear visible when aligned correctly. Note that the 'DET' and 'SDGND' will not be needed (these are for the Pi3 EXT connector).

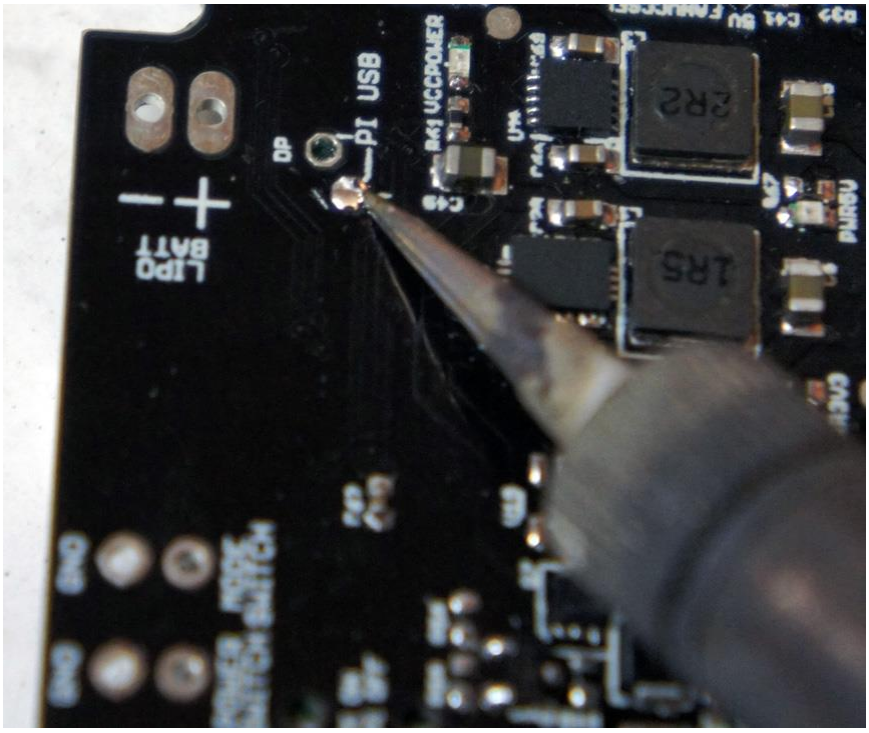
5.5.5 Solder USB and SD Pads of Pi

This step is the most important. It is best to solder the USB, SD and POWER ONLY pins. This way it's possible to test using a HDMI screen to check everything is working before proceeding. It is a LOT easier to fix if the GPIOs haven't been soldered. ONCE SOLDERED, DO NOT ATTEMPT TO REMOVE THE PI FROM THE SAIO. YOU WILL BREAK IT.

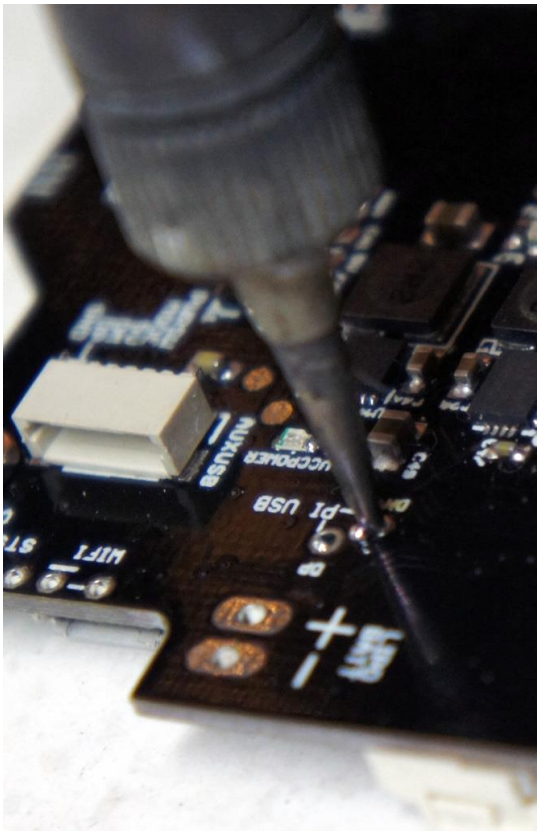
Step 1: Place fine tipped iron on the edge of the hole, touching the edge but over the hole slightly:



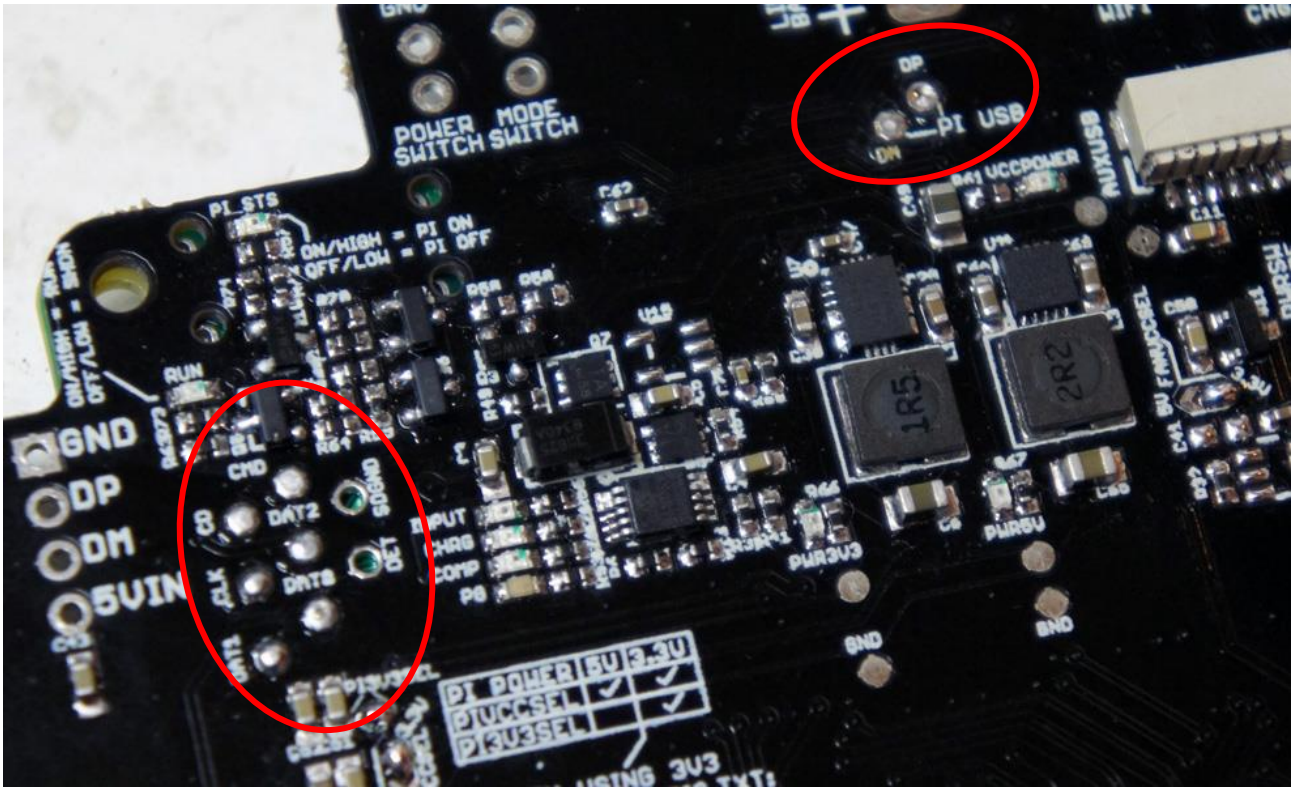
Step 2: Push the solder thread at the hole, not the iron tip. SLOWLY start filling the hole with solder so that it wicks down the sides of the hole to the bottom. Keep filling until a nice dome is present on the top:



Step 3 (OPTIONAL): If the joint has been made successfully, this step may not be required, however it is difficult to tell so perhaps if there are problems come back to this step and try it to see if it solves the problems! Using a fine time, place the iron VERTICALLY over the hole, so that it melts the solder and pushes all the way to the bottom (melting the solder we put there in an earlier step). Remove the iron SLOWLY after a short while, while adding more solder as you remove it. After performing this, do step 2 again to add more solder to give a nice finish.



Step 4: Admire results. The bottom of the board will look as follows:



5.5.6 Solder Power GPIO Pads of Pi

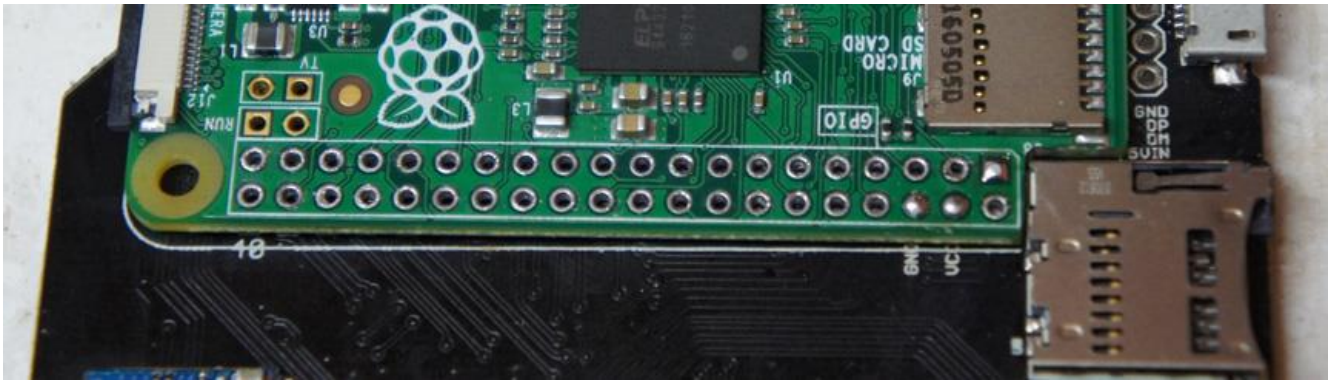
Following the same steps as before, apply the same to the following pads on the top side of the Pi. NOTE that the 'GND' pad (left most pad on the image below) will be the HARDEST to solder. Keep the iron here for longer to make sure it actually melts the solder and makes a good contact. A missing ground connection will prevent the Pi from booting. ALSO when soldering these three pads, make sure to push the board down in the corner because the further the Pi is from the mainboard, the harder it will be to get a good contact.

Step 1: Place fine tipped iron on the edge of the hole, touching the edge but over the hole slightly:

Step 2: Push the solder thread at the hole, not the iron tip. SLOWLY start filling the hole with solder so that it wicks down the sides of the hole to the bottom. Keep filling until a nice dome is present on the top:

Step 3 (OPTIONAL): If the joint has been made successfully, this step may not be required, however it is difficult to tell so perhaps if there are problems come back to this step and try it to see if it solves the problems! Using a fine time, place the iron VERTICALLY over the hole, so that it melts the solder and pushes all the way to the bottom (melting the solder we put there in an earlier step). Remove the iron SLOWLY after a short while, while adding more solder as you remove it.

Step 4: Admire results. The bottom of the board will look like the following image:



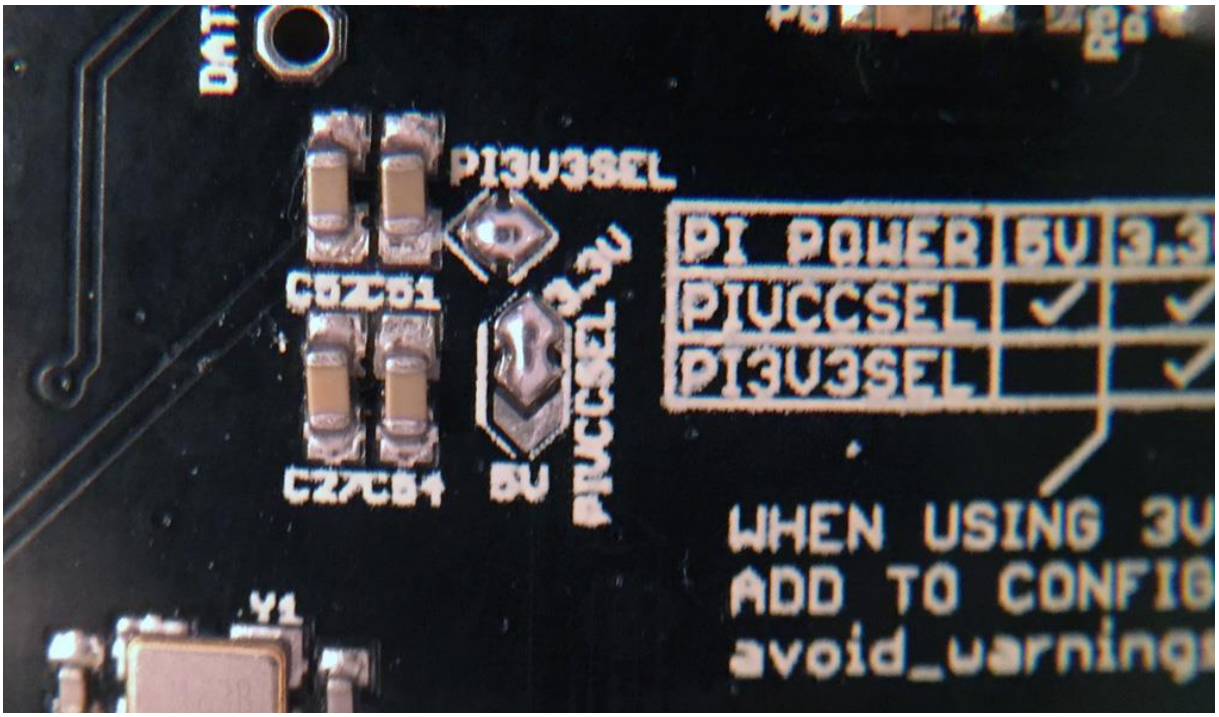
5.6 Test Pi booting/Buttons/Audio/WiFi/etc.

5.6.1 Preparation for Initial Testing

There are two ways to power the Pi, either by 3.3V or 5V. The solder jumper on the bottom of the board allows for each. For 3.3V the two jumpers need to be soldered as pictured below, for 5V the inverse needs soldering (that is the 'PI3V3SEL' should NOT be connected, and the 'PIVCCSEL' should connect the MIDDLE to the BOTTOM pad). ONLY SELECT ONE.

3.3V = Much Better power efficiency.

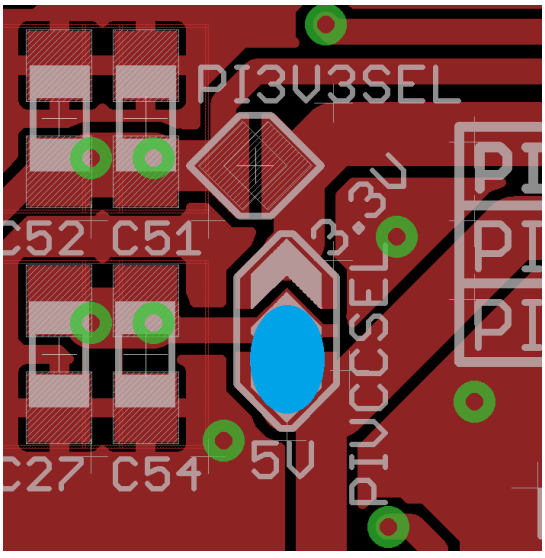
5V = Bad power efficiency.



For the first boot testing it is advisable to select 5V. And once successful change it to 3.3V.

ALTERNATIVLY you can NOT set the jumpers at all, and power the Pi by its own USB power socket.

To solder for 5V, make sure that only the BLUE area is covered in solder to join the pads:

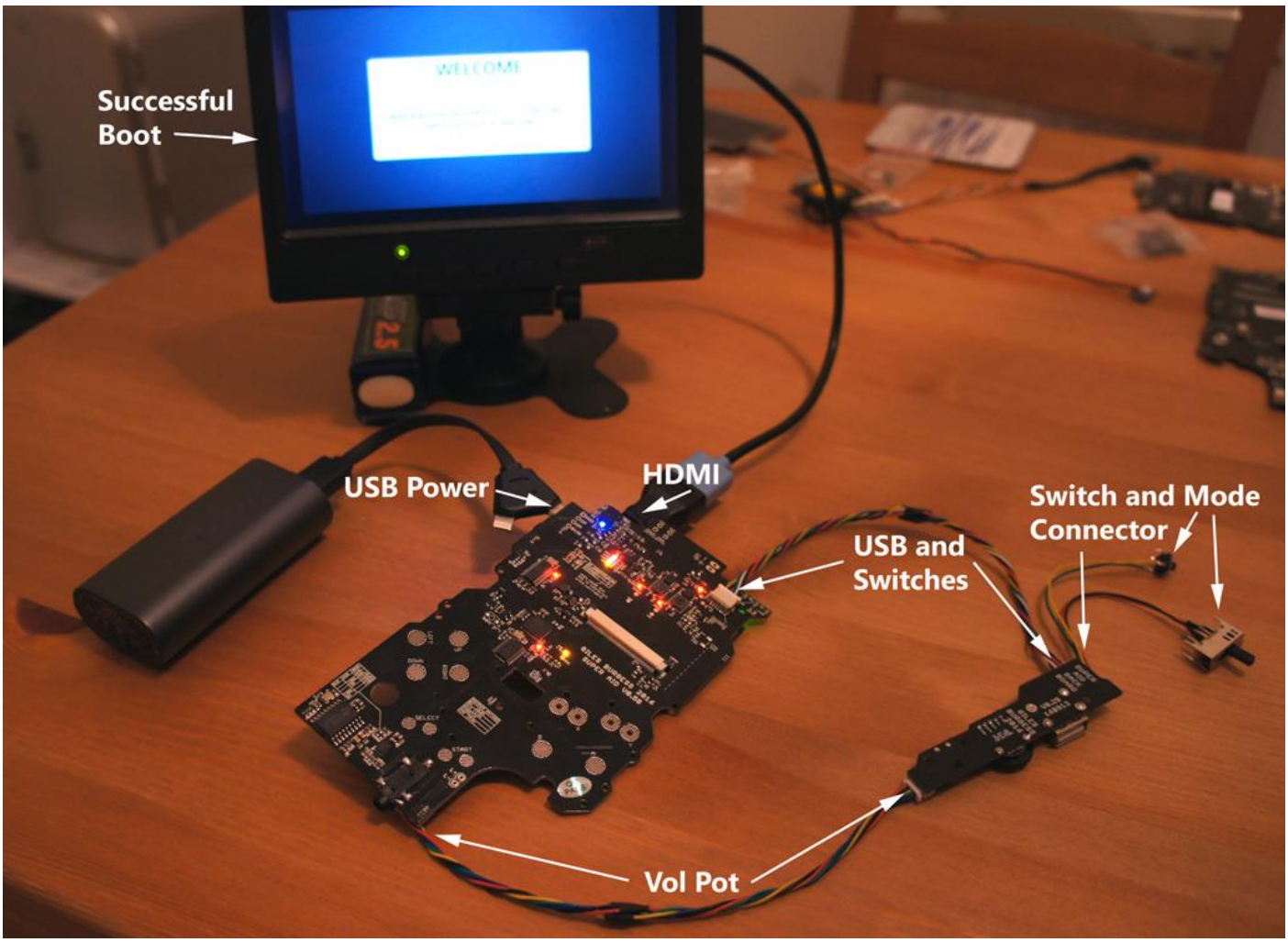


5.6.2 Setup for Initial Testing

All of the basic electronics are done at this point, and in theory everything should work except for the LCD (because we have only soldered 3x of the GPIOs so far). At this point everything should be tested to make sure it all works as expected, and if anything doesn't work then trouble shooting steps are required.

The following image shows everything connected with the exception of the battery and LCD. The micro HDMI port of the Pi is still available so by using an adapter it is possible to test out with HDMI (remember, at this step the built in LCD will not work).

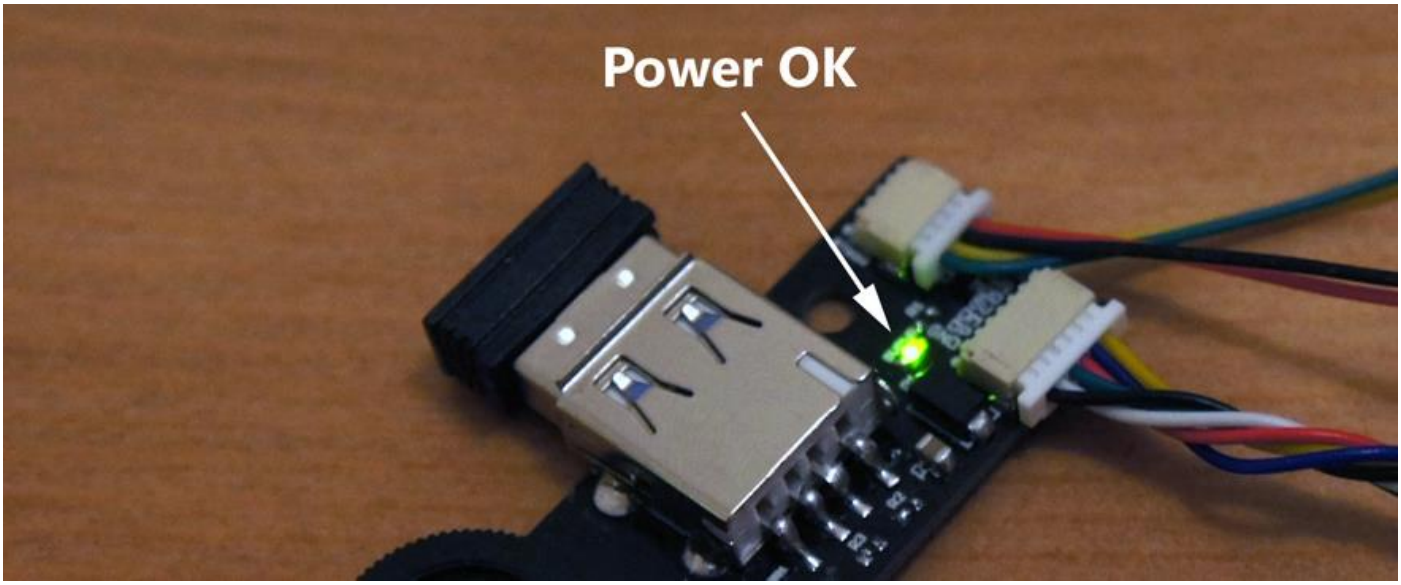
Connect everything up as shown in the image below, and write the STANDARD RETROPIE image to an SD card (https://retropie.org.uk/download/), insert it, apply power, and flip the power switch. Use USB and NOT a battery. You can test a battery if the USB test is successful (any shorts when using a battery could be really bad).



If all goes well, RetroPie will boot up (it may reboot on the first boot after resizing the partition) and eventually you will be presented with the welcome screen (shown below).

The text "1 GAMEPAD DETECTED" indicates that the USB HUB is working as well as the ATMEGA32u4 (with gamepad software loaded).

The Back Board should show a single solid LED (shown below).



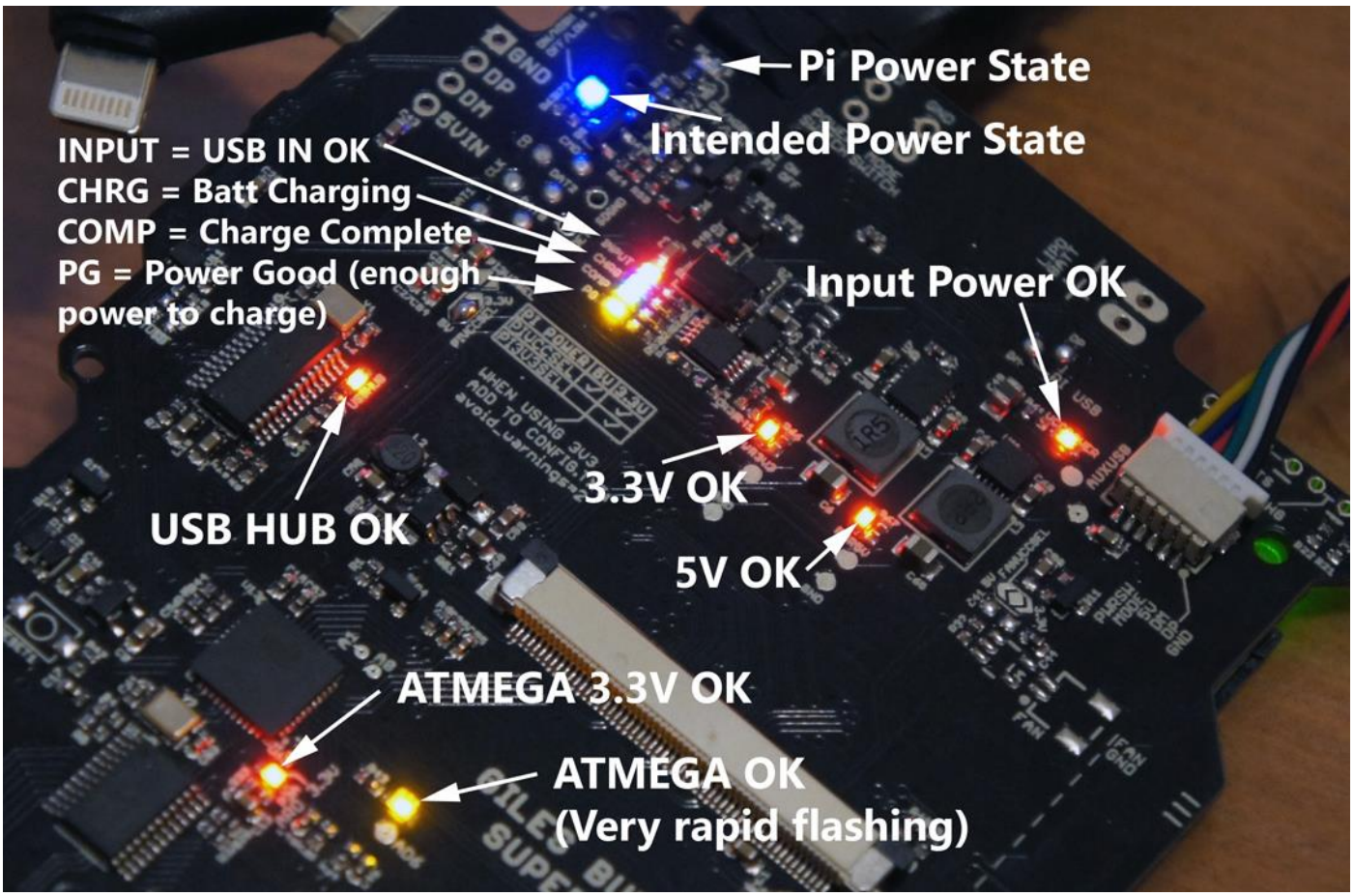
NOTE: At this point, safe shutdown isn't enabled, and sliding the power switch will instantly power off the Pi and board.

NOTE: At this point, USB Audio isn't configured either. Instructions can be found at the end of this guide.

5.6.3 Troubleshooting First Default Boot

If the first boot doesn't work, this section will help you identify where the problem is and how to solve it.

Firstly, the following image shows the main LEDs visible on the back side of the board:



LED Name	Expected State
"VCC" (Input Power OK)	- ON when SWITCH = ON
"PWR3V3" (3.3V OK)	- ON when SWITCH = ON
"PWR5V" (5V OK)	- ON when SWITCH = ON
"ARD 3.3V" (ATMEGA 3.3V OK)	- ON when SWITCH = ON - ON when USB plugged in (SWITH = ON/OFF)
"ST1" (ATMEGA OK)	- VERY rapid blinking = GAMEPAD OK - INTERMITTENT blinking (brighter) = MODE mode or USB not working (could be a sign of it)
"INPUT" (Input Power)	- ON when USB plugged in
"CHRG" (Charging)	- ON when battery charging - FLICKERING when no battery present
"COMP" (Charge Complete)	- ON when battery charged - FLICKERING when no battery present
"PG" (Power Good)	- ON when USB power is good (>4V?) - OFF when USB power is bad (<4V?)
"USB HUB" (USB HUB OK)	- ON when USB hub connected to Pi successfully
"PI_STS" (Pi Power State)	- ON when Pi has booted (only when configured in /boot/config.txt) - OFF when Pi has shut down (or safe shutdown not configured)
"RUN" (Intended Power State)	- ON when main power switch is ON - OFF when main power switch is OFF (which can be read by the Pi to trigger a safe shutdown)

5.6.3.1 No Board Power

The power system follows the path:

INPUT -> VCC (input power) -> 3.3V/5V

Check which LEDs light up. No power is nearly always a short somewhere, and most likely in a place recently soldered, so backtrack from there. Use a multimeter to measure voltages and continuity to ground.

5.6.3.2 Pi does not boot

Not booting could be a few things:

Is the Pi getting power? – Use a voltmeter to check if the pins soldered contain 5V or 3.3V. If those voltages aren't present then you perhaps have a power issue or a soldering issue (attempt to re-solder those connectors with fresh solder).

Is the GROUND pin connected? – Using a multimeter in 'continuity' mode, place one end on the Pi's USB connector and the other one the main board USB connector (both the metal outside of it). This should beep or read 0ohms. If it has no connection, the USB pin is not soldered. Use more heat and more solder to re-do the solder connectors.

Does the green status LED on the Pi Zero itself flash on/off? – This LED is the SD activity light.

So there is power and continuity, but no boot! – Then it is most likely the SD card pins. Re-solder these. If you are able to slide the SD into the original SD slot then try this (if it won't go in because of the USB port, don't force it as you'll break the SD card, you could use a flexible micro SD extender).

5.6.3.3 Gamepad not detected

Is the "USBHUB" LED ON? – If it is NOT then the problem is those USB solder pads, try again! If you didn't use kapton tape or cut the pad smaller like it was noted in a previous step, then it is most likely a short! Check continuity.

If the "USBHUB" LED is ON, then the Pi to USB HUB is all ok! It is most likely that the firmware has been modified or not loaded on the ATMEGA32u4 (Arduino). It will come shipped with a working firmware so it is not necessary to make any changes.

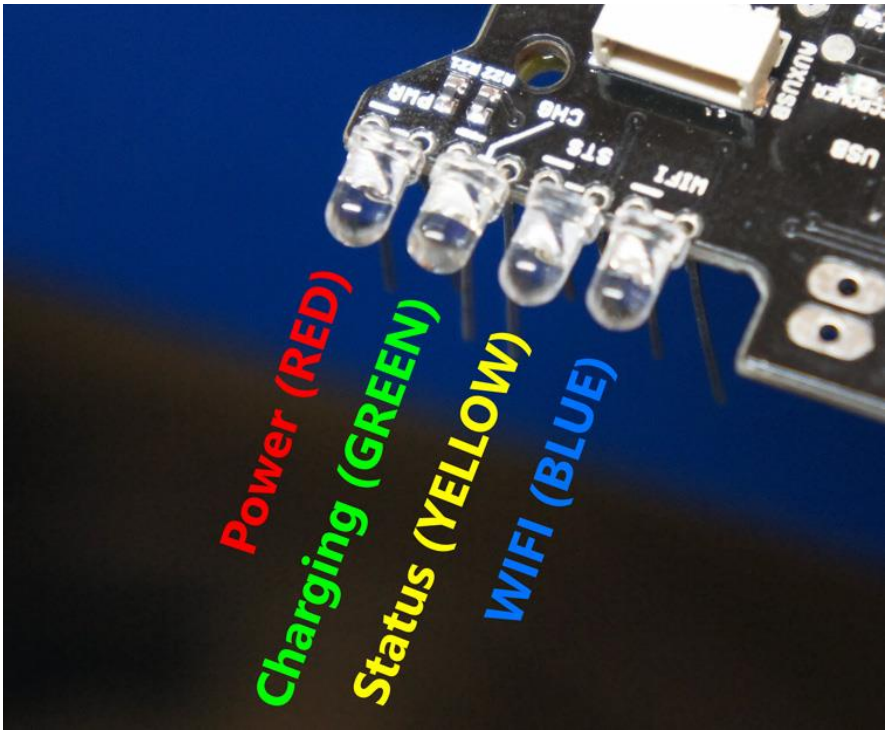
I broke my USB solder pads, is there any hope!? – Yes there is! There is a connector called 'PIUSB' which is a 4pin 1.00mm connector, it is the same as the USB solder pads. It is possible to use a 4pin connector here and solder a micro USB the other end and plug it into the Pi's USB port. This is actually required when doing a Pi3 build!

5.6.3.4 External USB not working

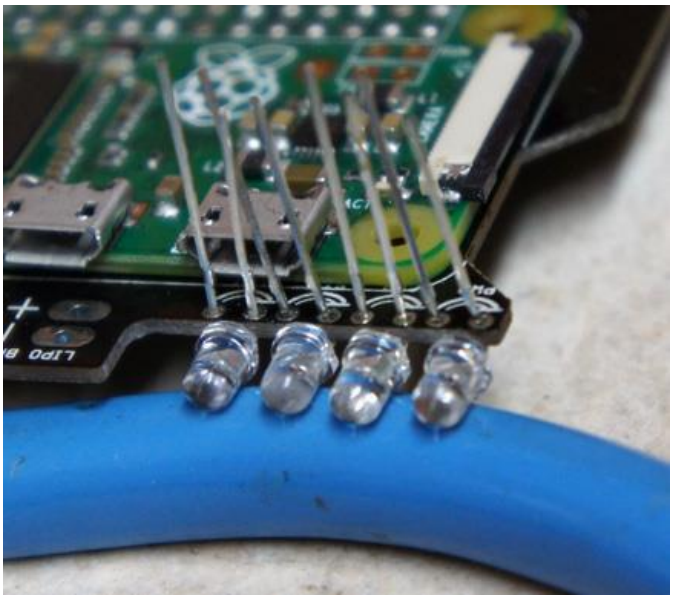
First, check that the ATMEGA32u4 is working and that the "USBHUB" LED is ON. If those are ok but still no external USB, then it is most likely a shorted connection on the USB port that you soldered earlier (check continuity on the middle two pins) OR you may have mounted the USB port the wrong way up! You will need a hot air reflow station (~$40) to remove an already soldered USB connector.

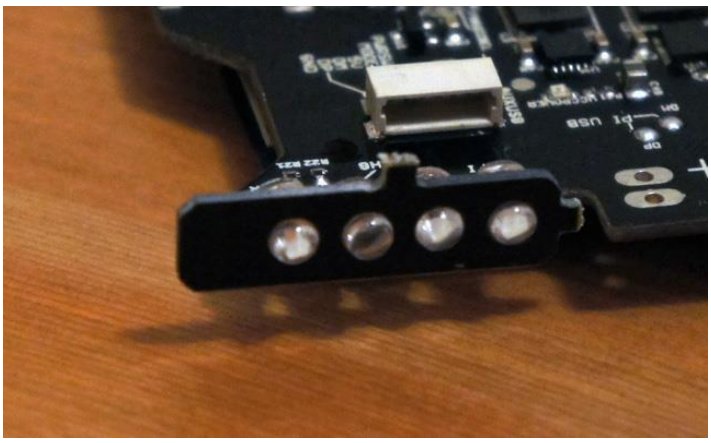
5.7 Solder Status LEDs

In order to easily add status LEDs we can drill holes in the side of the case and then fill them with glue. By putting an LED pointing at these glued holes, light will shine through in just the right place! Adding the LEDs requires bending the LEDs at 90degrees at their base and soldering on, taking extra care of polarity.



Using a multimeter in 'diode' mode, you can test the colour and polarity of the included LEDs.

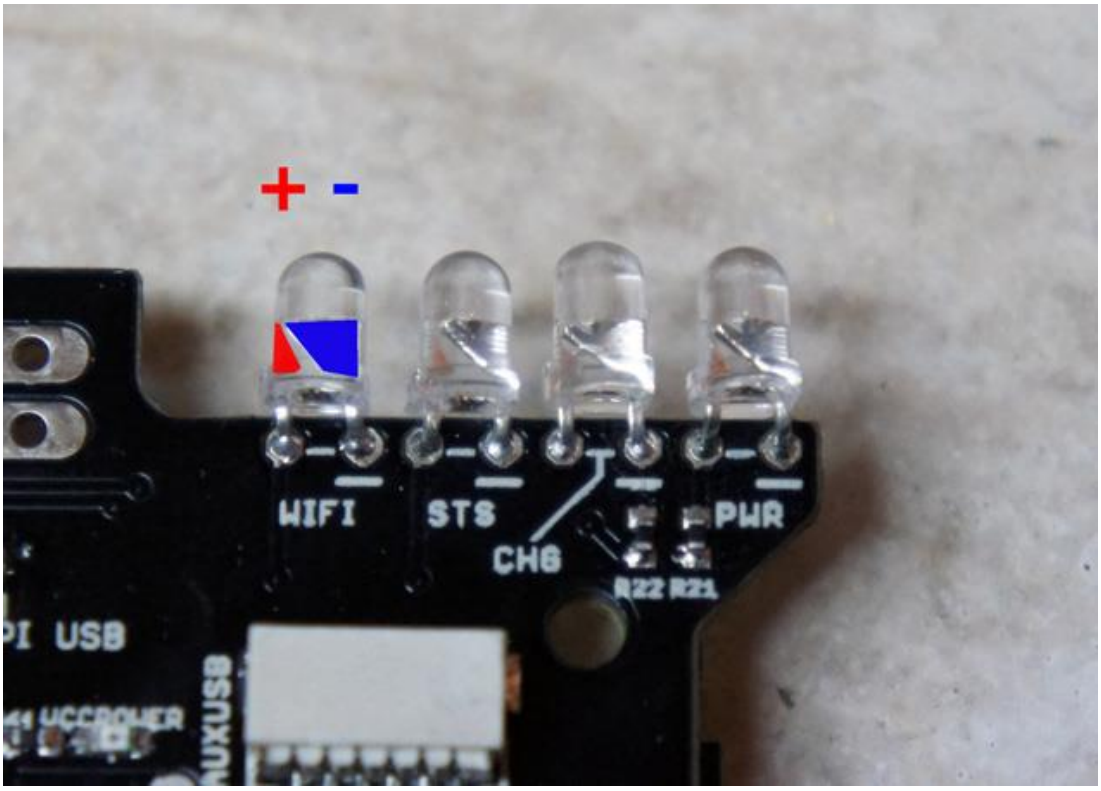




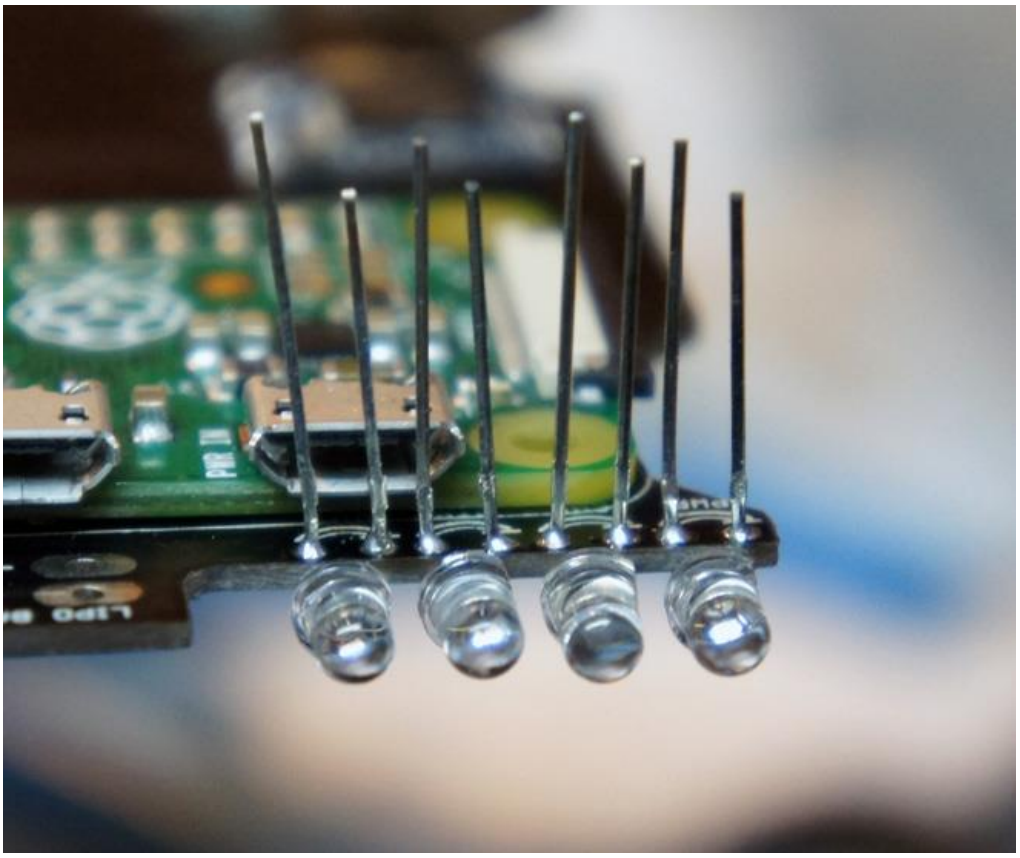
The images above show a recommended way of placing and holding the LEDs. Make to bend as close as possible to the LED base while still allowing for the LED to be parallel to the board. The legs of the LED are protruding on the side that the Pi is mounted on. It is possible to test fit the board in this state before soldering to test for fit. The entire board must slide into the case.

NOTE that the LEDs are best soldered from the side with the Pi, so inserting them from the back side (as pictured).

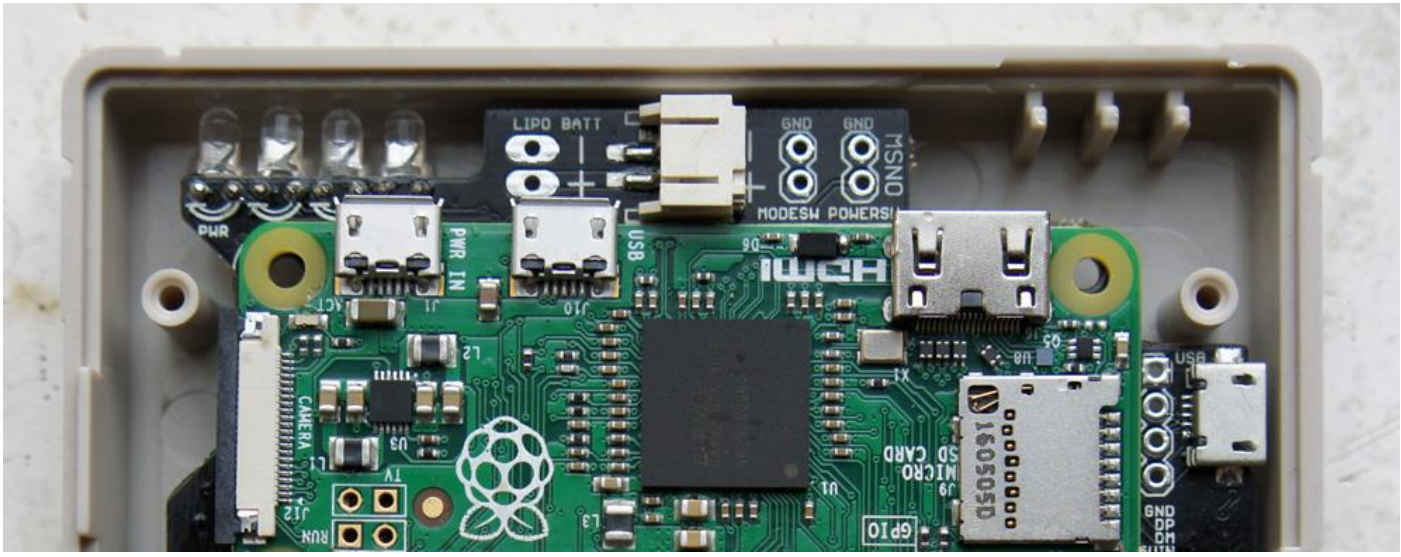
See the following images pinout:



The above image shows the LED pinout. The internal of an LED has a large silver plate and a thin plate. The large one is NEGATIVE (ground), and the smaller one is POSITIVE. The main board has a notation of a white line (---) which indicates the ground side (or consult images above).



Once soldered, trim the legs as low down as possible.



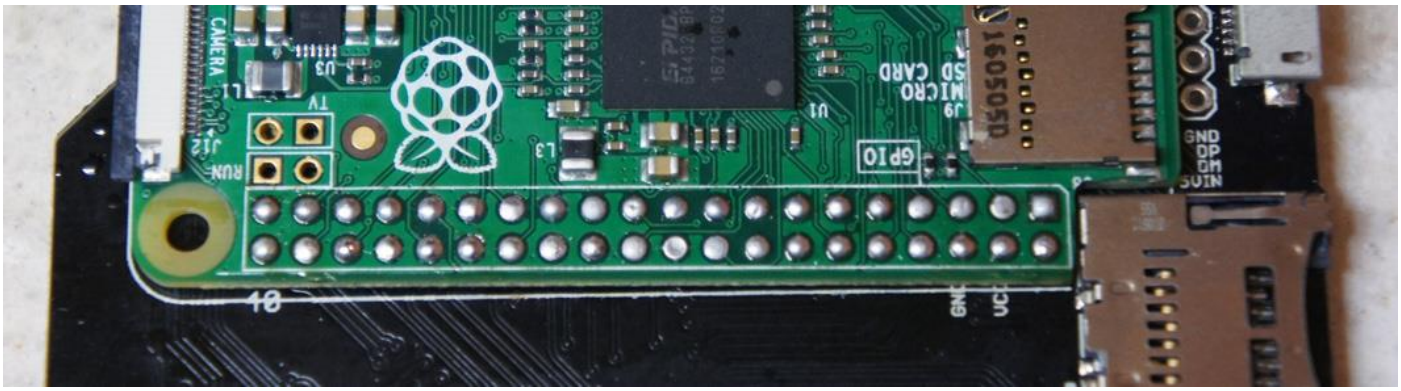
The entire board should slide effortlessly into an unmodified case. The above image shows how the LEDs line up to the top of the case and they fit in nicely without needing to be bent.

Re-test board, the LEDs should do the following:

LED Name	Expected State
POWER	ON when power switch is ON
CHARGING	ON when charging FLICKERING when no battery
STATUS	VERY rapid flashing when operating (ATMEGA32u4)
WIFI	ON when Wi-Fi enabled OFF when Wi-Fi disabled

5.8 Solder Remaining GPIO Pins

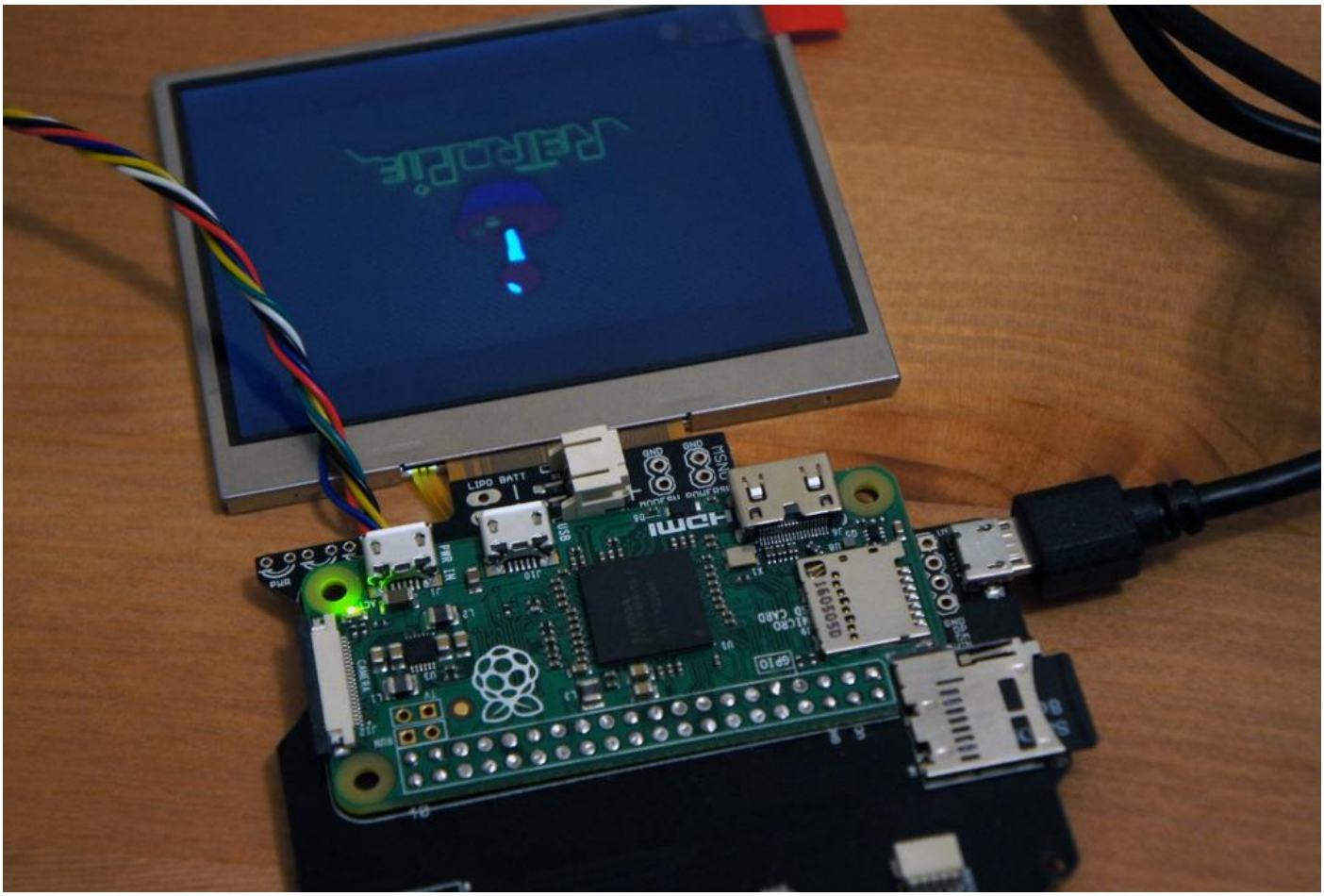
5.8.1 Solder the Connectors



With the same technique earlier in the guide, solder the remaining pins. Use lots of flux and do each one slowly and carefully. Start from the RIGHT side and work your way left. If you have a hot air reflow station (or hot air gun) you might find it easier to 'pre-heat' the boards slightly. Any way to increase the temperature of the boards while soldering will help.

Then if you haven't done so already, then solder the 3.3V jumpers (much better power efficiency).

5.8.2 Test the LCD

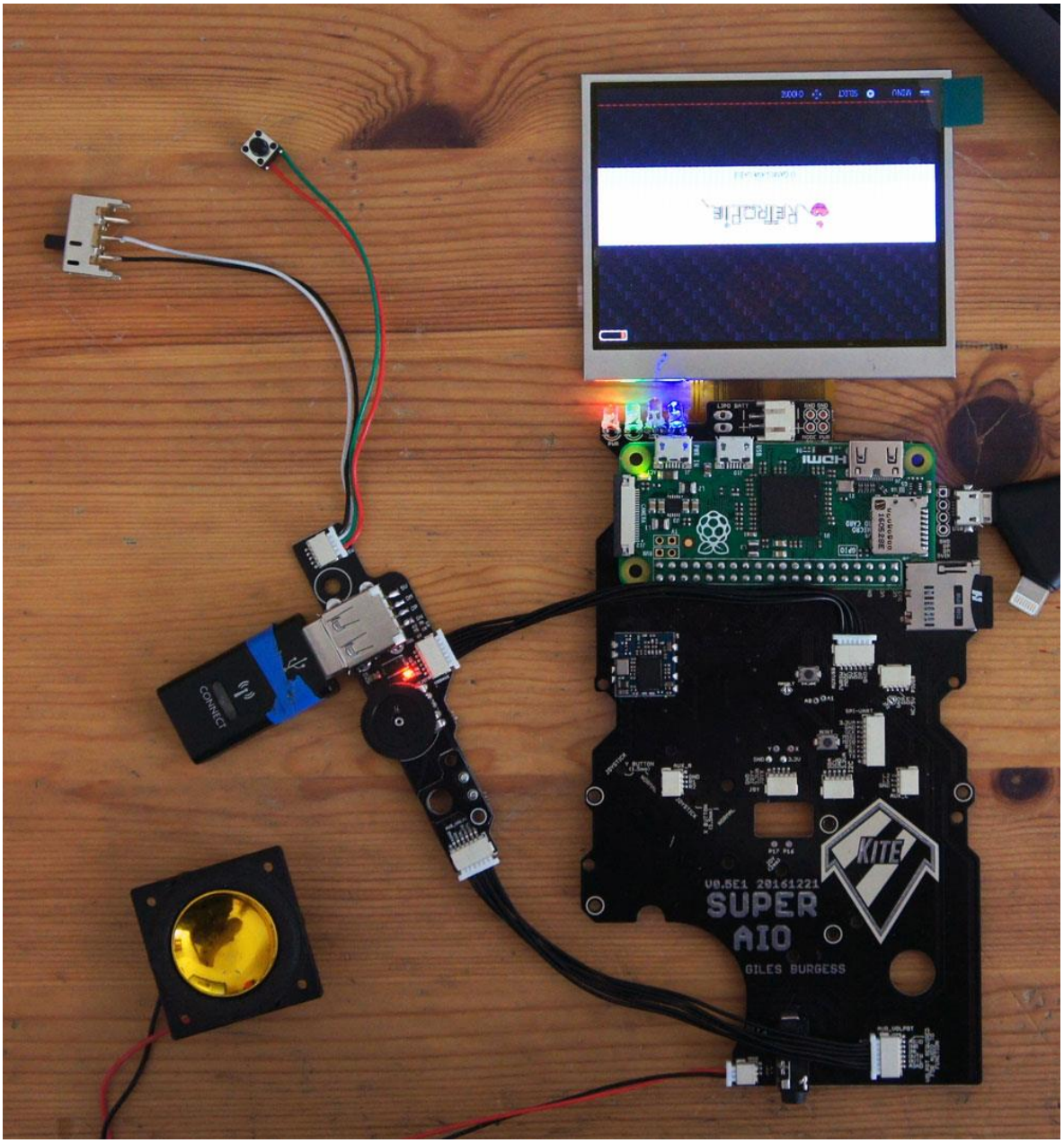


Flash the modified RetroPie TEST image (See section 12.1 Pre-made Image (pg. 91)). The test image should boot up and list a status for the USB devices, and then show a test image for the LCD.

Be very careful with the LCD ribbon connector, it is very delicate. Do not bend or tear sideways.

Once flashed, connect LCD and all cables as done earlier and power on. You should see an image as shown above.

The image on the following page shows everything wired up in order to test. The USB dongle is for a wireless keyboard.



5.8.3 LCD Troubleshooting

The LCD shows a white screen only – Either the wrong RetroPie image was used or there are some GPIOs soldered badly. See any of the 'Pi does not boot' troubleshooting from earlier in the guide. If the Pi Status LED (seen above on the top left) is not flashing, then the Pi is not booting. If it is flashing and the screen is white then either the LCD is not configured in the config.txt, or there is a bad connection. Re-solder pads and flash a fresh image of the MODIFIED RetroPie.

The LCD works but the colours are a bit weird or one type of colour isn't right – Bad soldering or the LCD isn't seated in its connector properly. Re-solder the pads with some fresh solder and make sure there aren't any shorts or blobs of solder where they shouldn't be. Check LCD ribbon for rips.

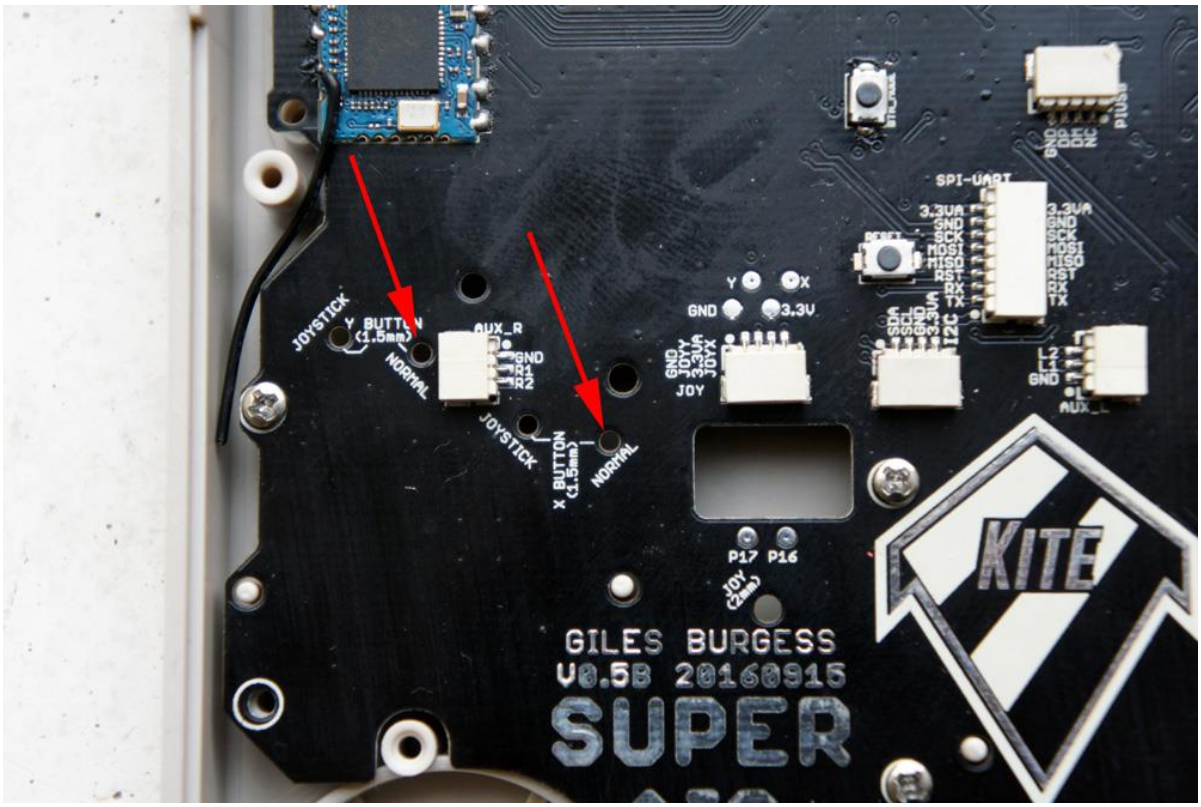
6 Phase 2 – Prepare front half of case

6.1 Drill Button Holes

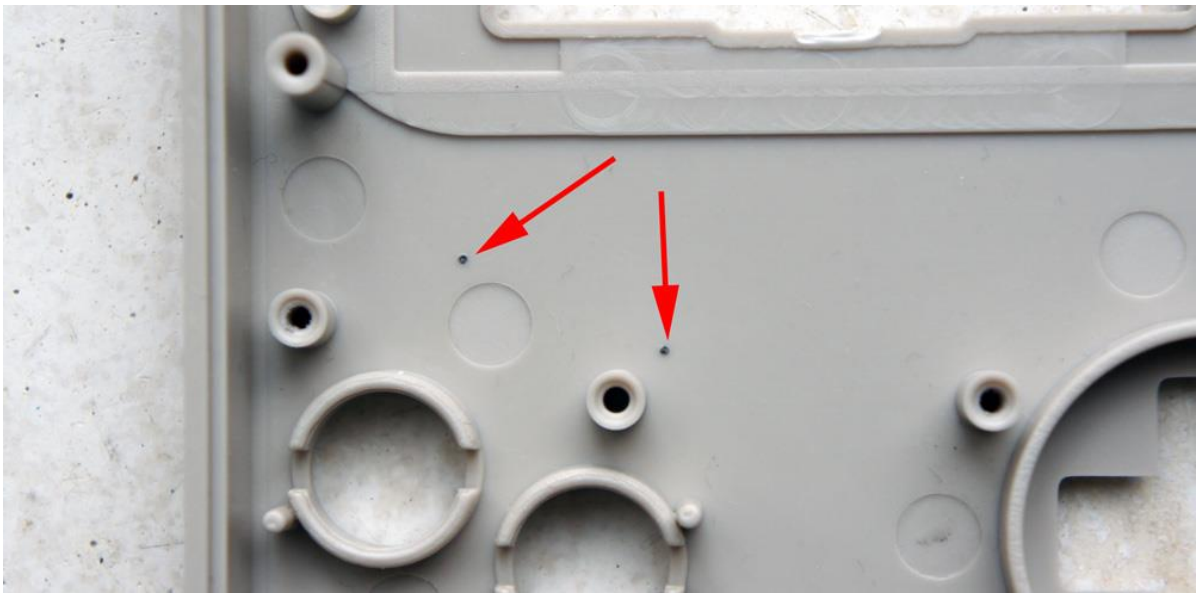
6.1.1 Prepare Drill Holes

Fit the main board and add a few screws to hold it in place. There are a number of template holes, it is advisable to pick the 'normal' holes (labelled "NORMAL") which will give a SNES style layout. The "JOYSTICK" layout will have the buttons vertically aligned with each other, and is required if using a 3DS joystick.

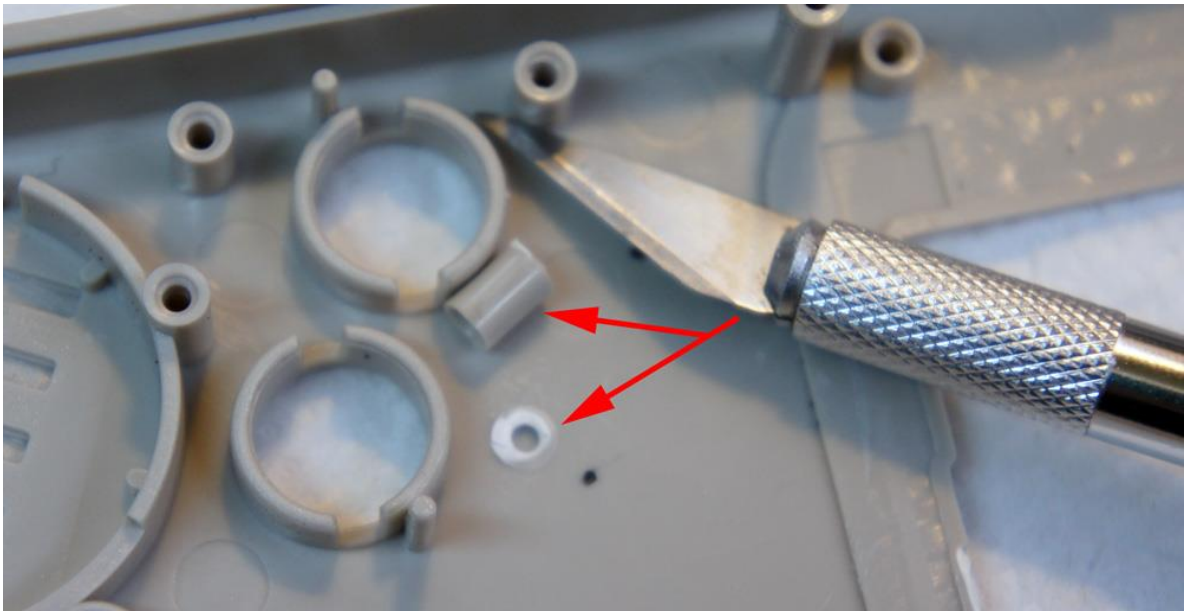
Using a needle or 1/1.5mm drill bit, put through the hole vertically and push slightly into the plastic to leave a dent.



Remove the main board and mark the dents made with pen/marker to highlight where to drill.



Next, cut the single post that is in the way. Using a sharp blade and slowly cutting around it is the best way, a rotary cutting tool tends to melt everything so avoid where possible.

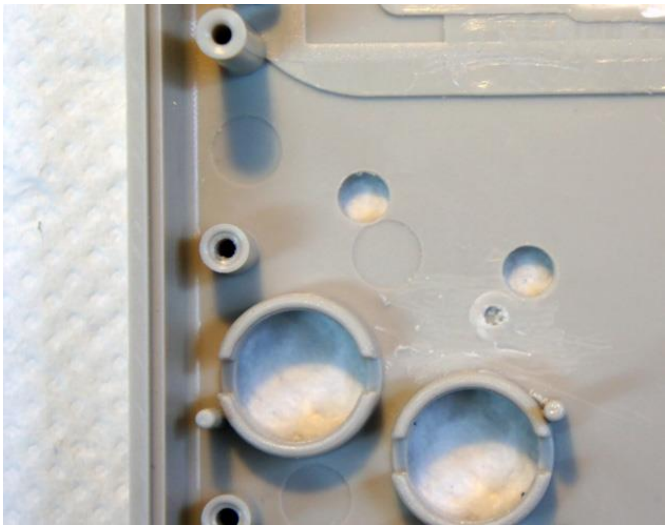


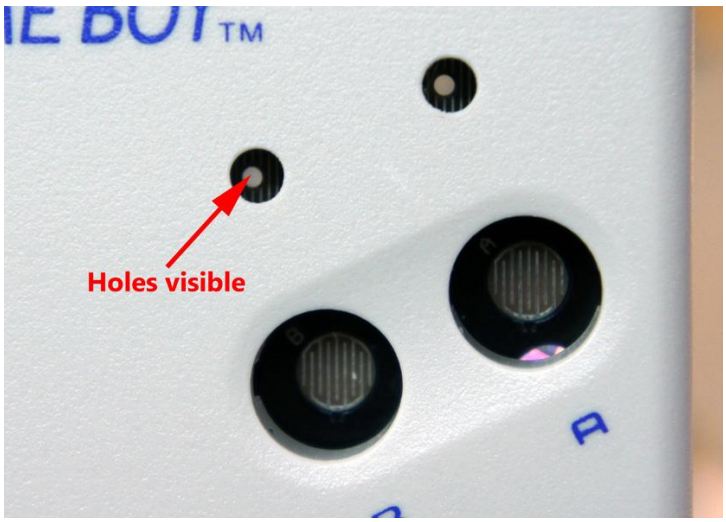
Using the blade or sand paper, flatten the remaining mount so that it is flat and smooth.

6.1.2 Drill Pilot Hole

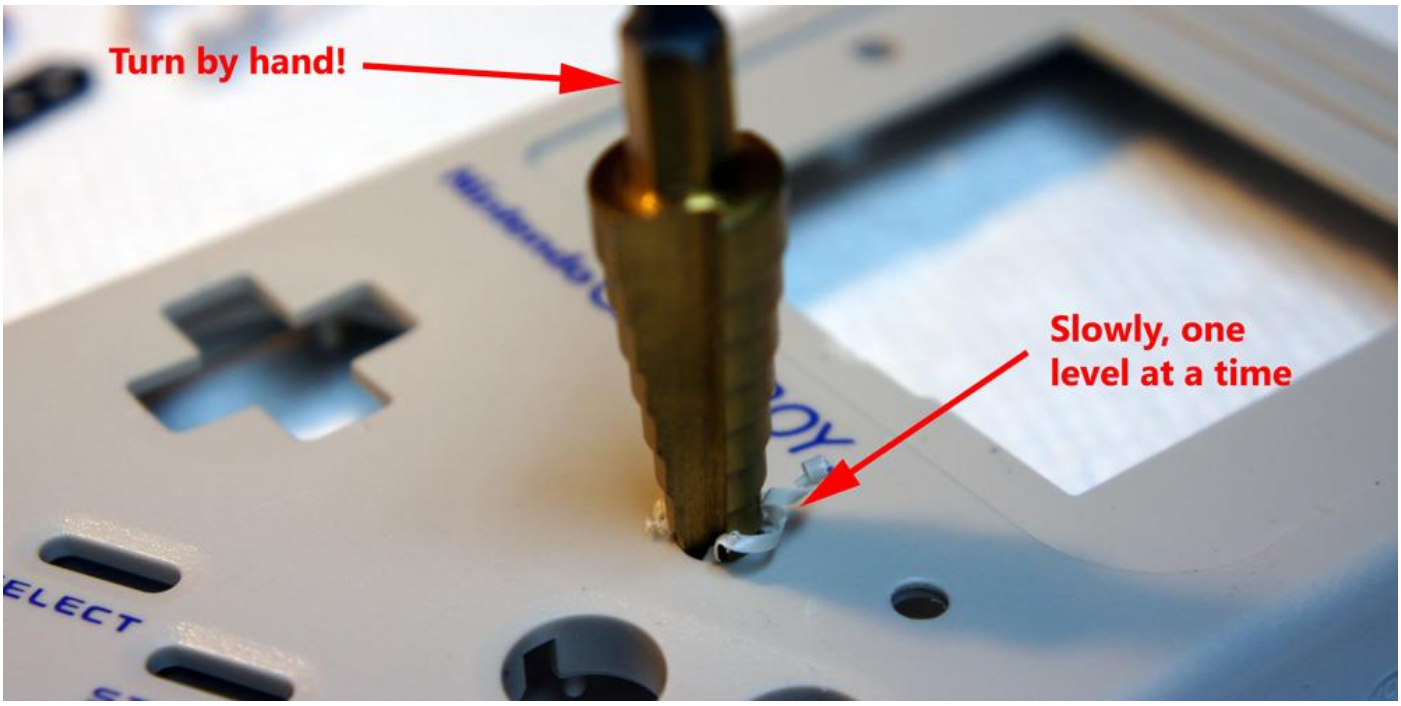
It is a good idea to use a "center punch" (or a sharpish needle or smaller drill bit) to make an indent where the hole is. This will keep the drill bit in the right place when starting the hole.

Using a 3 or 4mm drill bit, carefully drill the marked hole. It should now line up with the main board template holes.





6.1.3 Enlarge Hole

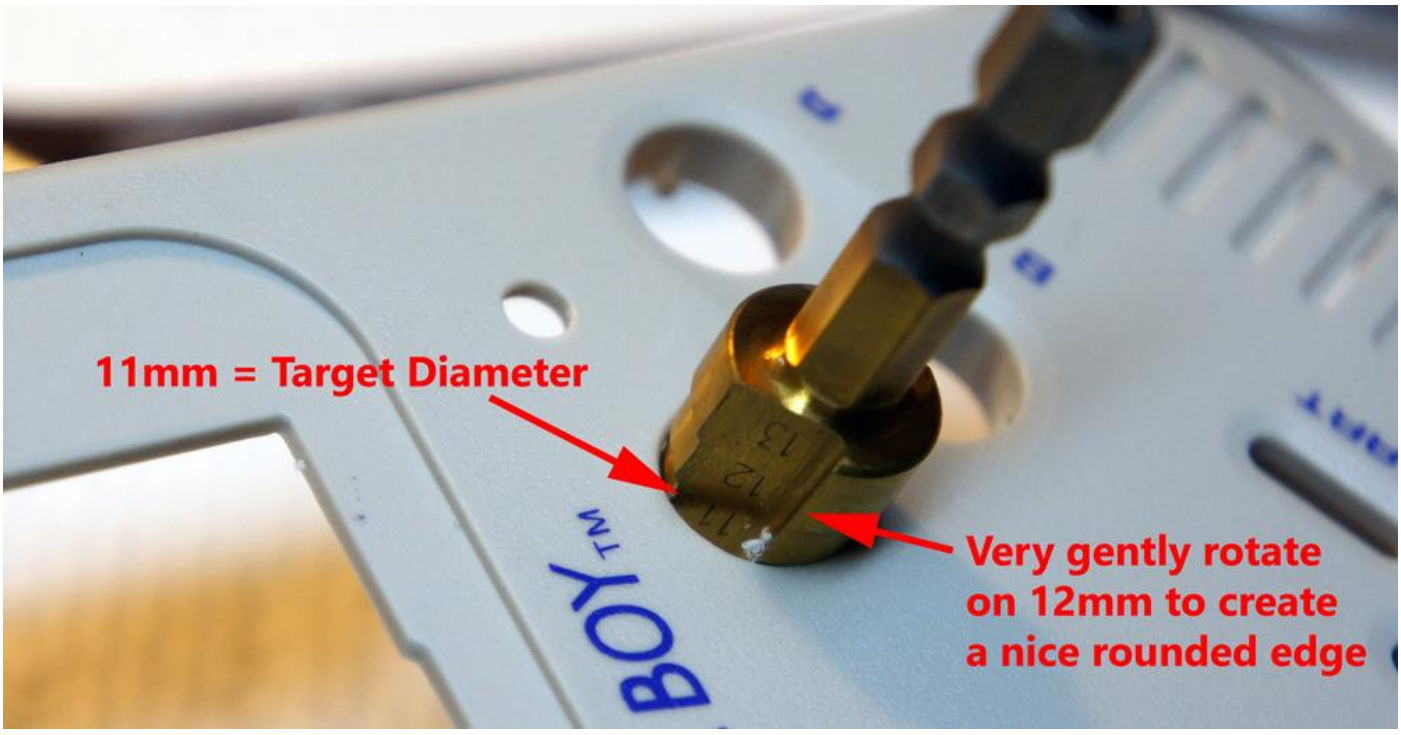


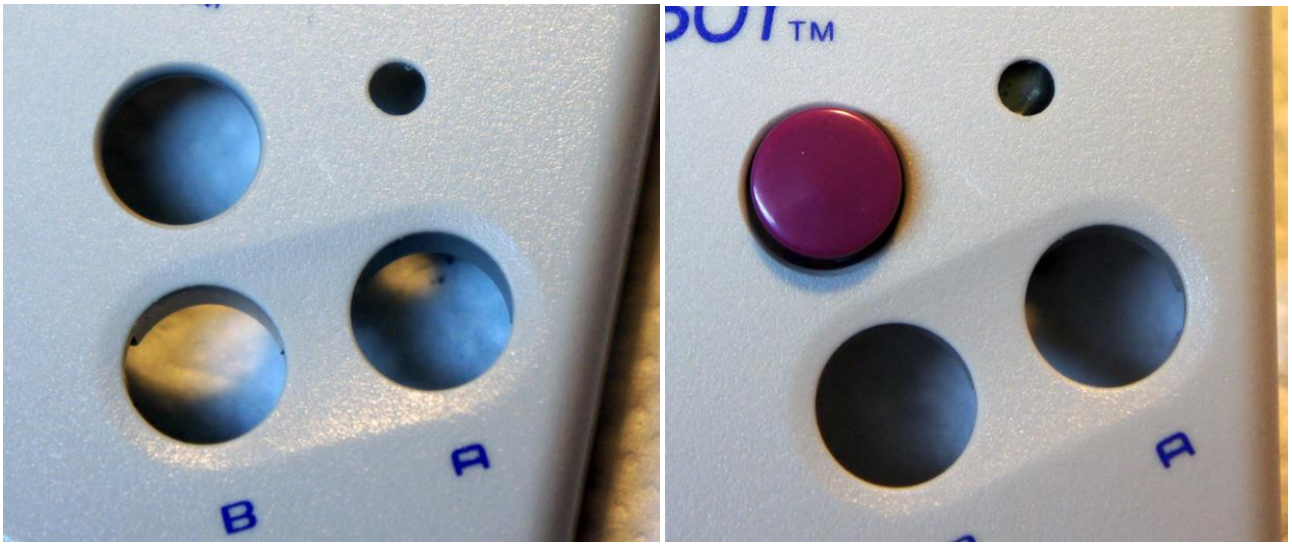
Using a step drill bit that goes to 11mm, place it into the hole and start turning. It is possible to do this by hand (or with a pair of pliers on the shaft, or a multitool adapter, or an adjustable spanner) and is not recommended to use a drill for this.

Rotate until you get to the 11mm mark. Technically 10.8mm would be a better size, but they don't exist!

6.1.4 Sand and Deburr

By very carefully rotating the step bit so that the 12mm section creates a small countersink on the surface, a nice edge can be achieved this way. It shouldn't be necessary to use sandpaper or a file, but if there are any bad bits use your tools to neaten up.





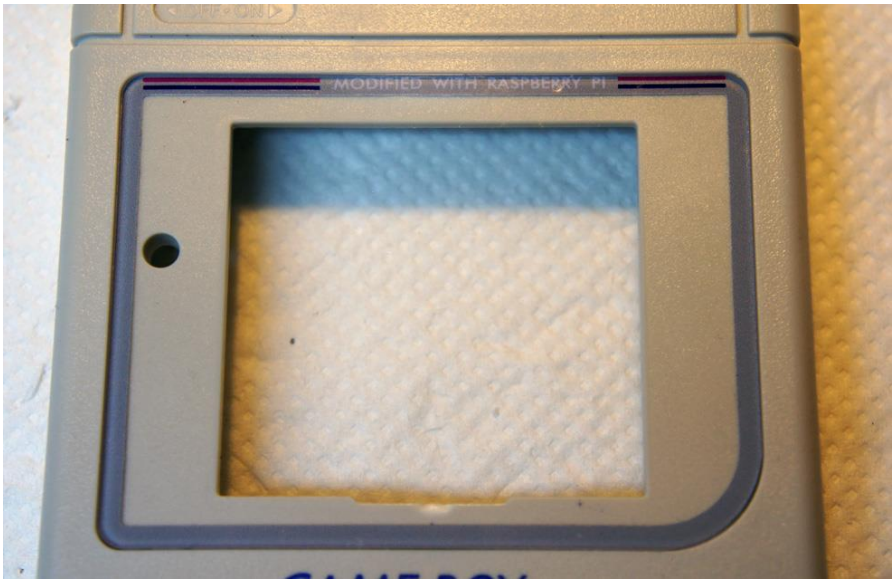
The images above show a finished button hole and test fitting with a button.

6.1.5 Make the Second Hole

Repeat the same steps to create the second button hole. The end result should look like the image below:

6.2 Cut Out Screen Area

During this step the excess plastic on the inside of the screen will be trimmed. A small lip around the edge of 2mm is required to make the screen fit perfectly. The goal is to do it without being able to see this lip from the outside.

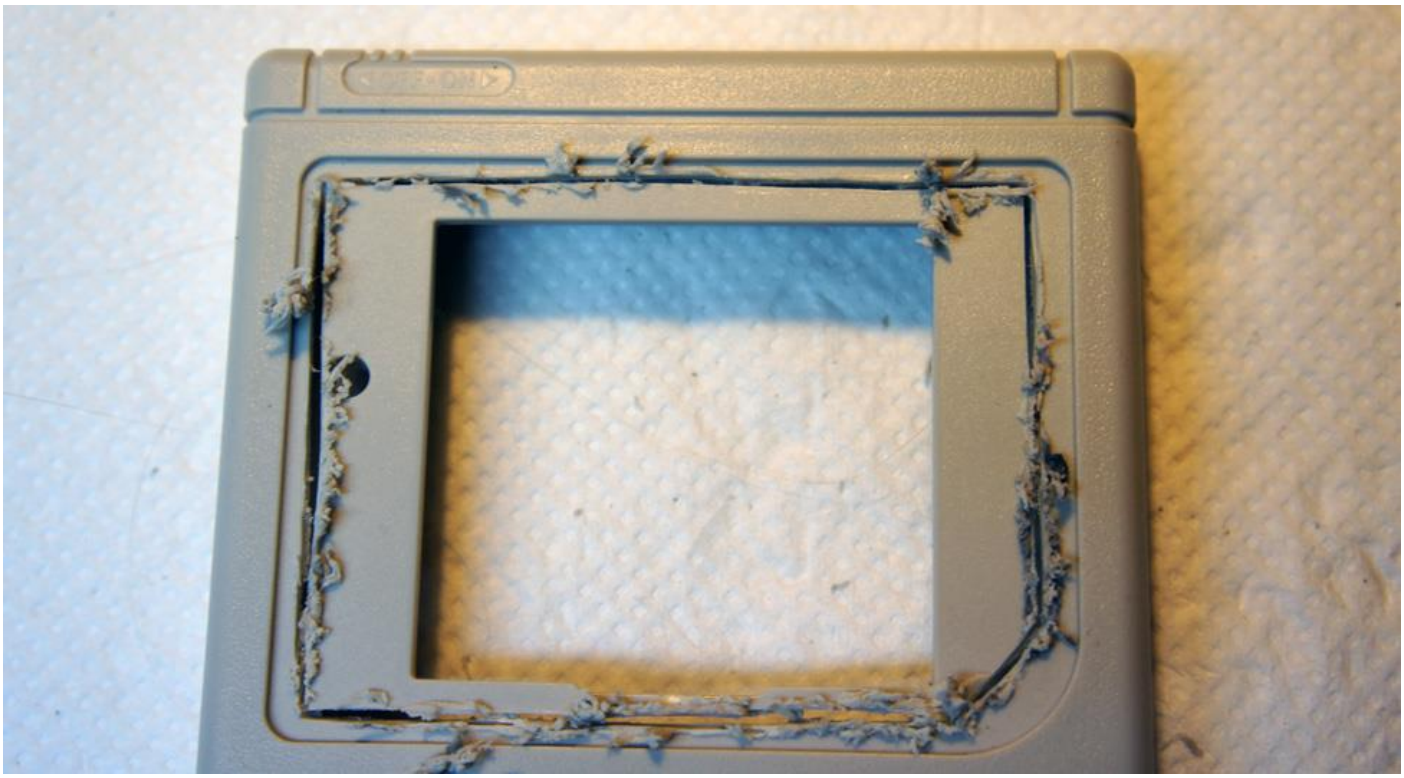


6.2.1 Cut Posts as Low as Possible

There are 4 large screw posts on the inside of case that are used to hold the two halves of the case together. These MUST BE KEPT FOR A LATER STEP, and they need to be AS LONG AS POSSIBLE. Cut them off at the base as low as possible.

6.2.2 Cut out Approx. Screen Area

Using a rotary cutting tool, cut out the approx. area of the screen, leaving about 5mm on all sides. Do not try and cut right to the edge using the rotary cutting tool, they tend to melt everything. It will be trimmed down later on.

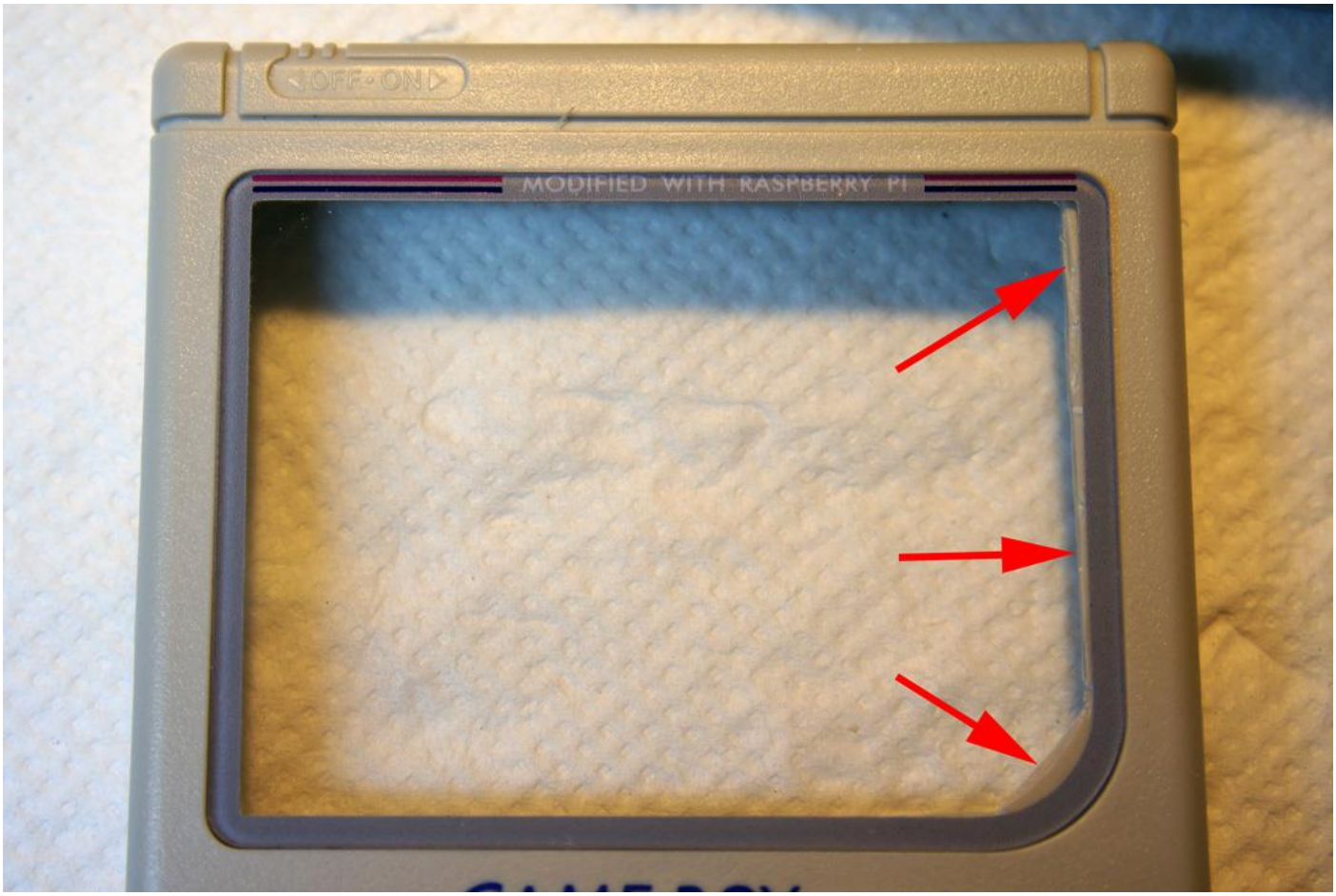


After removing the melted bits it should look like the image above.

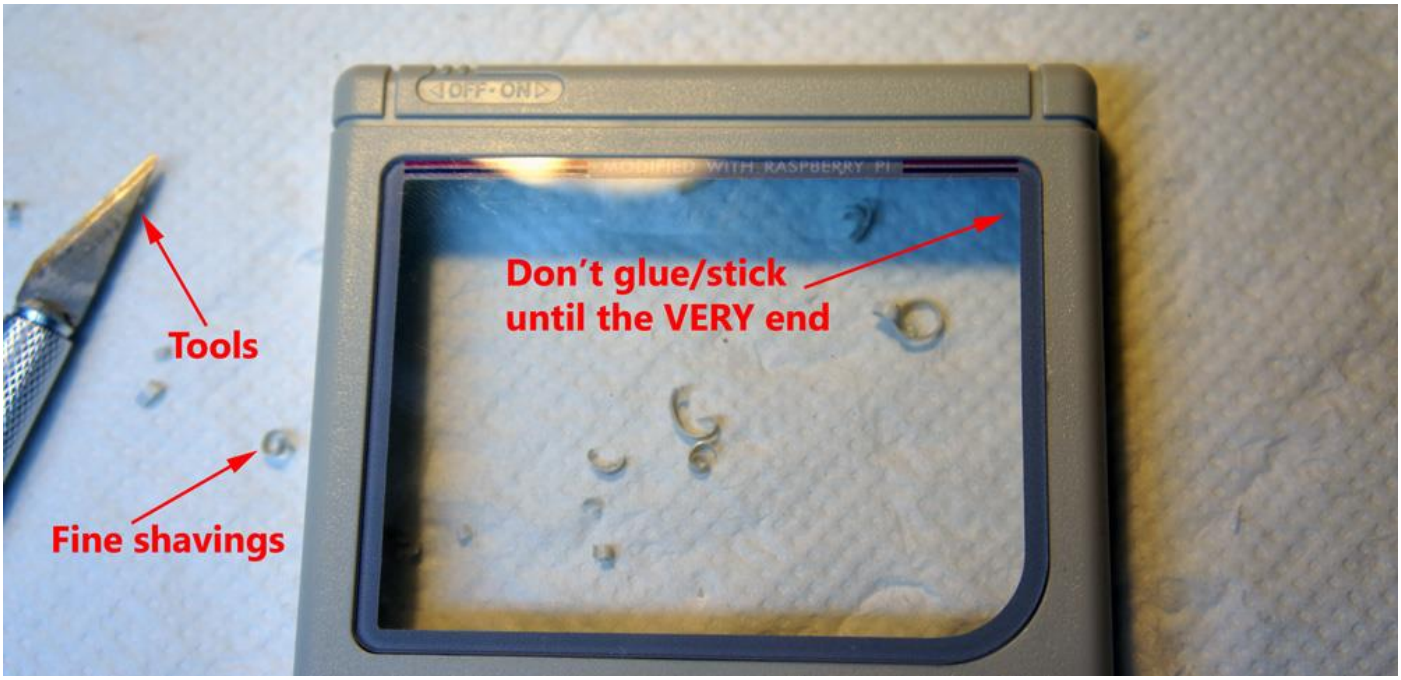
6.2.3 Use Knife to Trim and Neaten up Screen Area

The plastic will cut like butter, so use a knife to start trimming down to the right size. Use it like a plane and take off little bits at a time.

Test fit the screen overlay and see what needs to be further worked on. In the image below the right hand side and the bottom right corner need more work.



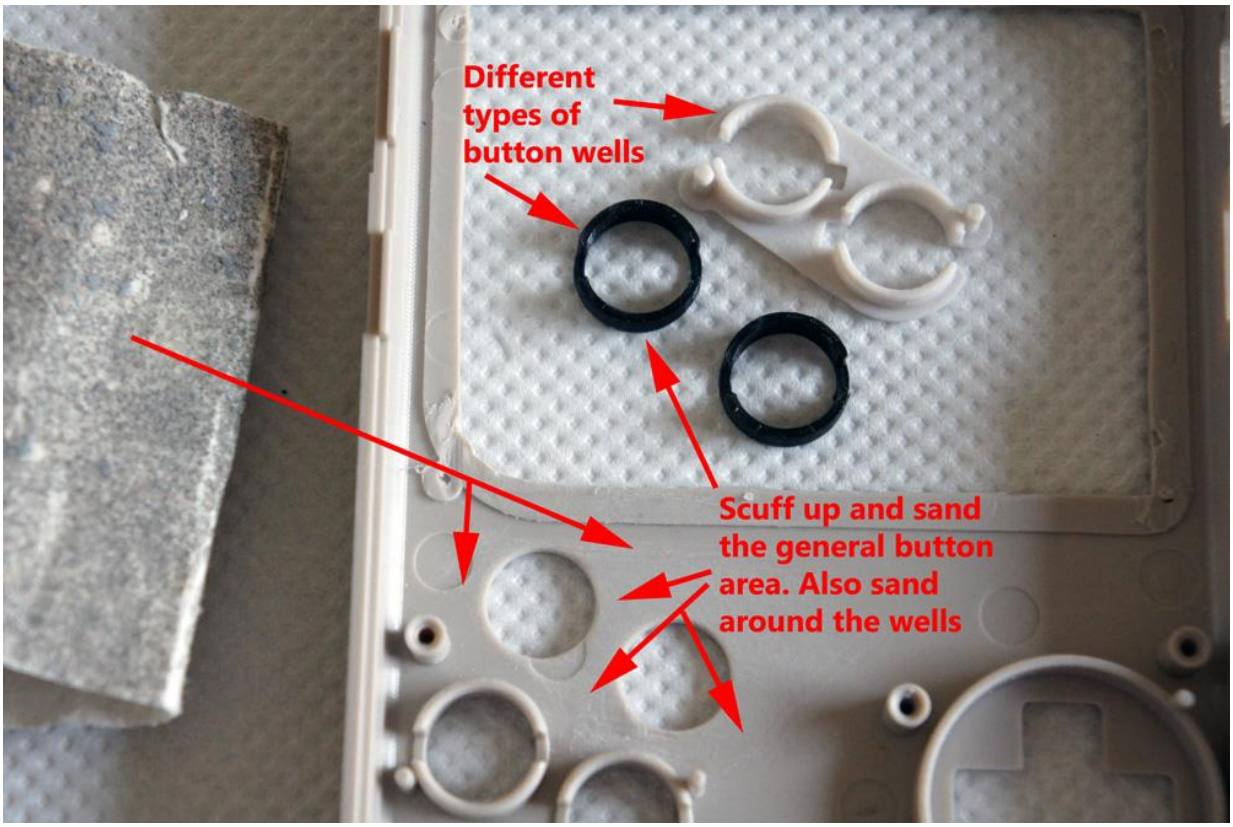
When it has been trimmed to the right size, leave it like this. DO NOT GLUE/STICK THE OVERLAY IN YET. This will be the VERY LAST thing that is fitted in this project, to avoid scratches and avoid dust on the inside of it, so for now put it somewhere safe.



6.3 Glue Button Wells

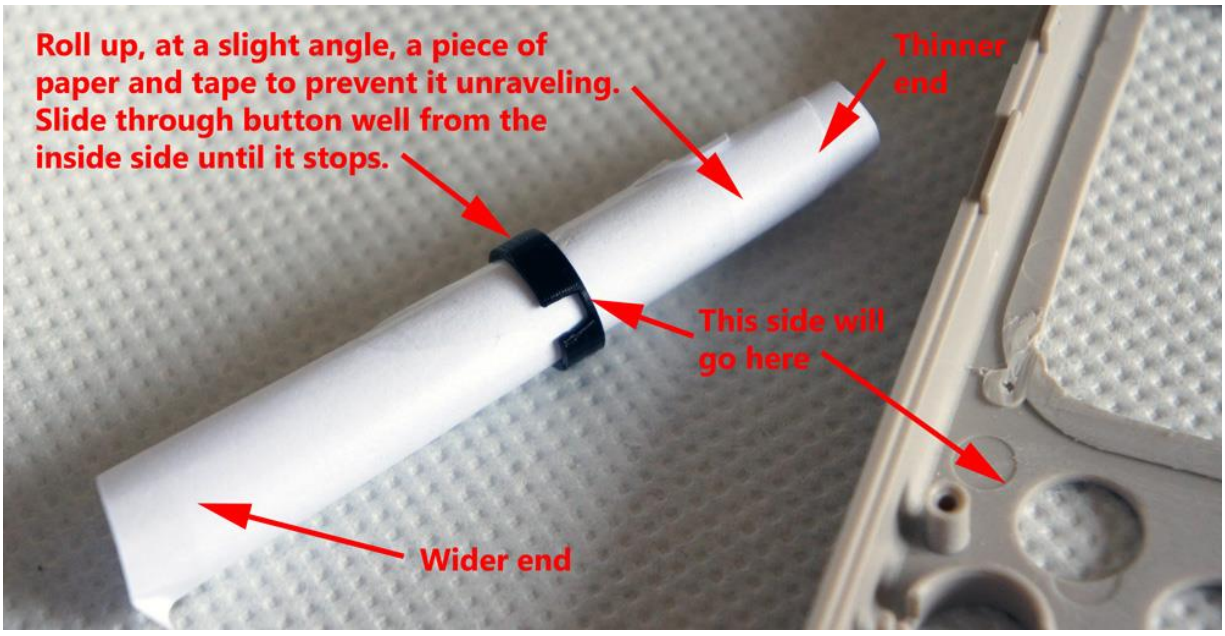
6.3.1 Prepare Wells

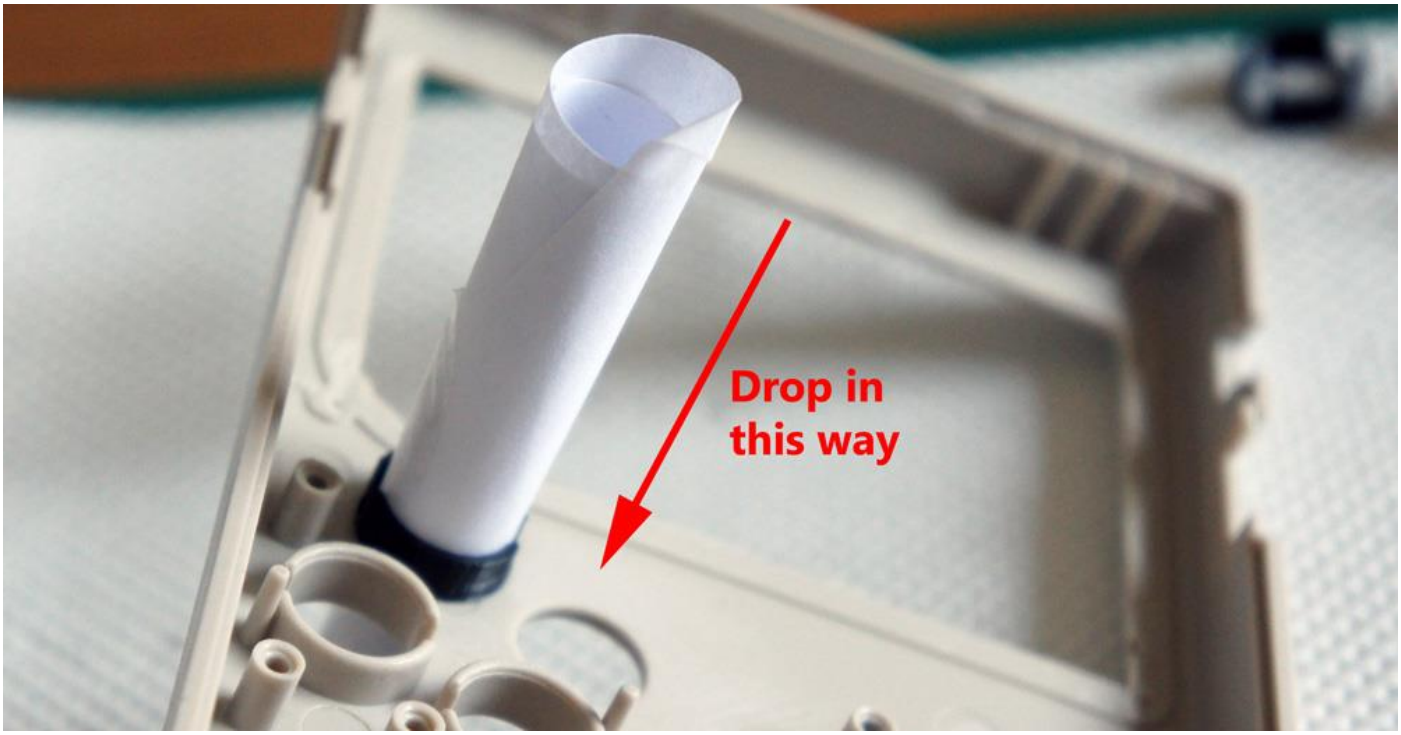
Prepare the case for the button wells by sanding down the area as well as the wells themselves. Sanding and roughing up the area will make the hot glue stick better.



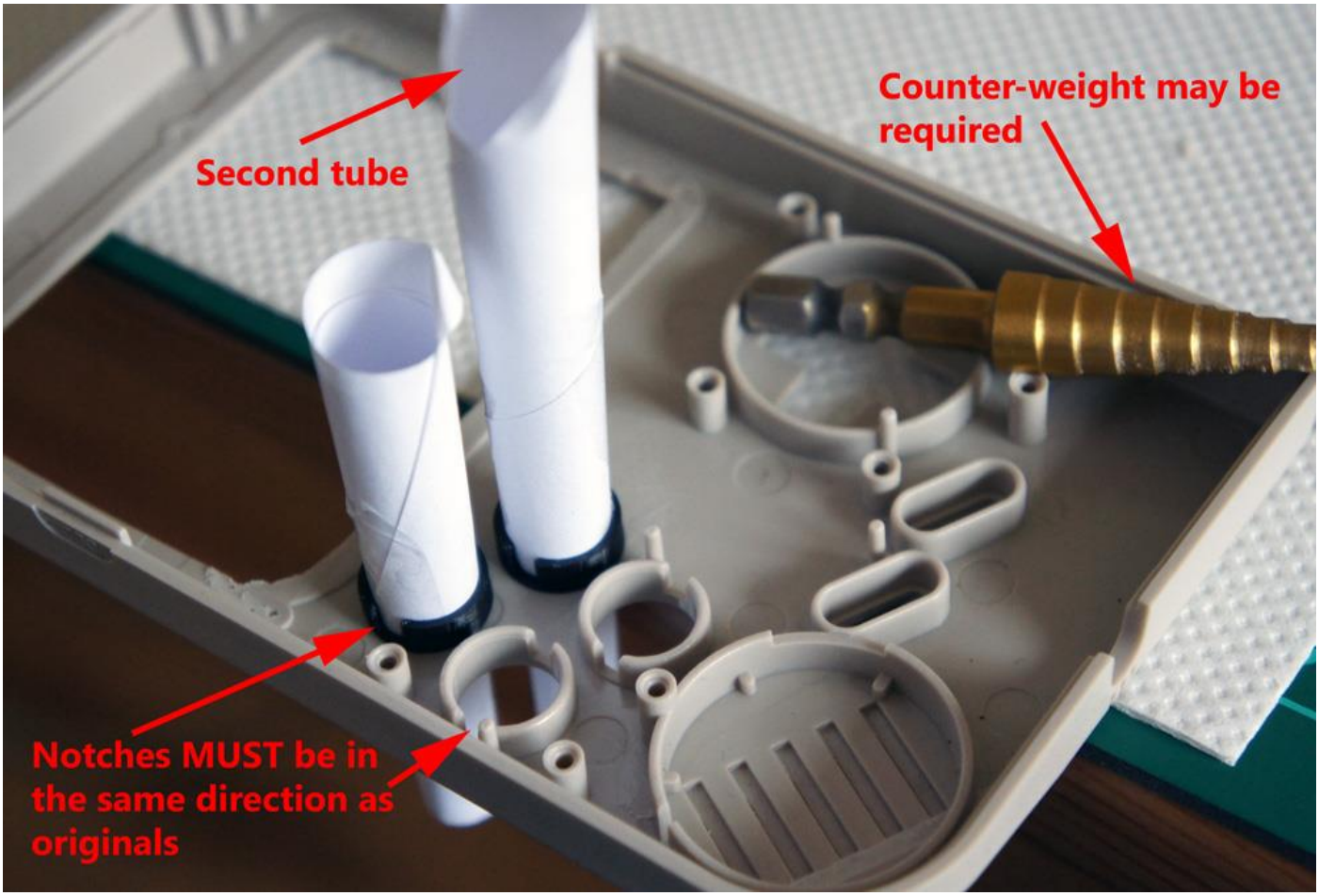
6.3.2 Glue Wells

To get the perfect alignment, roll up a small bit of paper into a very slight cone and tape it. Push the cone through the button well (from the inside side) and then drop in to the button hole (from the inside side). Push the paper through slightly further to make a snug fit.





Make a second one for the other button well. Make sure the notches are parallel to the originals. Balancing over the edge of a table may be required!



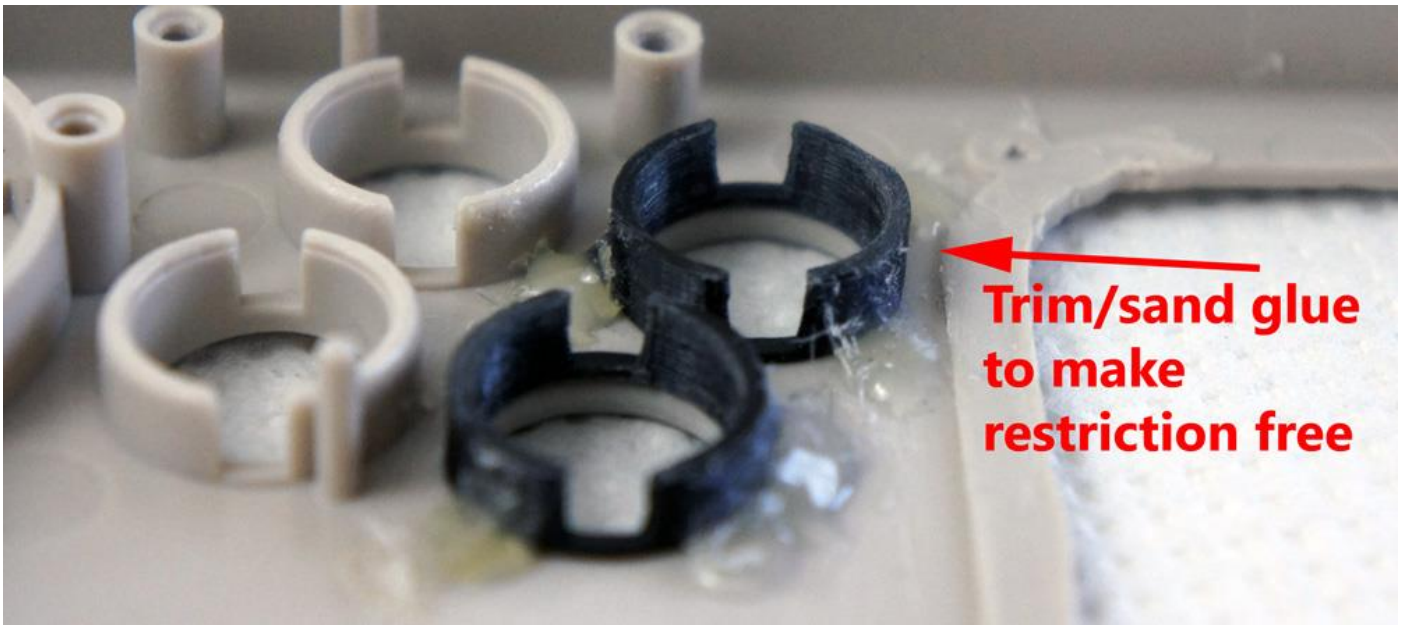
Apply glue, do not glue around the marked areas. Not much glue is required as these parts aren't load bearing, they are just guides for the buttons, so tiny blobs are all that are needed.

6.3.3 Make adjustments

Test fit buttons and check for fitment. Sanding the inside of the wells or cutting away some glue might be required.

Test fit the membrane too, it will require some trimming (scissors of a knife work fine).

Ensure the glue doesn't interfere with the membranes. If the buttons feel a bit mushy, you may need to trim more from the membrane. A bit of trial and error and it is possible to get them to feel the same as the originals. I found that the bottom edge/lip of the membrane needed removing completely.

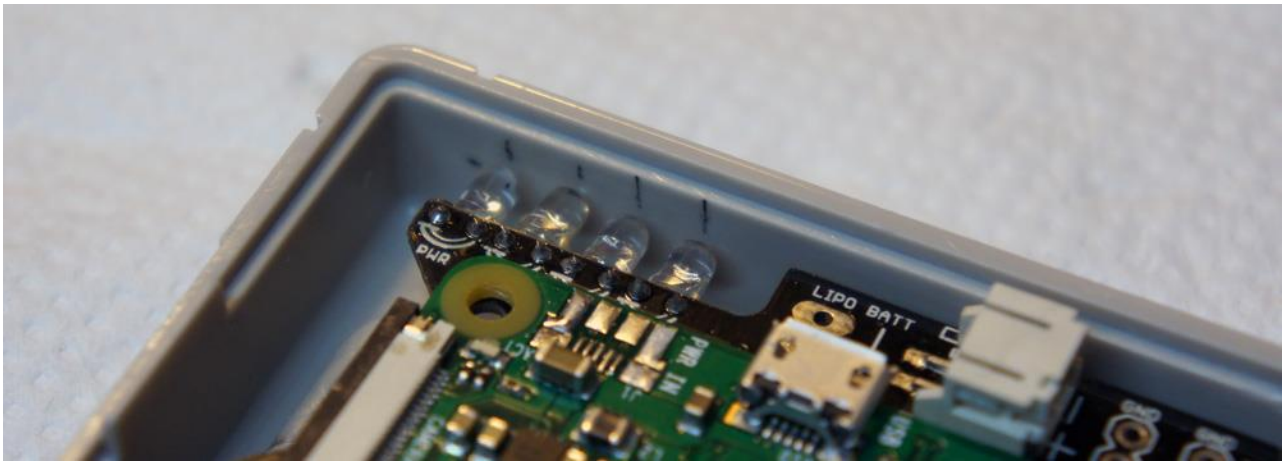


6.4 Drill LED Holes and Fill with Glue

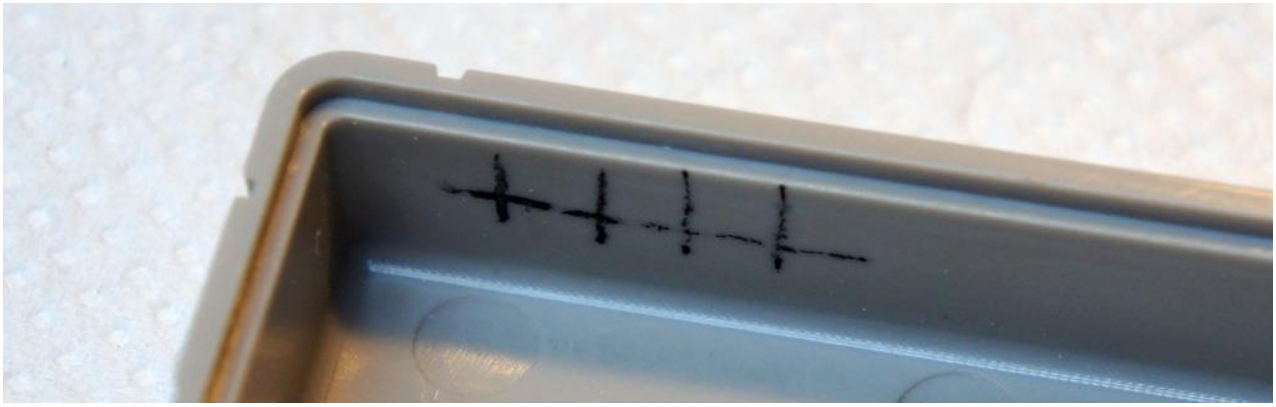
6.4.1 Prepare LED Holes

The simplest way to make status LEDs is to make small holes (2mm) and fill them with glue. The hot glue doesn't dry perfectly transparent and so when light is shone from the other side, the glue makes a nice diffused glow. Alignment isn't 100% critical, and the LEDs can be bent slightly to match better anyway.

Start by fitting the main board, and marking approximately where the LEDs line up to. In the image below the top and side of the LEDs have been marked as best as possible. *NOTE: Ignore the missing USB connector*.

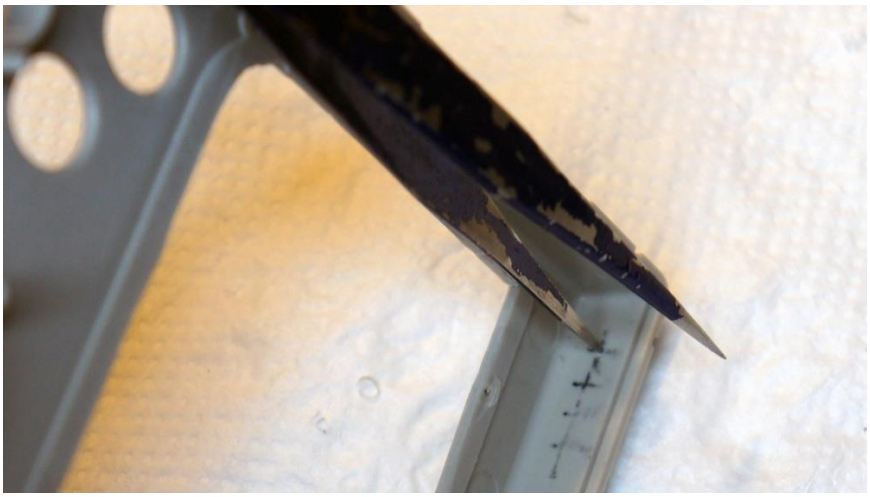


Joining the dots up gives us a template.

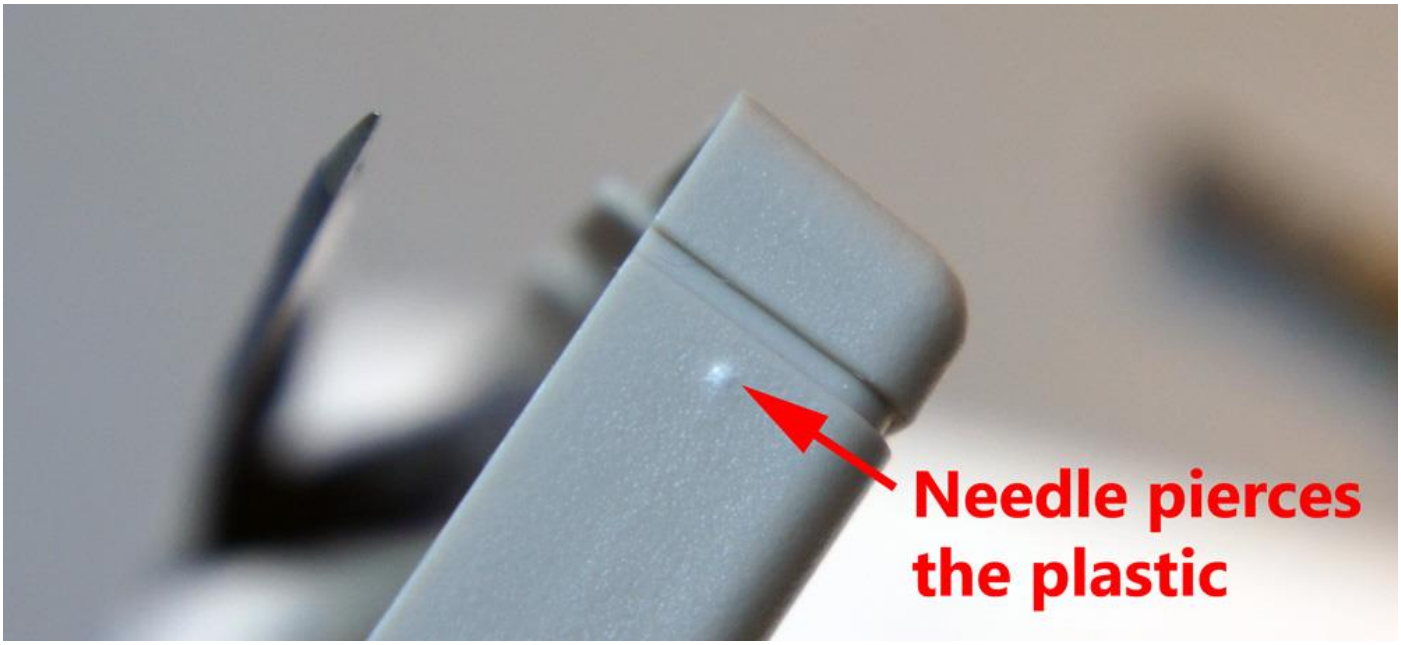


6.4.2 Drill LED Holes

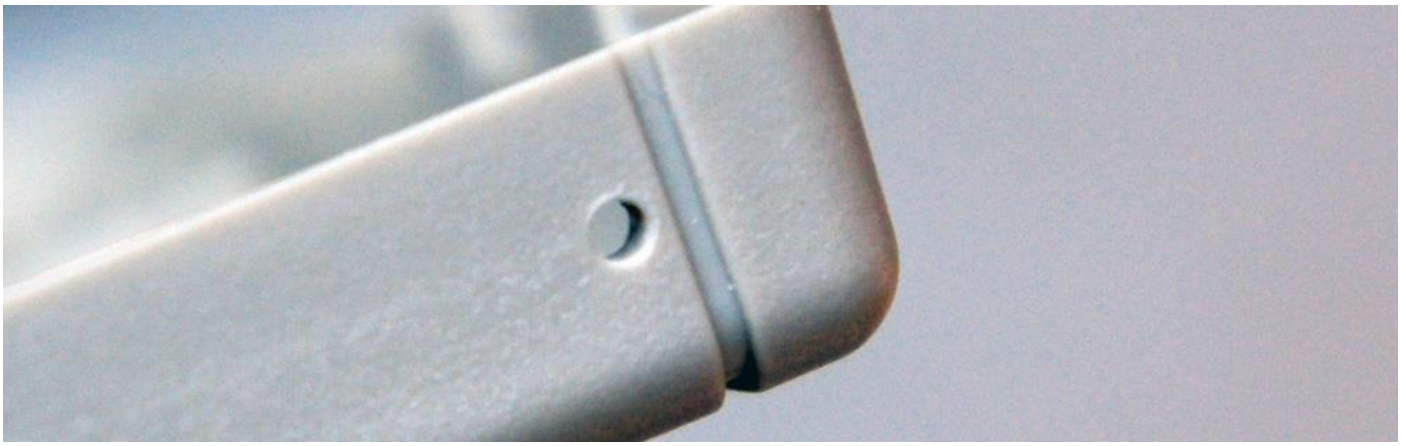
Using something very sharp, like a needle, push from the inside of the case where the outermost LED is. Keep pushing until a distortion mark is seen on the other side. Rotation and encouragement required.



The image below shows that after pushing through, a small mark is seen on the other side. Using the needle again, push it from this side and the hole will join up.



Using a 2mm drill or so, enlarge the hole.



Using the template, you can now mark the remaining holes. The template has 3mm holes so some careful alignment is required. Tape the template to the case to hold it if necessary.

The end result should look like the image below. Be VERY careful when drilling the holes, you can see in the example image that the drill slipped on the second from left hole and has made a larger dent on the outside (the drill chuck hit the case) you should be able to avoid this if you are careful.

6.4.3 Fill LED Holes with Hot Glue

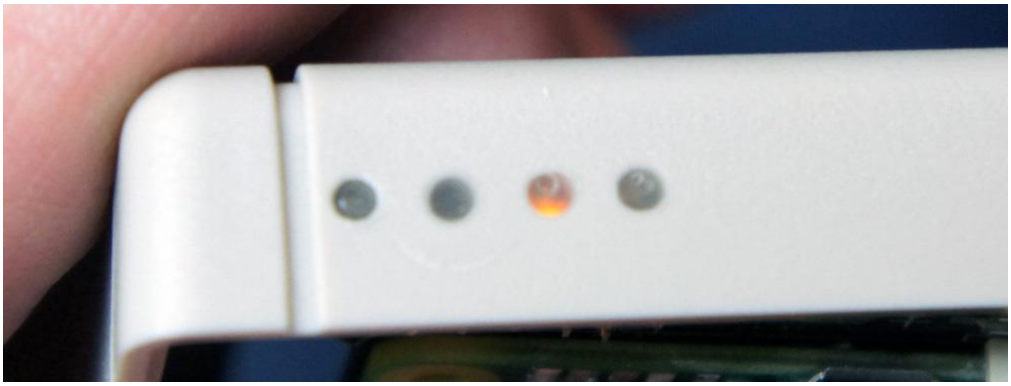
Using kapton tape on the outside of the case, push all the air bubbles out and make flat as pictured.

Fill each hole with hot glue. You will find that if you push glue into the holes there will be an air bubble. While the glue is hot use a needle to pop the air bubble and apply more glue. When filled, use the nozzle of the glue gun to melt the glue blobs flat. Using a knife you can trim the glue further. The image below shows the end result.

When the glue has cooled, remove the kapton tape.

6.4.4 Clean up LED Holes

Test fit the board, and trim the glue where necessary. You can apply power to see what it looks like.

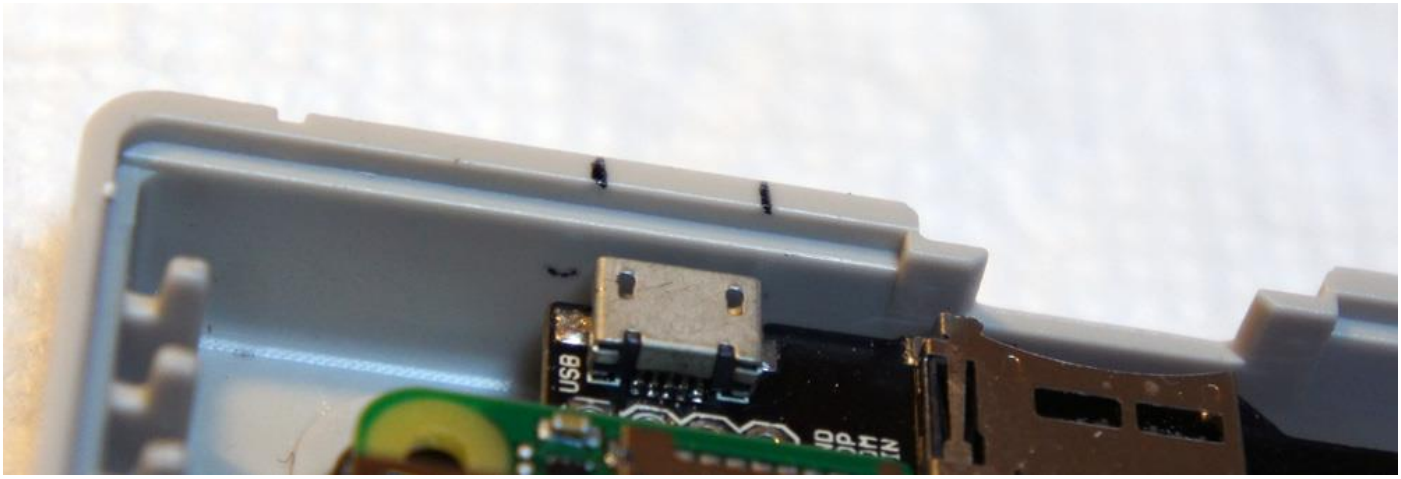


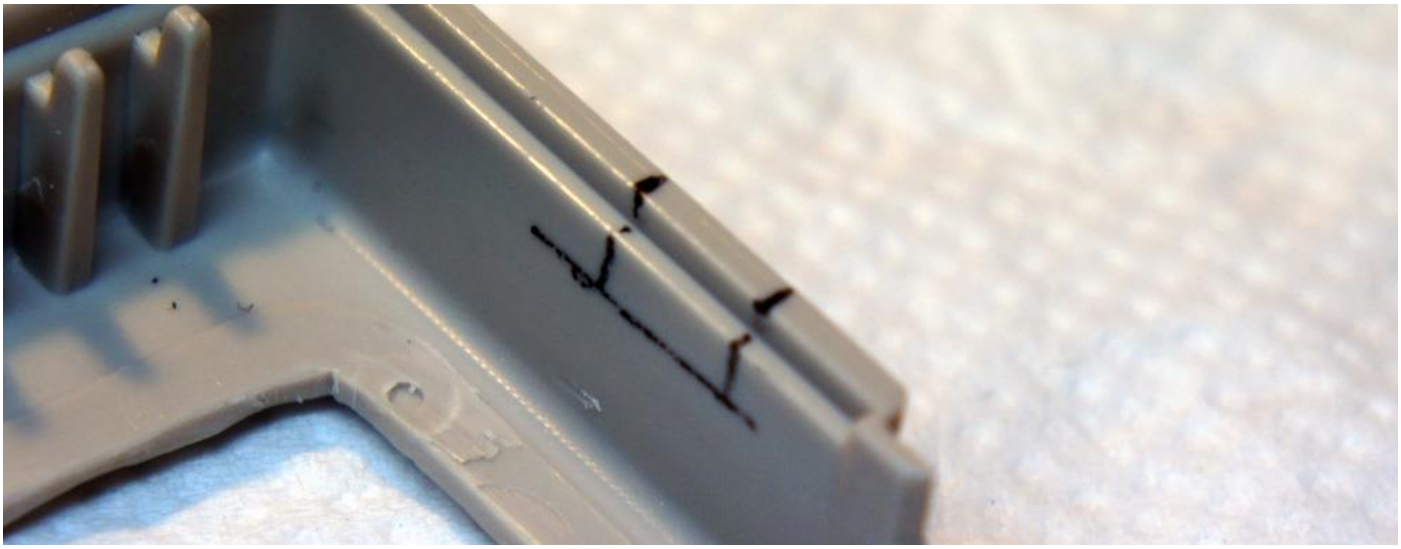
The following image shows what the ultimate end result will look like. You can still make out the air bubbles in the yellow LED, but it's not that noticeable. It is easy to peel out the glue and try again if you aren't happy with the result.

6.5 Cut USB Port Hole

6.5.1 Prepare USB Port Hole

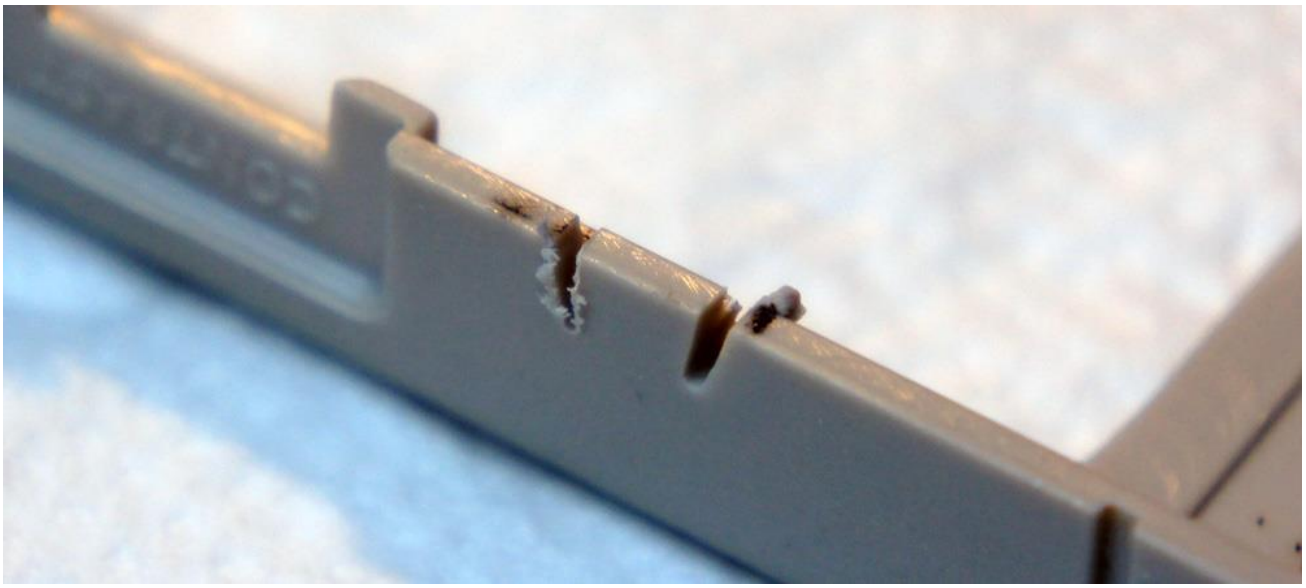
Test fit the board, and mark where the USB port lines up to. Remove the board and join the dots to form a template.



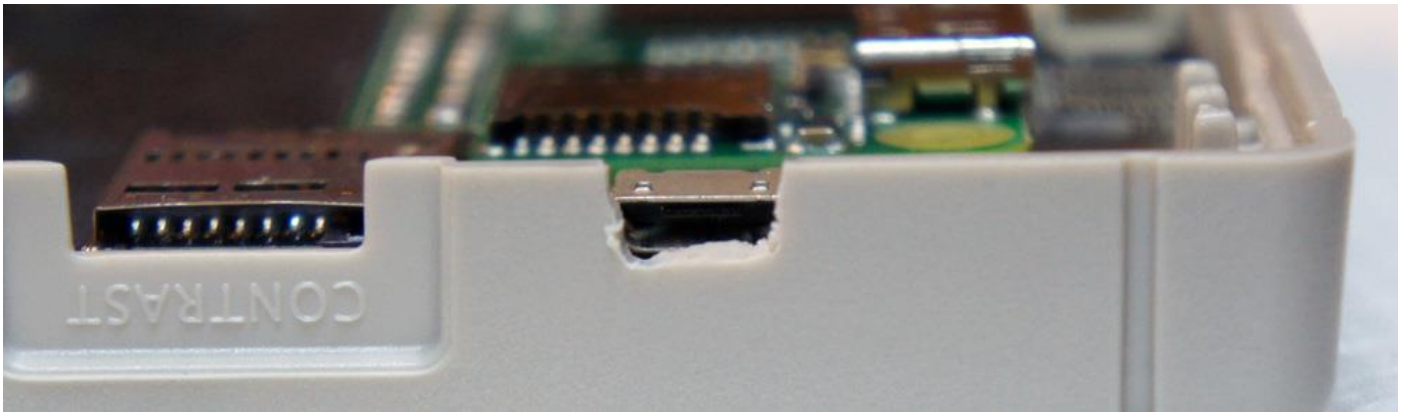


6.5.2 Cut USB Port Hole

Start with a rotary cutting tool to get it approximately right. Be careful not to go too deep.

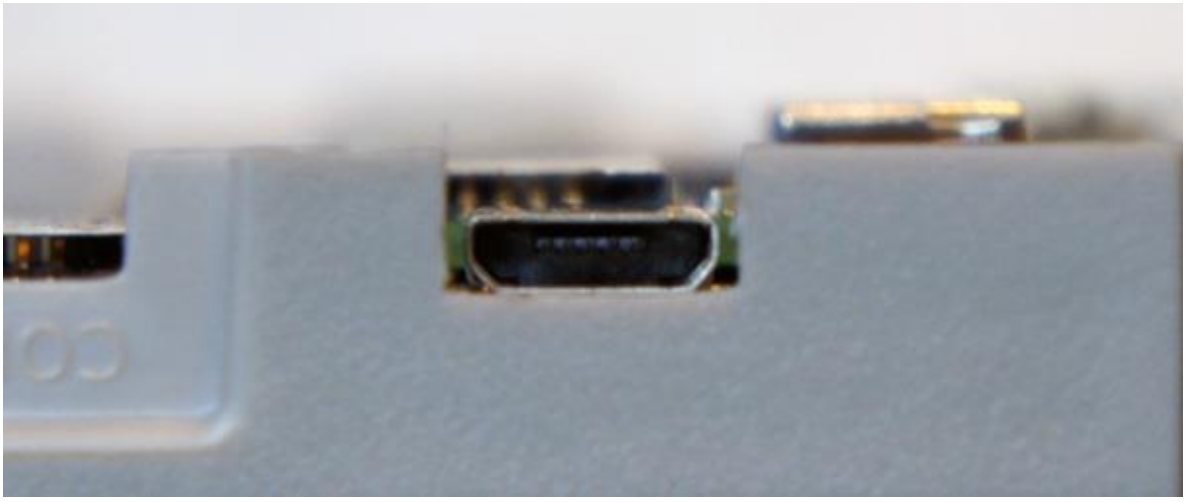


Breaking off the tab and we have a nice but messy hole, but it's looking good so far.

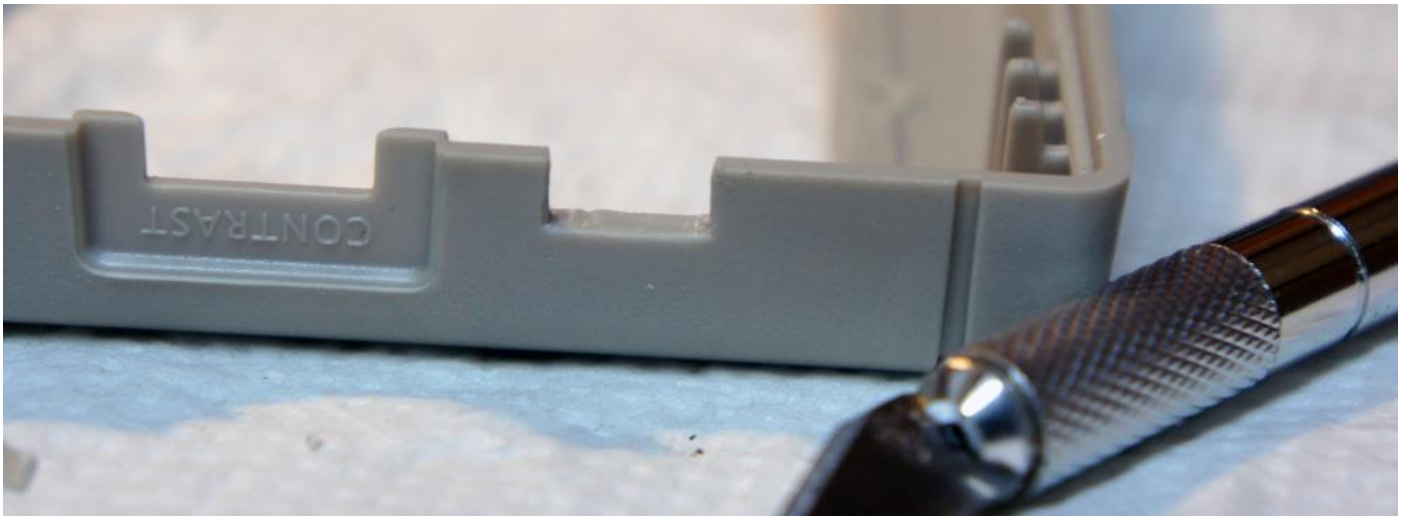


6.5.3 Trim and Adjust USB Port Hole

Using a knife, carefully cut and trim to shape. The plastic cuts easily so just take it slowly and keep checking for fit. Using a file also helps to get a nice square edge and is probably the best tool for this job.



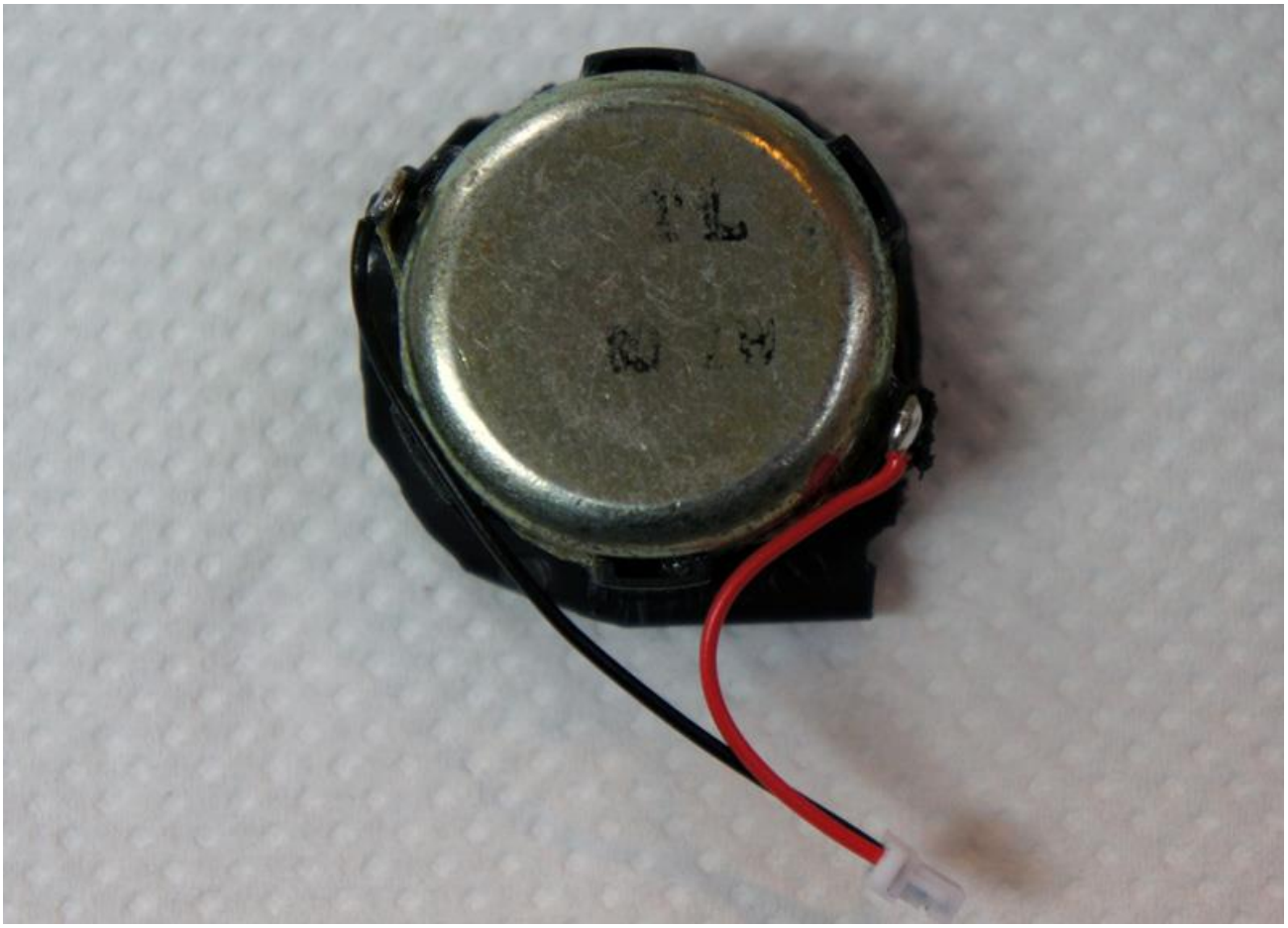
When the shape is right, trim the edges at 45 degrees with a knife and neaten up.

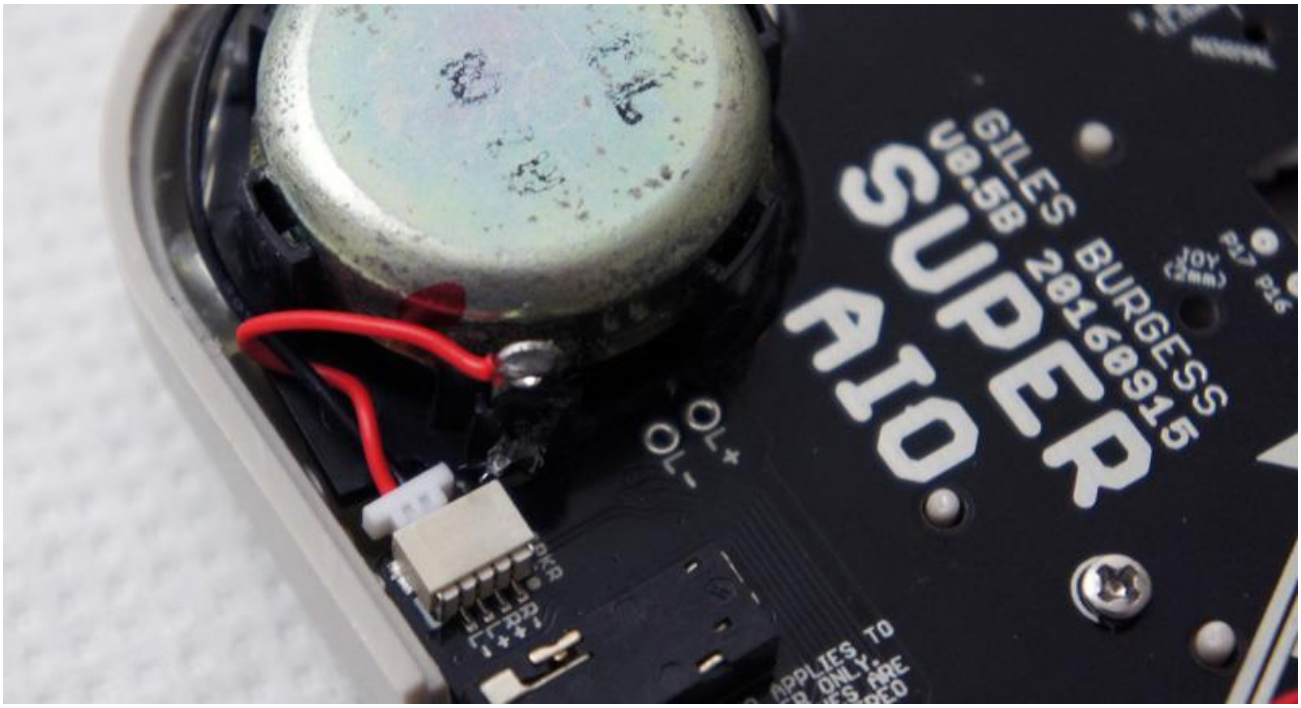


The end result should finish up like the following image.

6.6 Fit Speaker

All speakers are different so find the best way to fit it. If you are using an original speaker your life will be very easy. The speaker I chose was far too big and required a lot of careful cutting to get it to fit. The important things is to add the 2pin cable and connect it up. I wouldn't recommend this huge speaker!

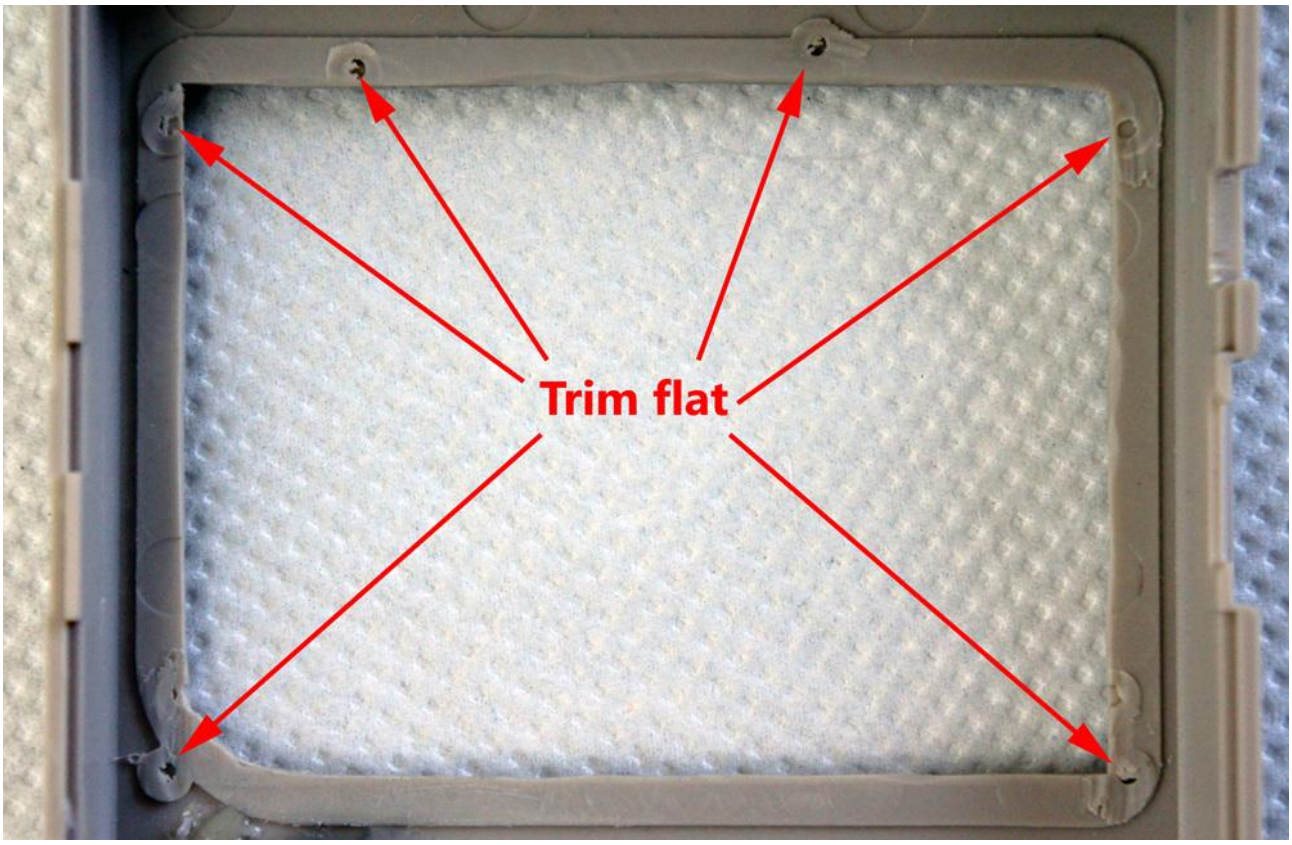




6.7 Fit LCD

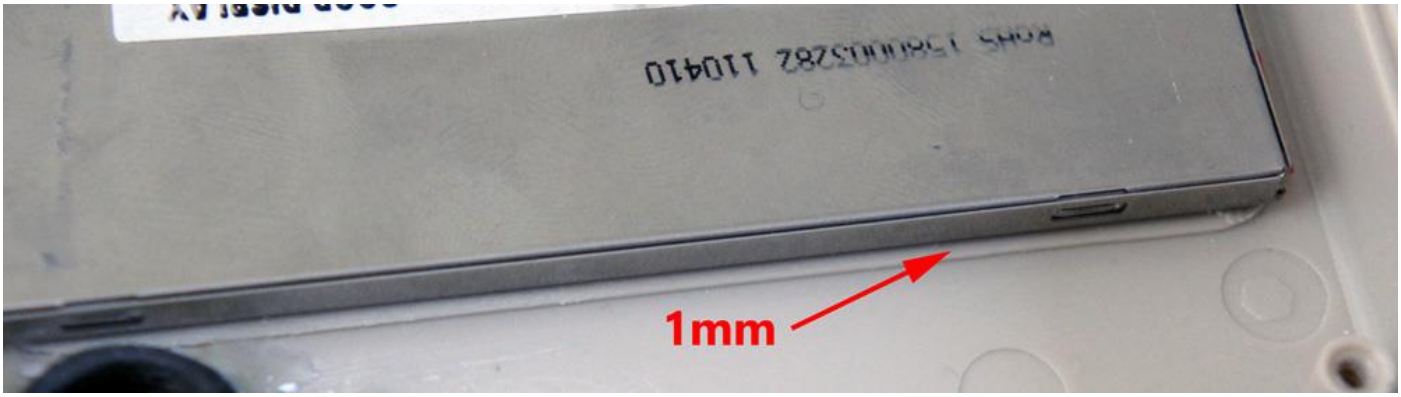
6.7.1 Place LCD

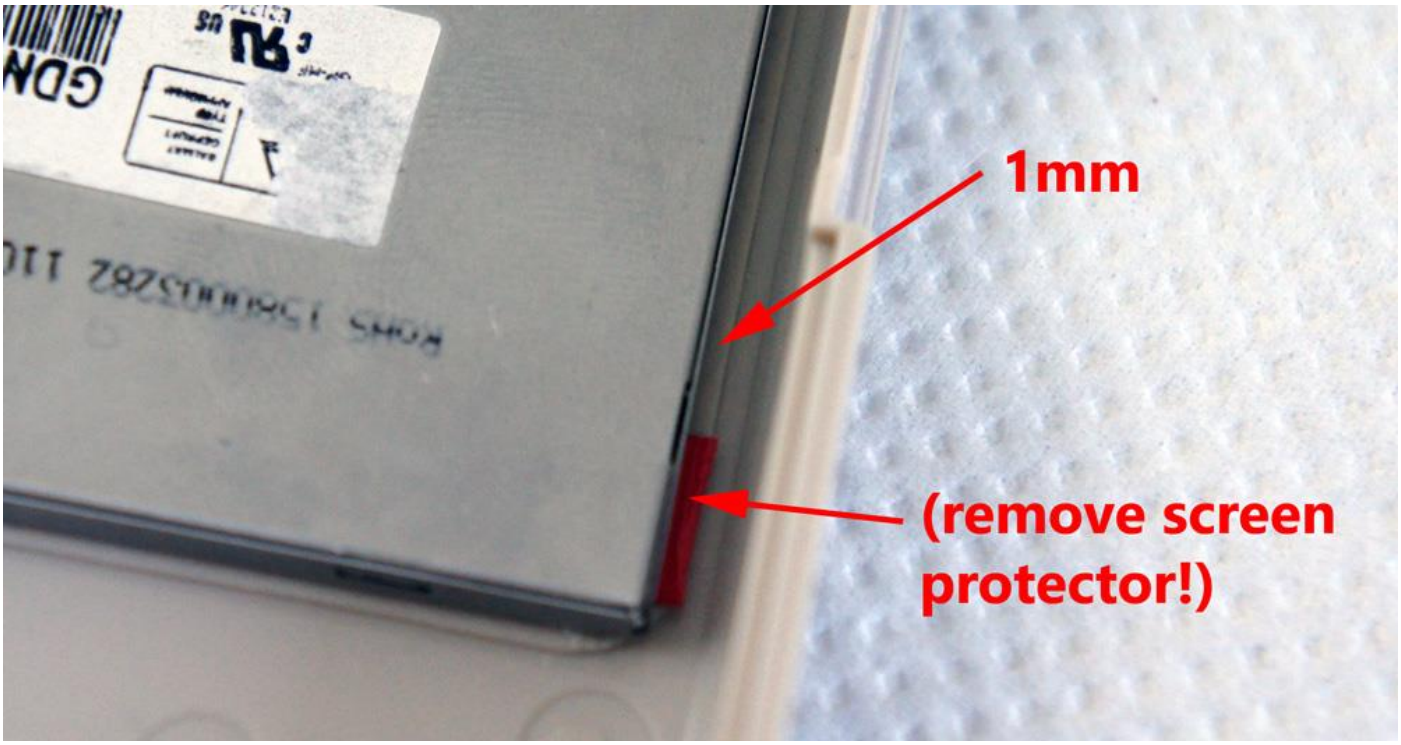
Prepare the inside of the screen area by sanding flat the old mounting posts to ensure the LCD sits flush.



Test fit with the LCD ribbon at the top.

The LCD sits perfectly when mounted 1mm from the left, bottom, and right of the original mould of the DMG. The following images show what this should look like. Make sure the LCD lines up parallel to this mould line and 1mm away from all sides and it will guarantee to be in the middle and not wonky.



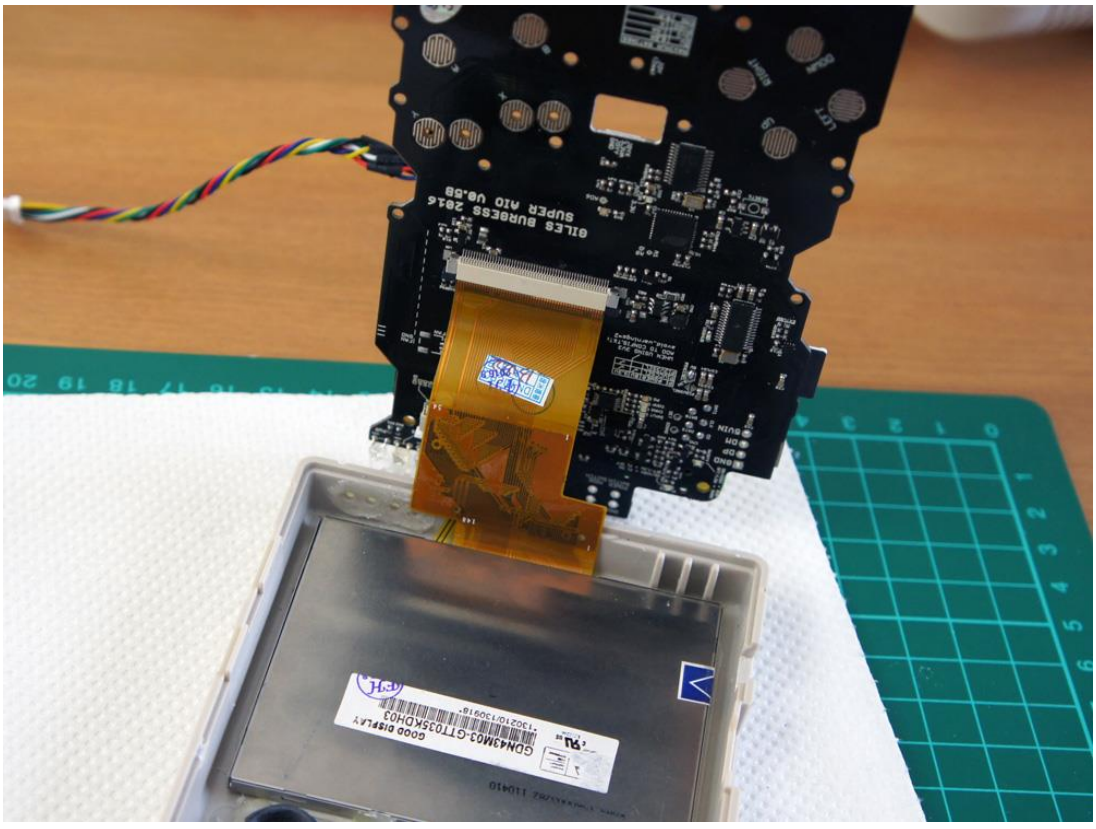


6.7.2 Tack Screen in Place (don't glue too much just yet!)

With the placement set, apply tiny blobs of glue and triple check alignment. While the glue is hot you can make corrections. Do the bottom edge first, and then once that is correct apply another blobs on an edge to hold it for testing.

6.7.3 Preview and test

The best way to attach the ribbon is to place the main board vertically on the OUTSIDE of the case, plug in the connector, and then lever down the main board and fit. See the image below.

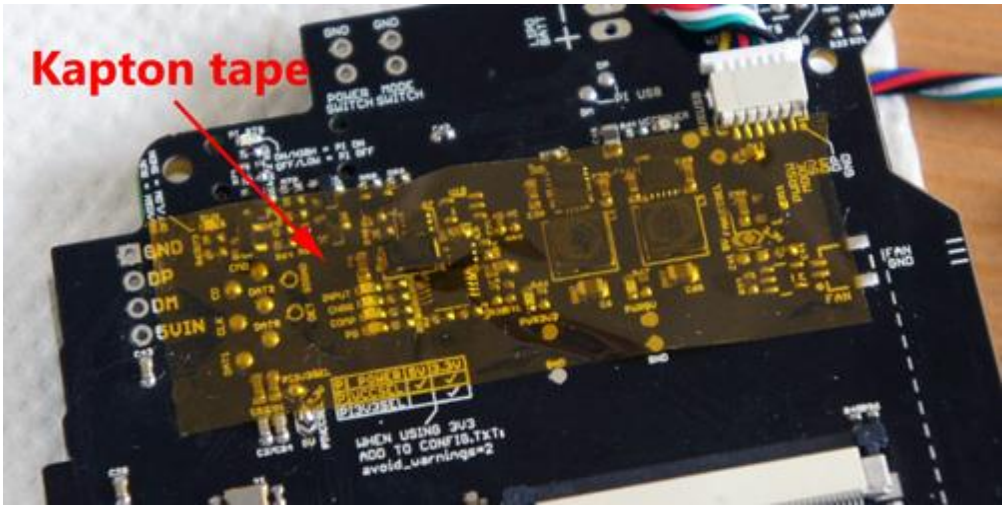


Test by powering on as before, if all goes as planned the screen will be in perfect alignment. DO NOT GLUE/STICK THE SCREEN OVERLAY YET.

In a later step the LCD should be fully glued in.

When connecting the LCD ribbon, do not put force on it. It is possible to move the main board around without pulling on the ribbon.

It is also a good idea to add kapton tape to the bottom side of the main board at this point. This will protect from any shorting on the battery and voltage regulators.



7 Phase 3 – Test Electronics inside Case

7.1 Test Fit Main Board in to Front Half of Case

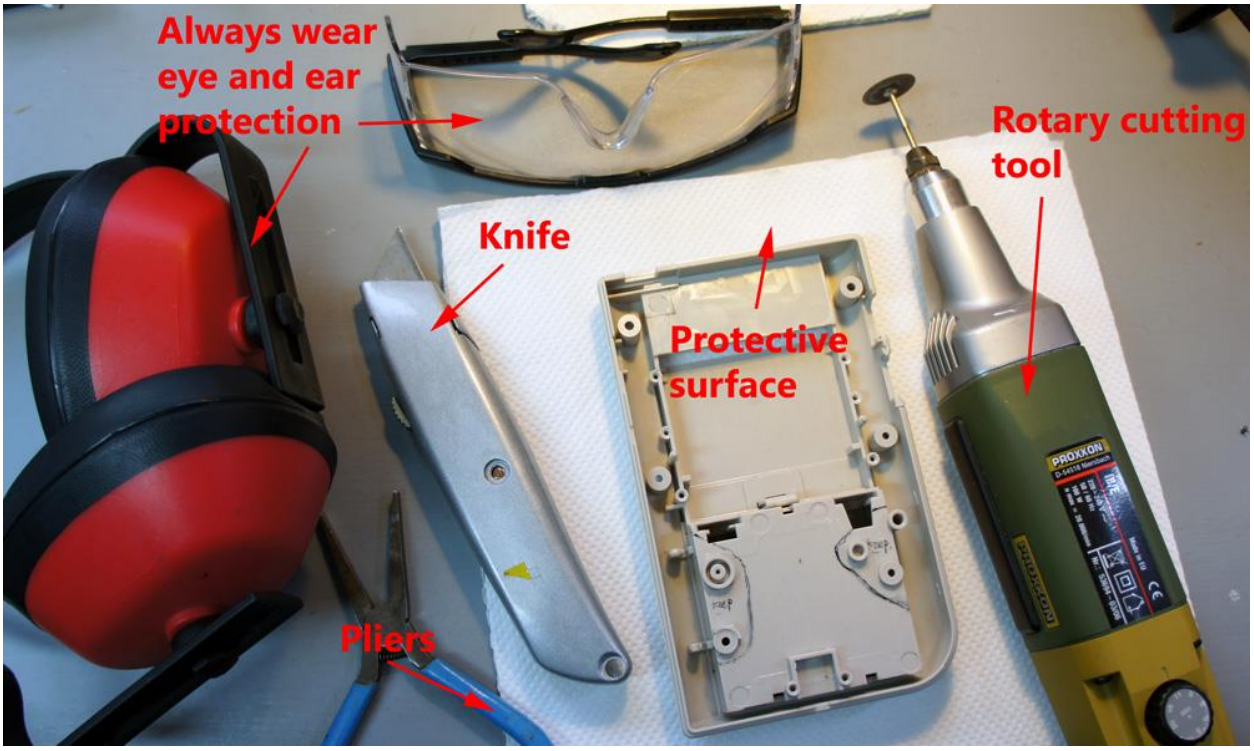
With the LCD working, fit the button and test that the front half electronics are all working as expected.

Debug and trim any poor fitting parts now.

8 Phase 4 – Prepare Back Half of Case

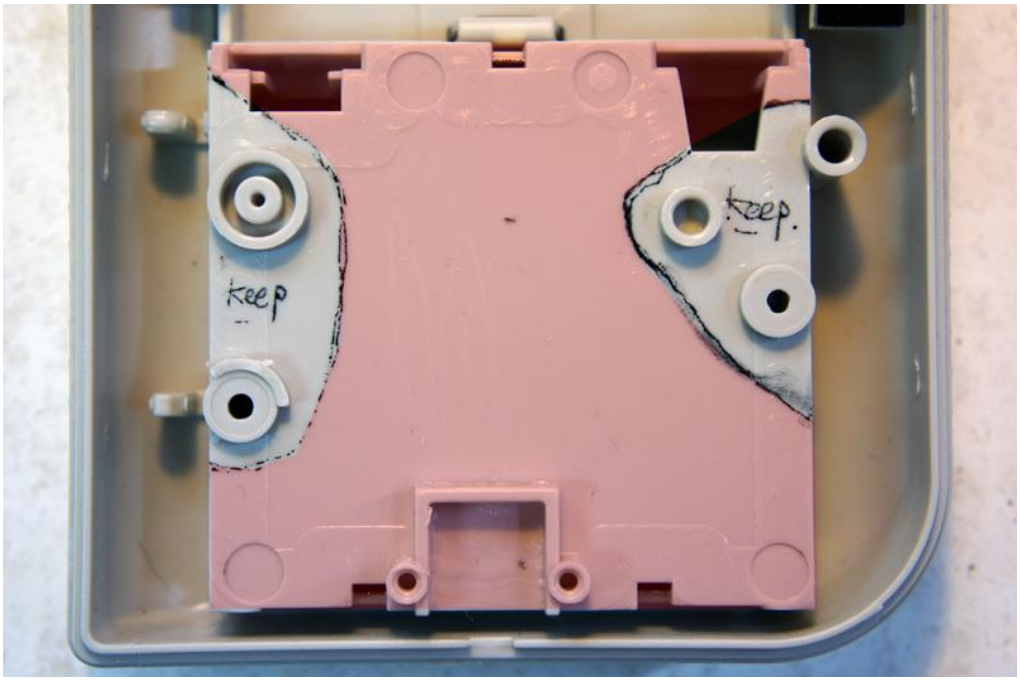
8.1 Tools for the Job

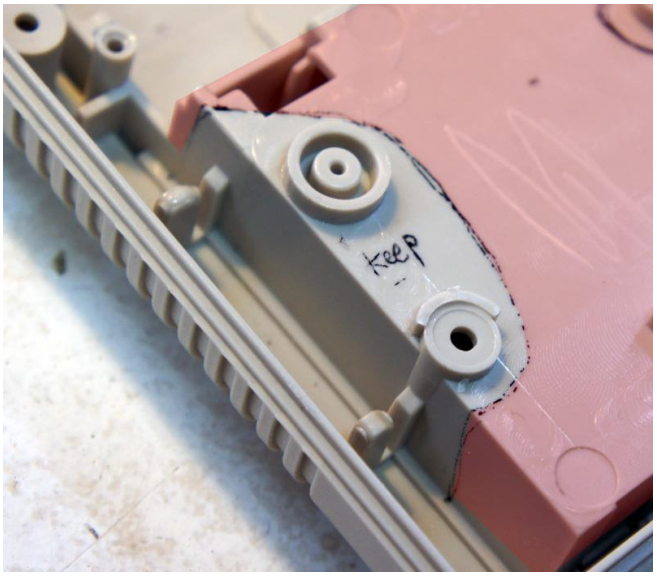
Modding the back half of the case requires a lot of cutting. Always wear ear and eye protection. Using some kitchen towel as a protective surface will protect the case from scratches. Use an old workbench or make sure to use protective matting.



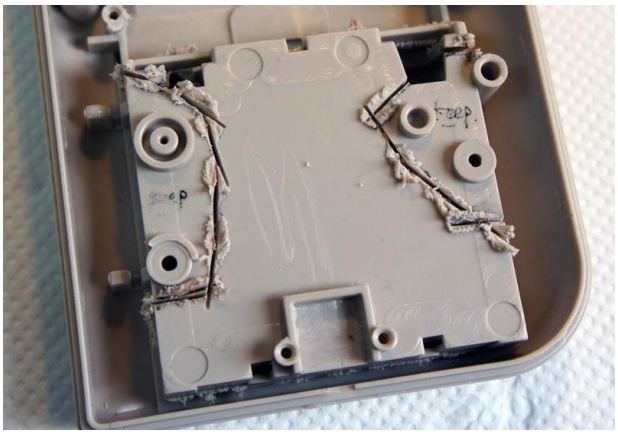
8.2 Cut Out Battery Bay

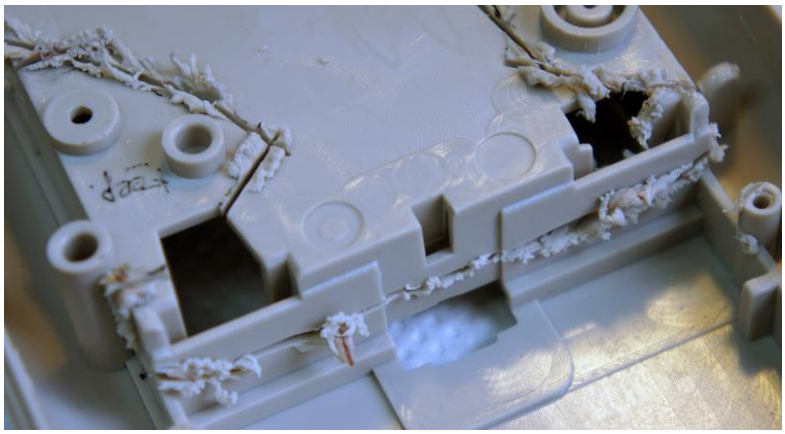
The battery bay needs removing, mark out where you are going to cut. The following images have highlighted in red/pink the parts that we are going to be removing.

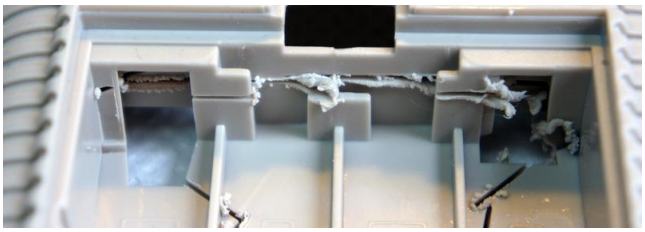


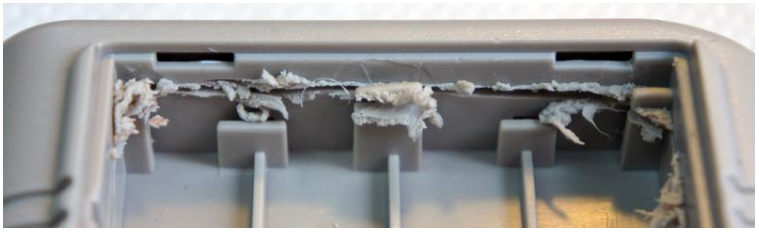


Once marked out, begin cutting! Roughly cut and trim later. The following images show all sides that were cut.

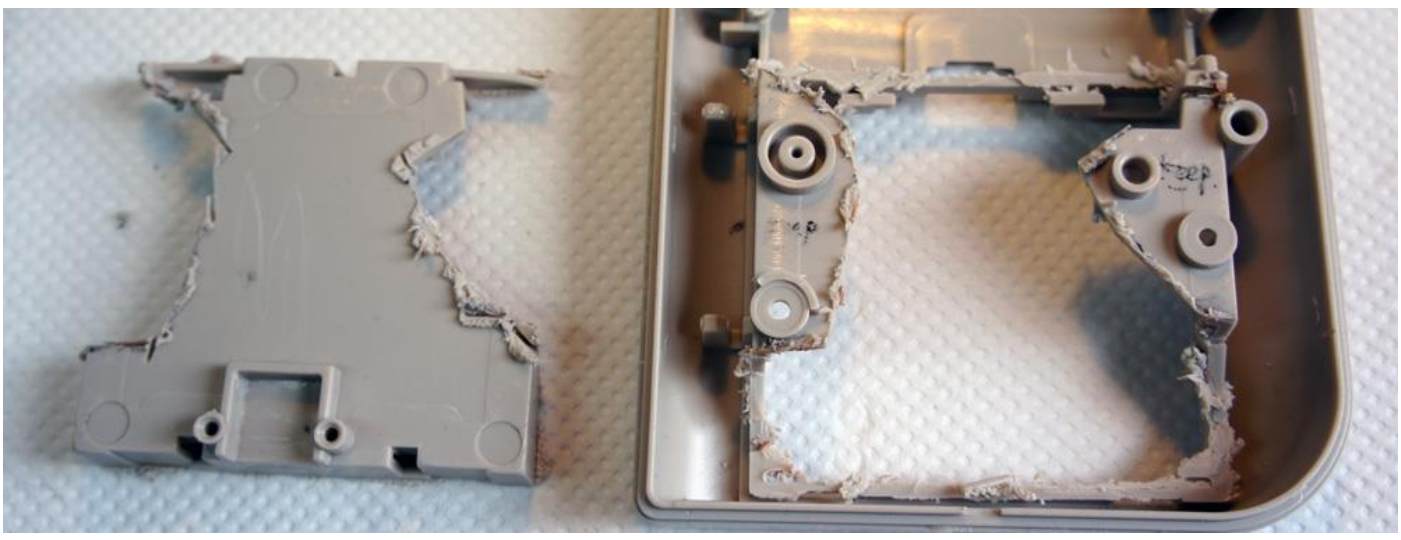




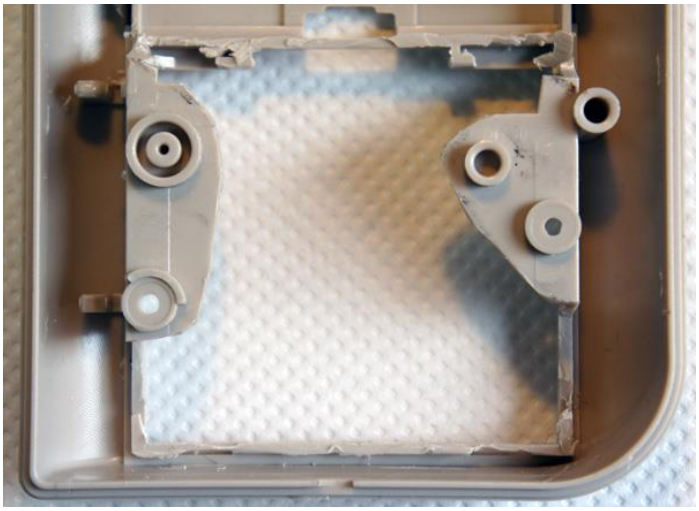


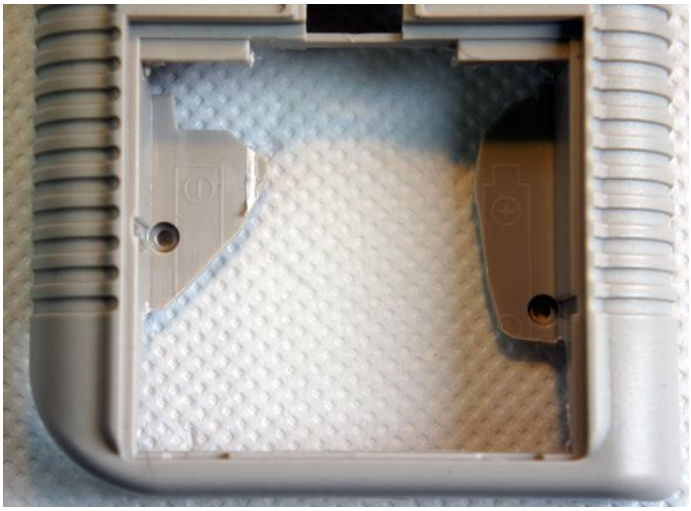


The cut out area should just pop out like the images below.



With some filing and using a sharp knife to neaten up, the bay will look clean like the image below.

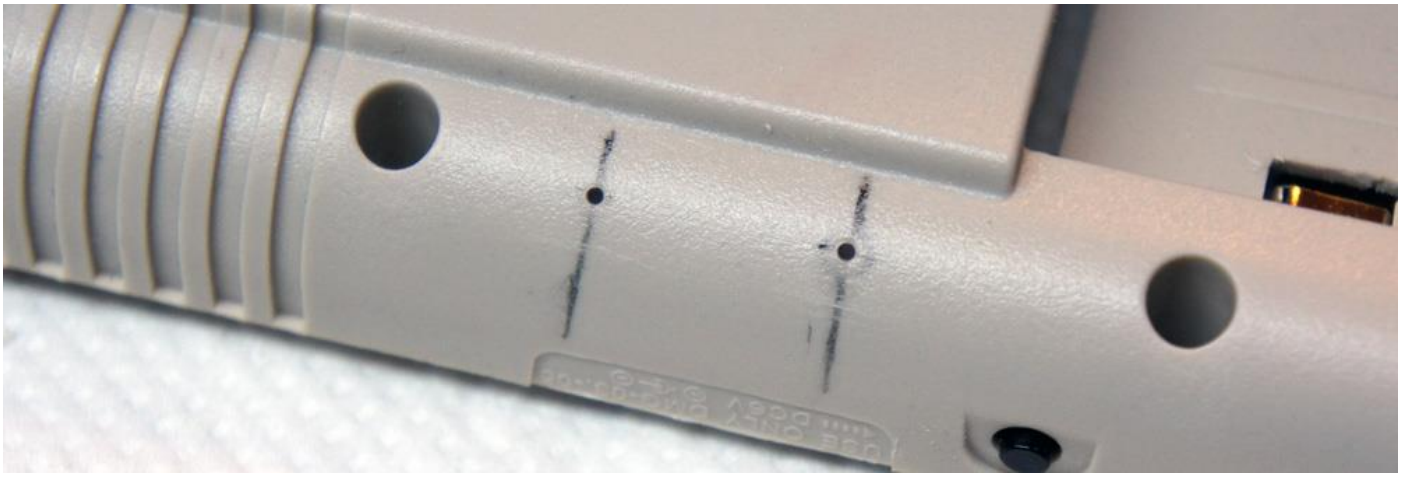




8.3 Cut Out L and R Button Holes

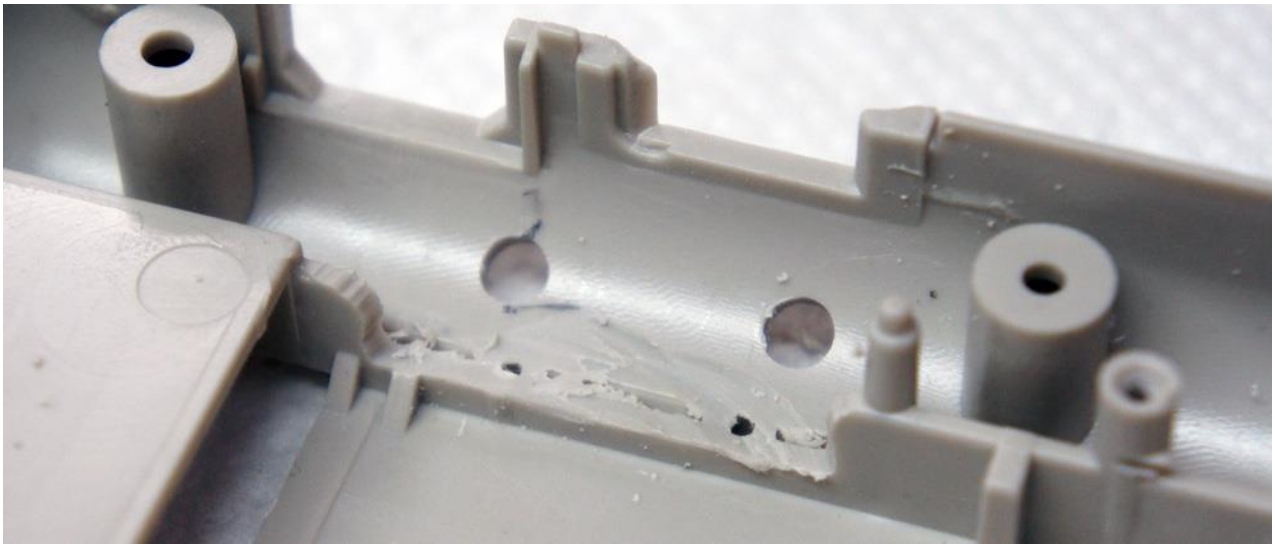
The L and R buttons are up to you to decide on placement and type of button. It is recommended to use ROUND buttons as all the will be required is a drill hole. I wanted to try square buttons and they were a pain and the finish wasn't as good as I was hoping. I have included the steps here anyway, adapt this to suit your build! 2x buttons isn't a requirement, you can use L1 and R1 and is probably the better option anyway.

Mark out the location and drill pilot holes. Be aware of what is on the other side of the case when drilling so that you know the buttons will fit.

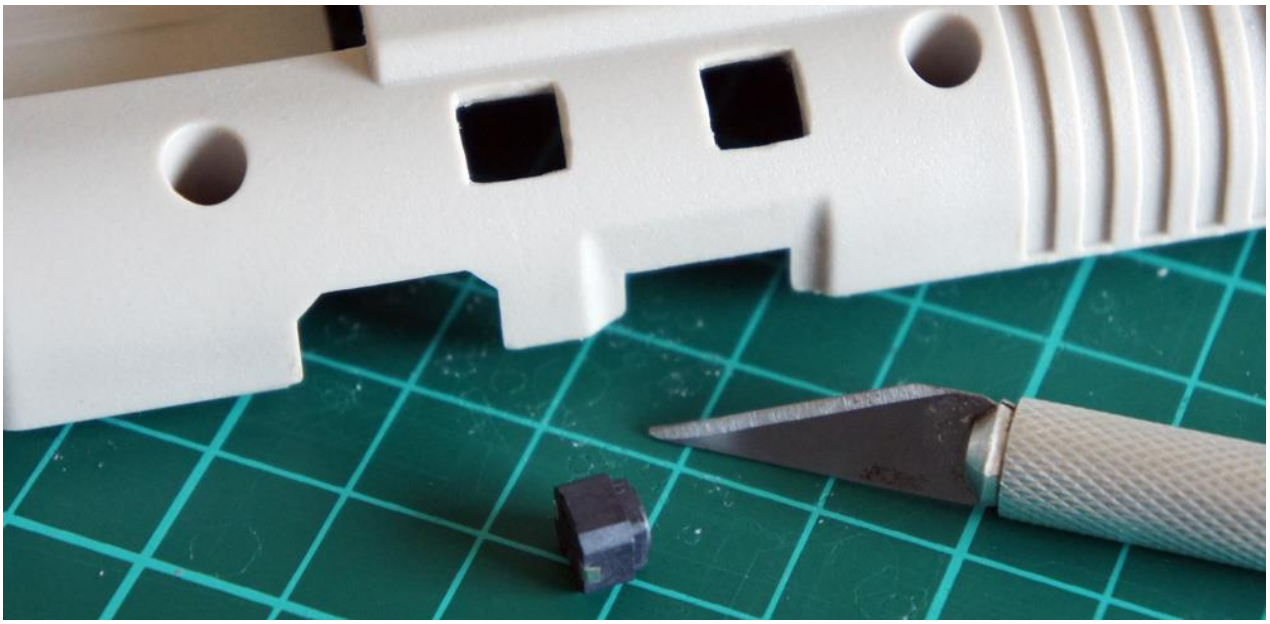


Enlarge holes to the diameter of your ROUND buttons.

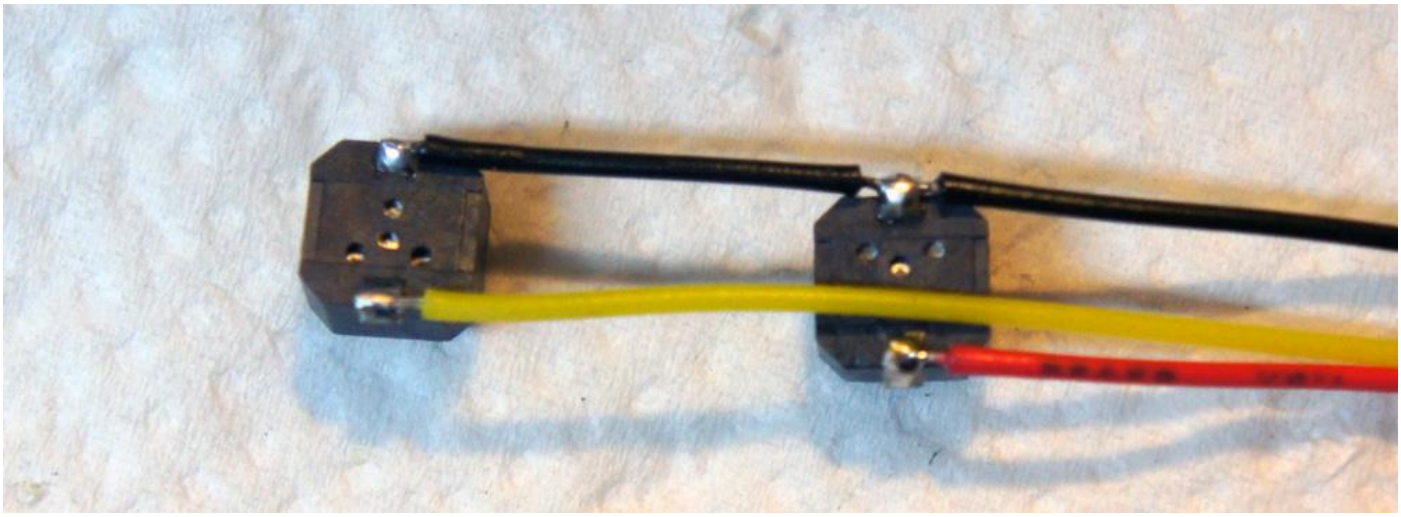
On the inside, the lip is most likely required to be trimmed.



I cut my holes out square (not recommended!).

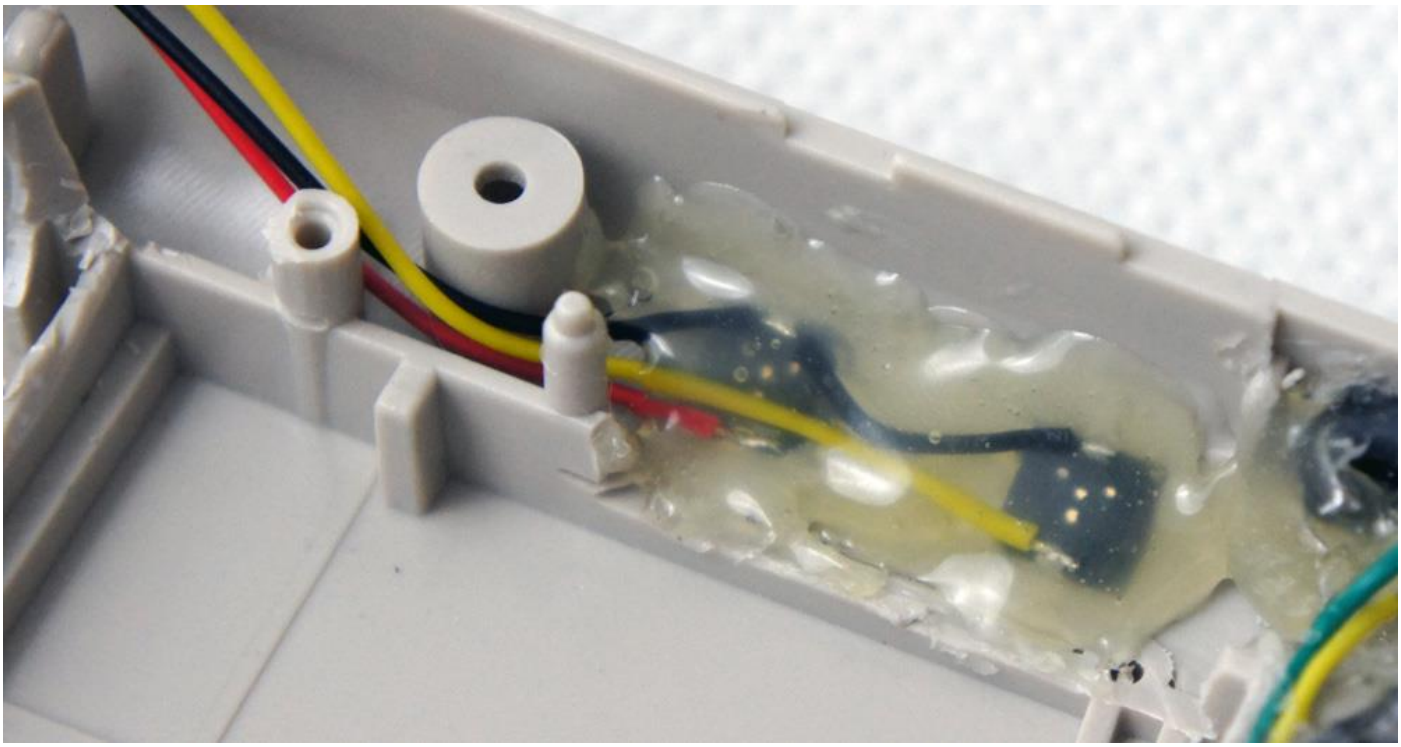


Soldering the buttons is simple. Each button will share ground (black wire) and the button 1 or 2 gets the yellow or red wire. If only using 1x button, remove one of the wires. Test button pinout with multimeter.



It is possible to carefully use a knife to cut the black plastic on the wire and then pull back the plastic slightly as I have done pictured above to make soldering easier.

Glue the buttons in, trying not to put too much glue everywhere.

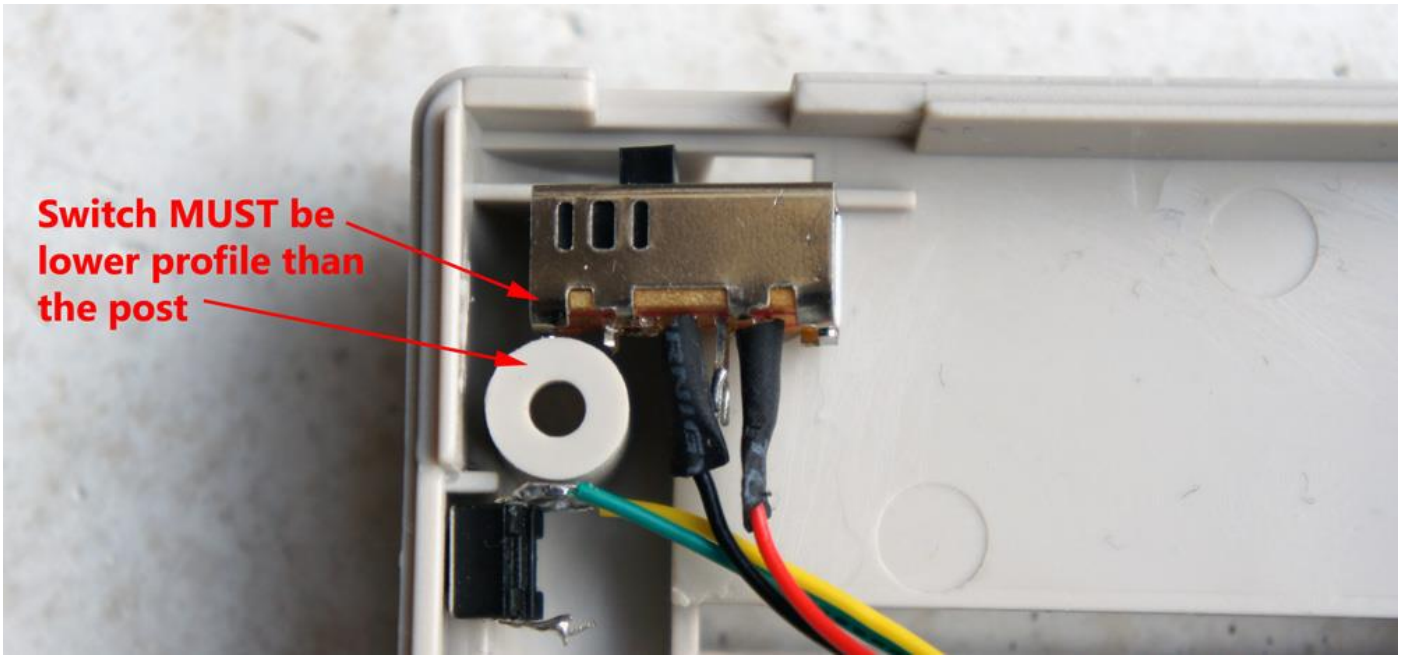


Your buttons should now fit well and function! Check that they don't interfere with anything (like that back board).

8.4 Fit Power Switch and Mode Button

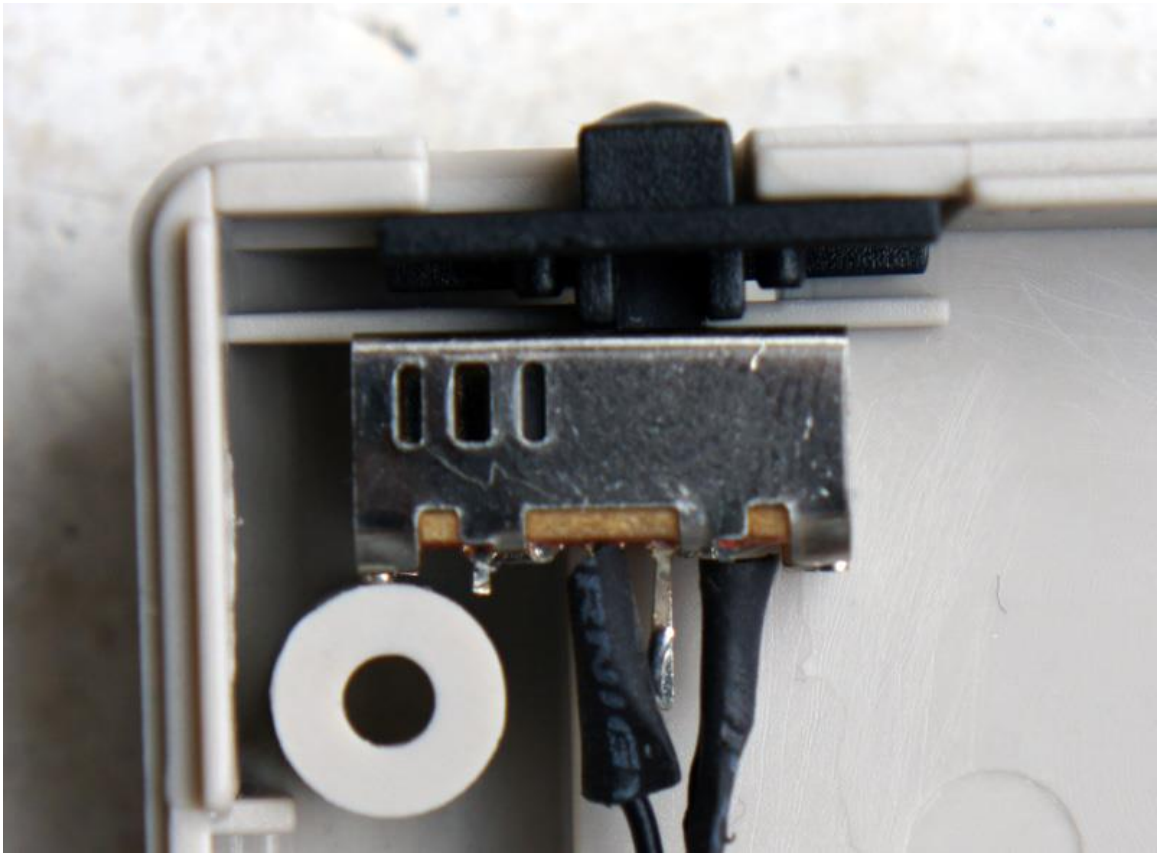
Offer up the switch to the place that it will be installed. The switch MUST be lower profile then the post that it is pushed up against. This is achieved by lowering it and cutting out the plastic underneath it. This does not affect the cartridge slot as the switch only needs to be lowered by 1mm or so. If you don't do this you can't close the case.

Bend the pins and make sure it fits as per image below.

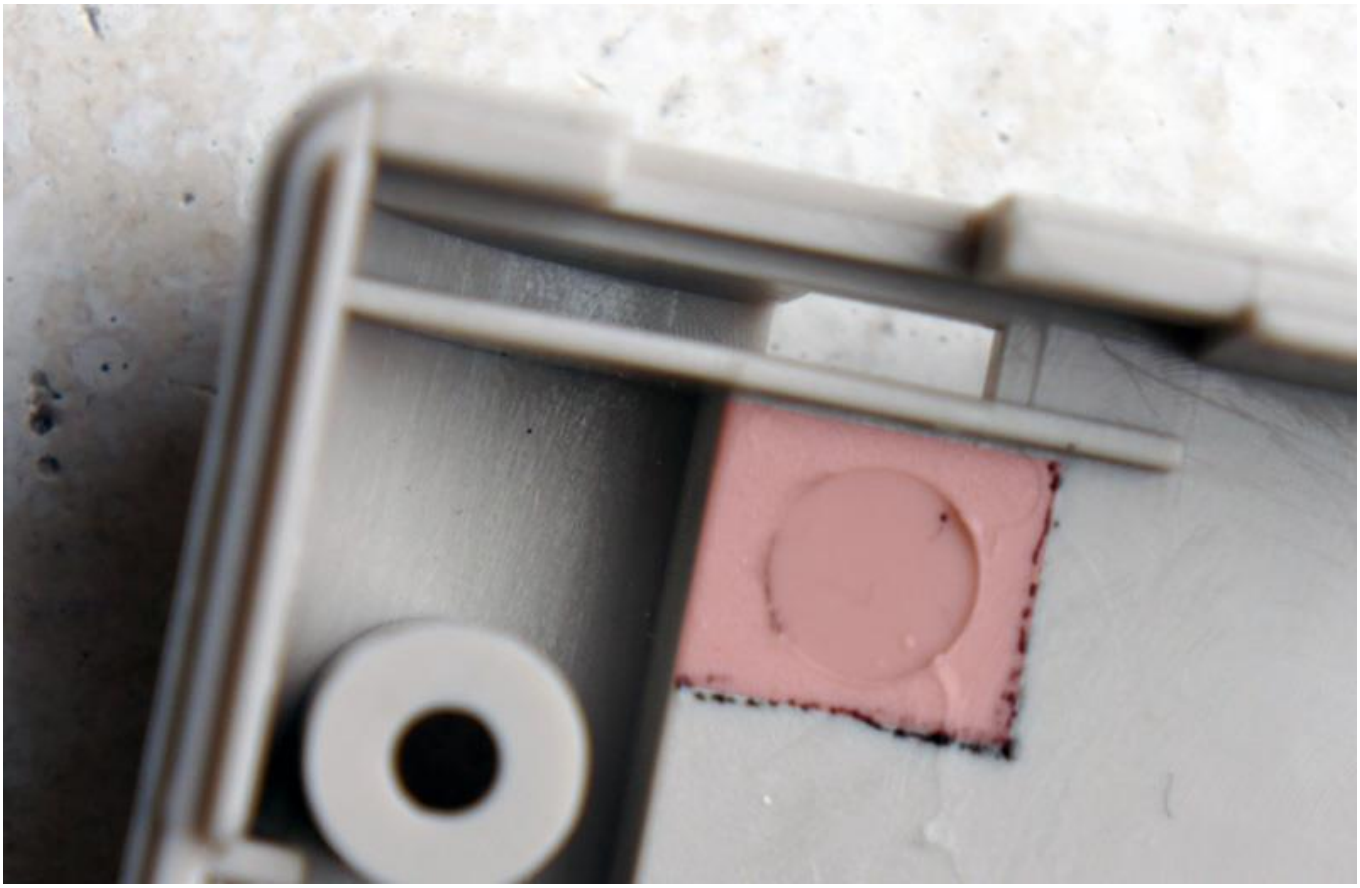


8.4.1 Fit Power Switch

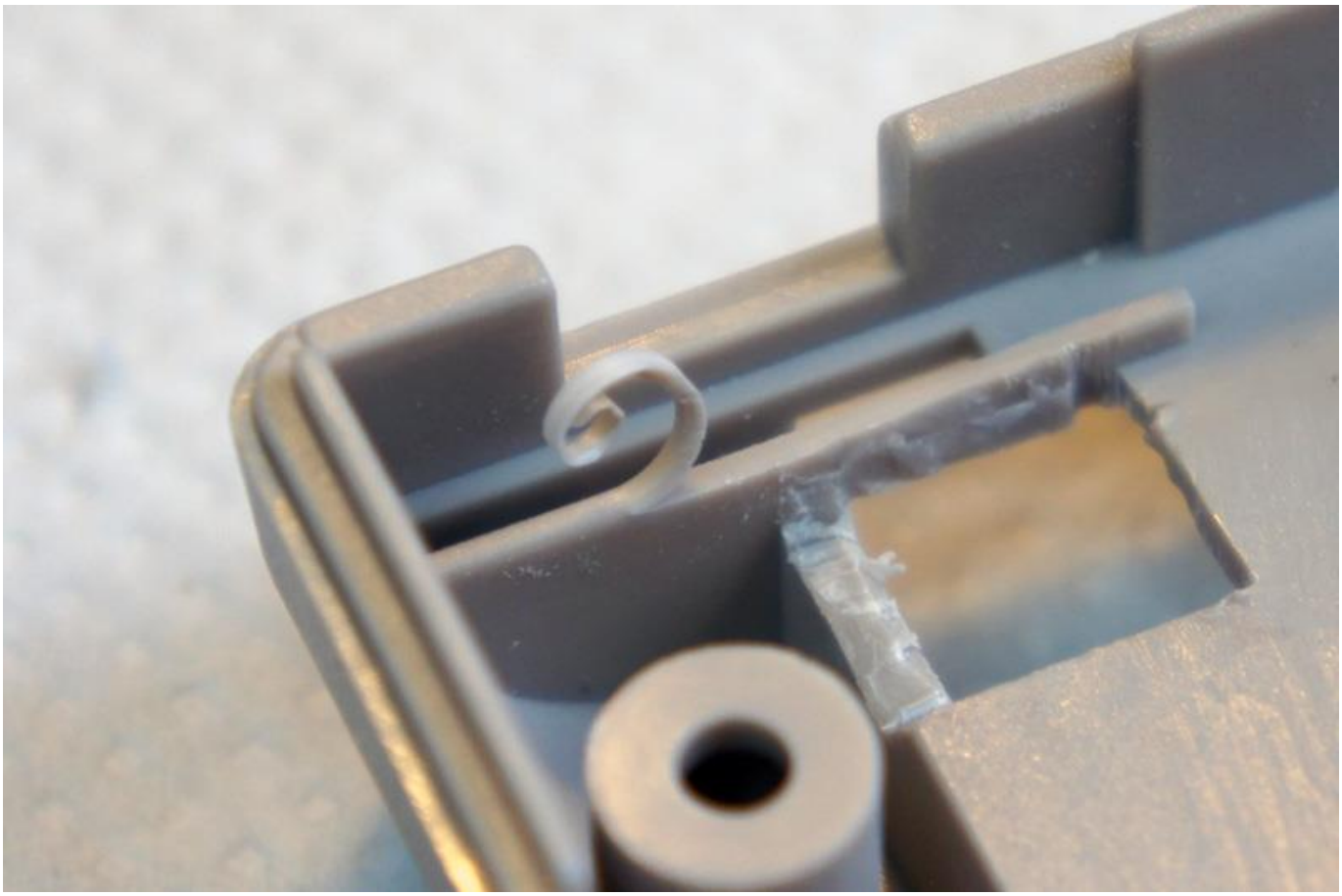
The actual plastic bit of switch will fit as per the image below. This is required to be fitted before gluing and also shows where you need to position the switch to get a full ON/OFF. You may need to trim the mounting post to fit.



Mark out where the case needs cutting. Do not cut down too far, only 1mm or so is needed.



The following image shows what was cut, and the 'guide rail' will probably need a slight trim too. Use a sharp knife.

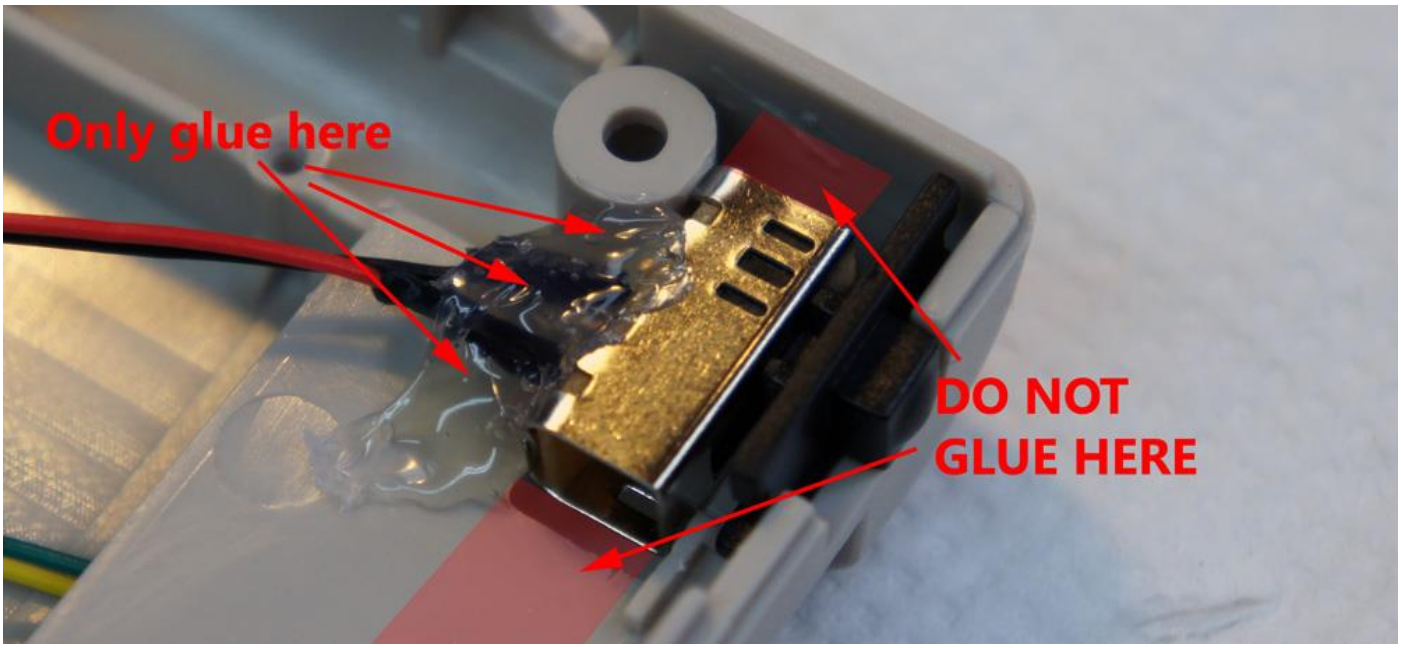


The back side should look like the following image. Neaten up with a knife if necessary. I didn't here because I am gluing the cartridge in.

Sand down the inside area to make sure glue will adhere well.

Apply glue. Not much glue is required and most can go on/under the wires. Do not apply glue anywhere near the sliding mechanism or to the side of the switch.

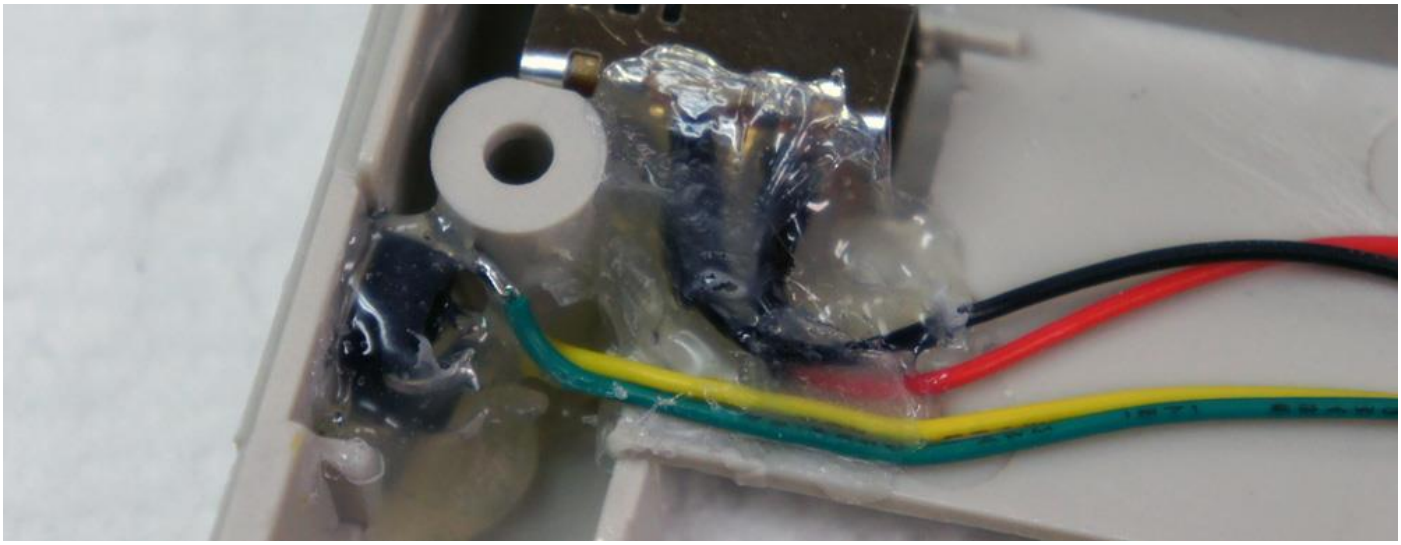
Trim any excess glue with a knife, making sure everything is LOWER than the post right next to it.



8.4.2 Fit Mode Button

The mode button will go in the place of the power jack. This button is used for controlling WIFI and backlight brightness.

When in place, fill with glue. Using a pair of needle nose tweezers you can hold the switch from behind to make sure it lines up nicely.

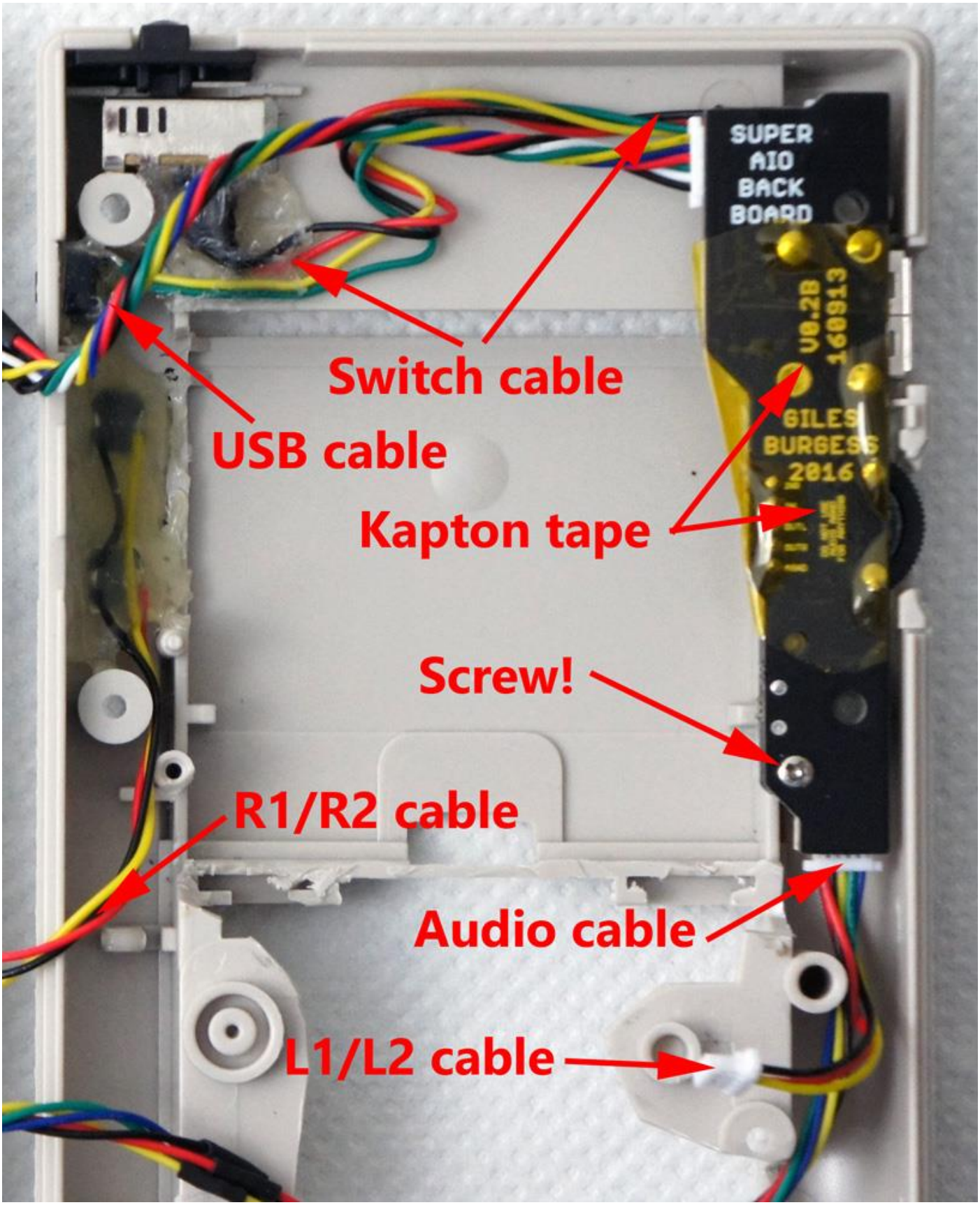


8.4.3 Test Switch and Button

Test the switch and button to make sure nothing was damaged during fitting. Glue or tape the wires to stop them being tugged and broken off (above you can see them covered slightly in glue).

8.5 Fit Back Board

Fit plugs and fit the backboard in place. Use a screw to hold the backboard. Try and keep the wires as neat as possible.



8.6 Test Fitment of Front Half of Case

When fitting the back board, be careful of the USB port metal casing. It likes to get trapped in the EXT CONNECTOR lip. Make sure it goes BEHIND the lip.

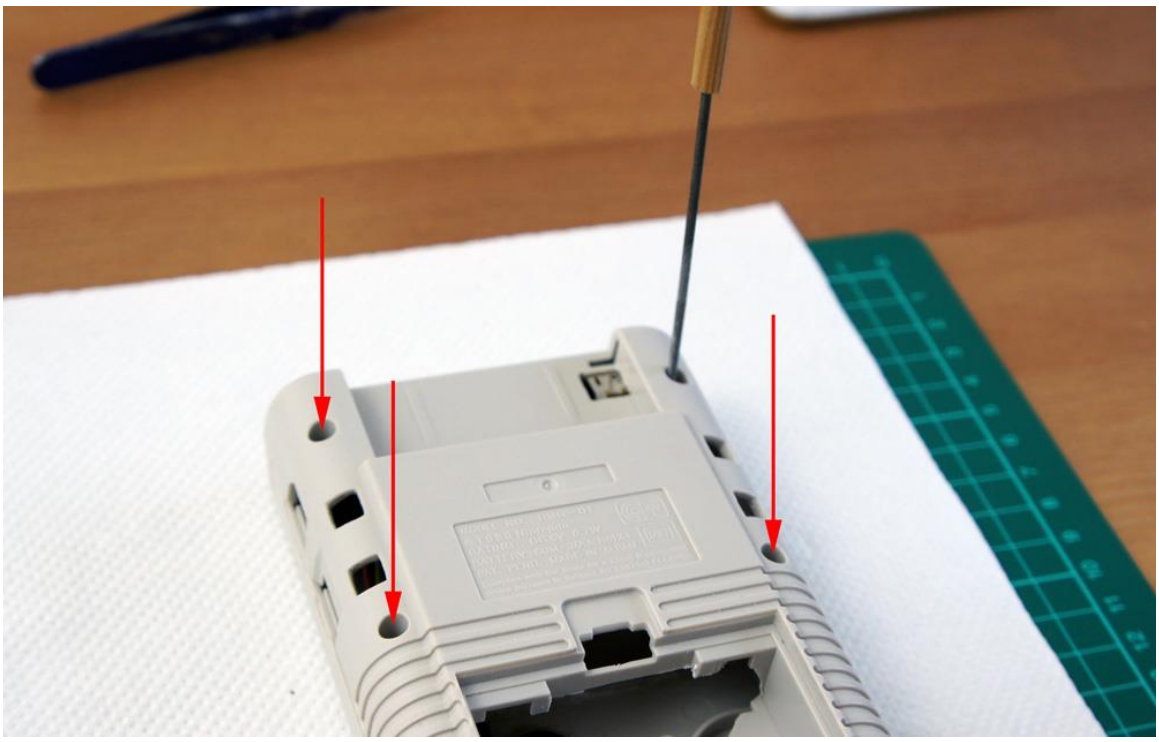
9 Phase 5 – Finish Front Half of Case

9.1 Glue Mounting Posts

During this step we will mount the posts that we cut off in an earlier step.

9.1.1 Prepare Mounting Locations

Place the back half over the front half, and using a needle/file/pointy thing push it through the back of the case and scratch the back of the LCD (don't push, just scratch in a small circle).



Remove the back half and find where the marks were made. These will be the points where the posts should be mounted.

Mark the points with a marker.

Sand and rough up around these mounting points. Redraw the mount locations where necessary. Extend the 'dots' into a crosshair, this will make it easier when positioning.

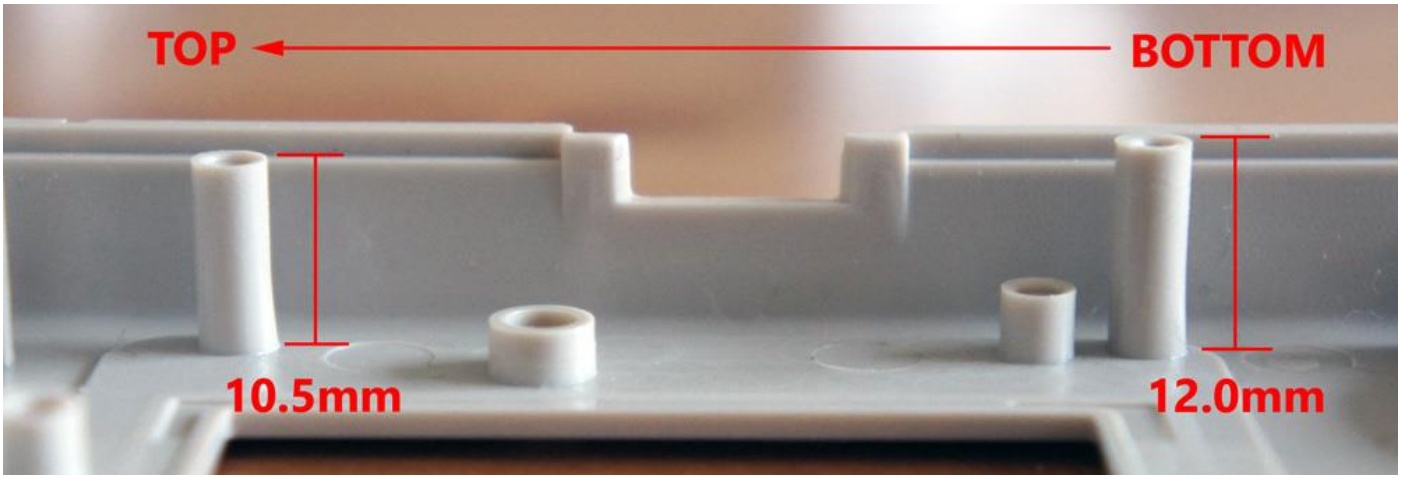
9.1.2 Prepare Mounting Posts

The posts are two different lengths. The TOP side of the board is 10.5mm TOTAL height, and the BOTTOM are 12.0mm TOTAL height. The LCD is currently in the way and is 4.0mm in height.

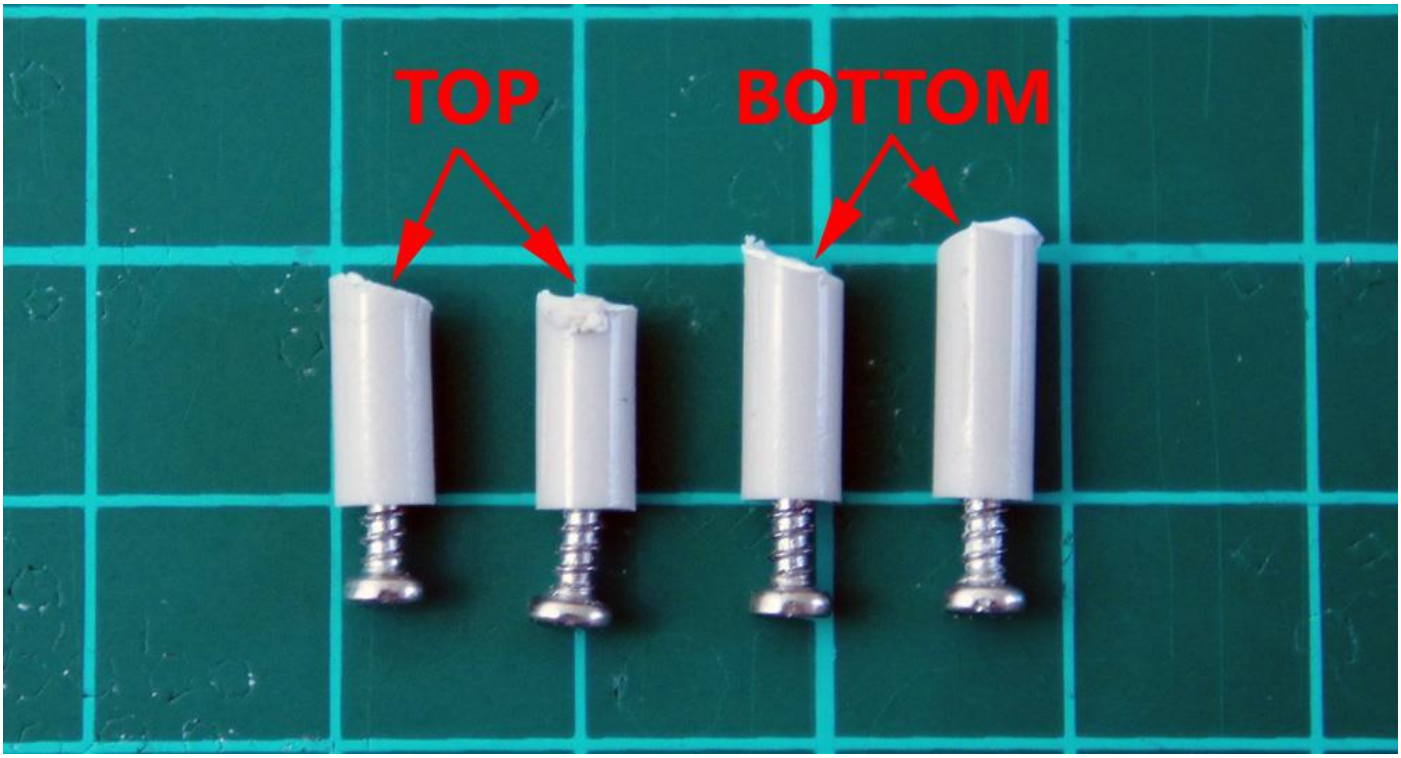
The TOP length to cut to is 10.5 – 4 = 6.5mm.

The BOTTOM length to cut to is 12 – 4 = 8mm.

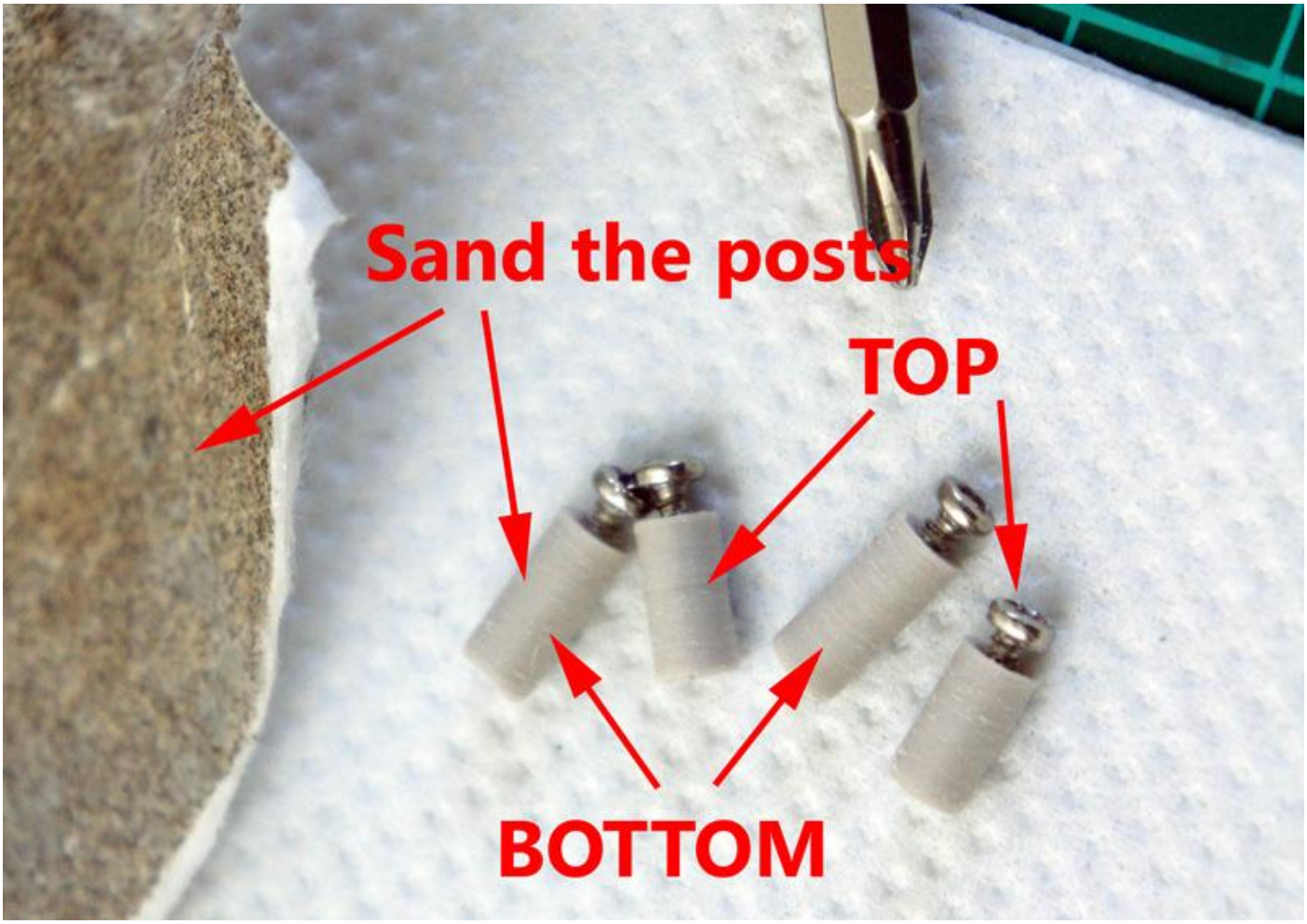
These values are approximate, it is better to make them longer and sand/trim them down later when offering up the two sides. If they are too short you may need to find additional longer screws! I have found that if this is the case, you can use an M2 bolt, and they screw nicely into the mounts.



After cutting from a previous step, screw in the screws (all the way and out and back in again) to make sure they cut the screw thread into the plastic nicely to avoid stress on the glue.

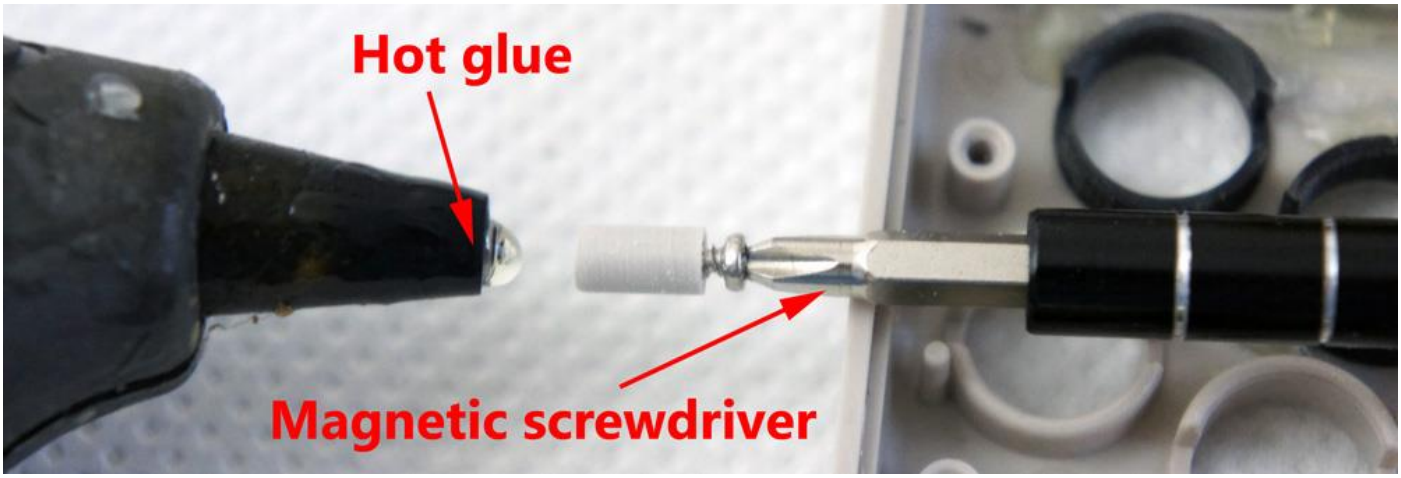


Once cut to length, sand the outside (the easiest way is to wrap in sandpaper and use a screwdriver on the screw to rotate the standoff inside the sand paper).

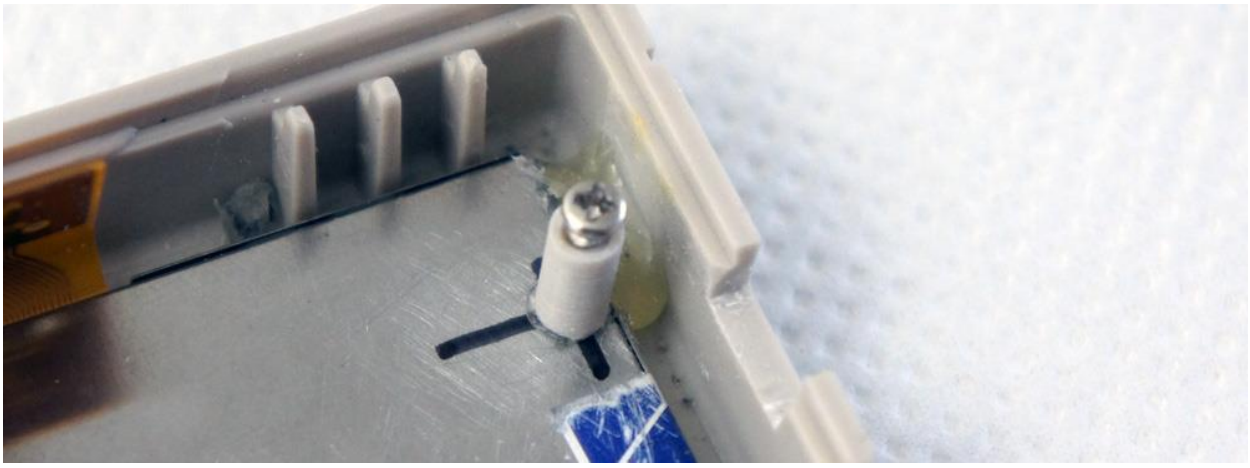


9.1.3 Tack Mounting Posts

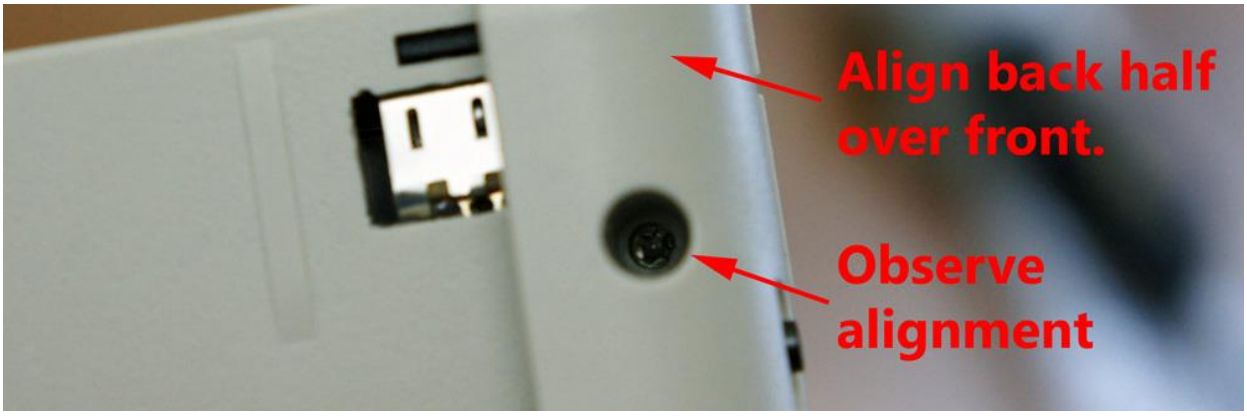
To get the post in the approximate position, lie the glue gun on its side and let it drip glue out (as they do). With a magnetic screwdriver, push it on to the glue and hold for a few seconds. Then quickly remove and place vertically and firmly on the marked position on the back of the LCD. The metal will cool the glue instantly, and if you place it wrong or the glue comes off because you tried to adjust it, then just snap it off, remove the glue, and try again.



The end result should look like the following image.



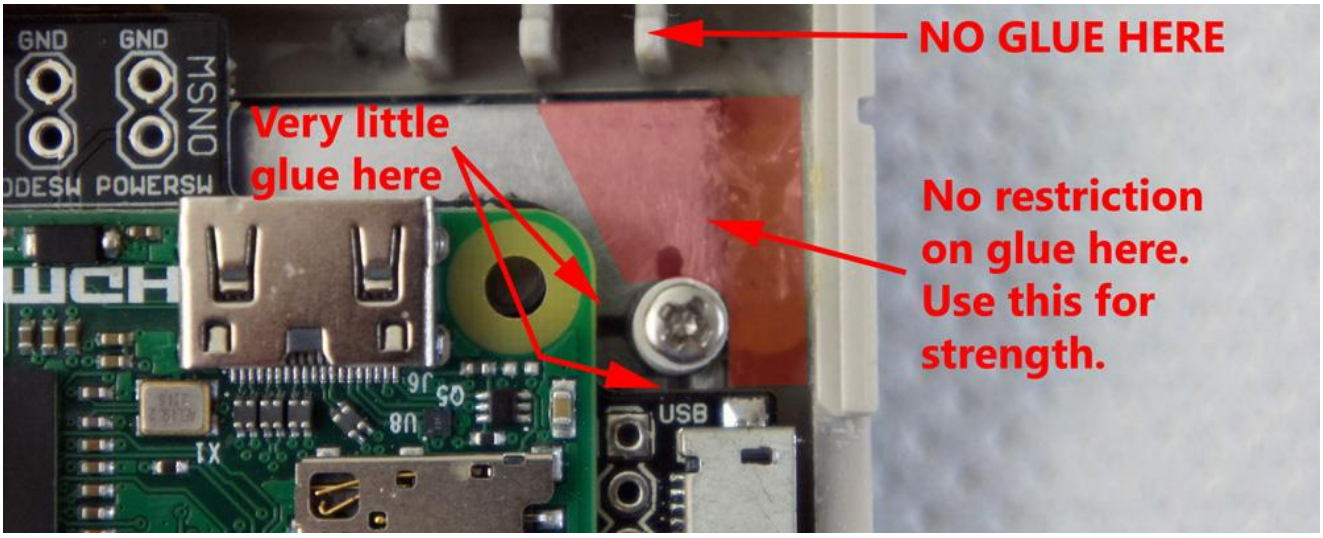
Now place the back half of case over the front. Looking down the screw holes you should be able to see the screw head perfectly. If it is not in the centre then break it off and try again (you may have to work out an angle to place the standoff down at, as the base may not be flat). If successful it should look like the image below.



9.1.4 Glue Mounting Post

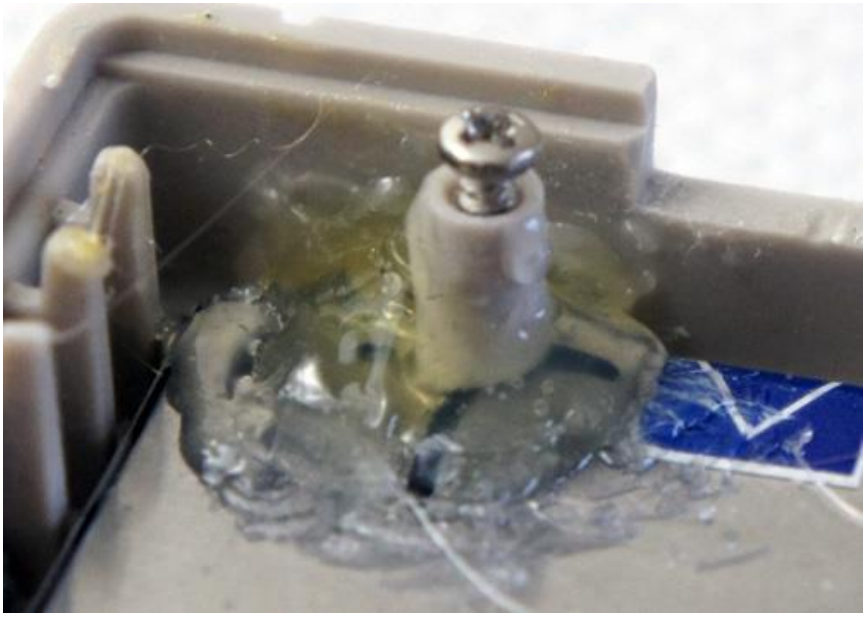
9.1.4.1 Initial Glue

Place the main board over the case. You will notice that there are some areas that you should use a little amount of glue, and other areas where there are no restrictions. The image below has highlighted in red/pink the area where the most amount of glue can be used. The other areas still need glue but they must be lower down. It can be trimmed with a knife or the glue tip later.



GLUING TIP: Hot glue works best when it has a solid connection to the materials that it is connecting to. You have already prepared the surfaces by sanding and roughing them up, which creates scratches/grooves/cracks for the glue to fill in and bind to. A perfectly smooth and flat surface wouldn't hold very well at all. In order to fill the cracks the glue needs to be hot. A good technique is to squish a blob of glue out the of glue gun in the location you want to glue, and hold the glue gun nozzle in place for a few seconds (inside the glue blob). The hot tip of the glue gun is very useful for re-melting or manipulating the hot glue to move it to where you want it to go. Be careful of pushing it into the plastic as it will start to melt it, but in a way that will make the strongest joint! You can see in the image below that I have tapered the glue around the post, and even put glue all over the LCD to create a strong 'cone' like shape out of the glue. On the 'stronger' sides I put the glue higher up the post, and on the 'keep out' areas I made it very steep and only put glue around the base.

The end result should look like the following images. Note that if during gluing the post moves (you'll need to do an alignment check again regardless) it is possible to re-move it by using the tip of the glue gun to re-melt the glue, and then gently move the post. As long as you have melted enough of the glue, this is easily possible.

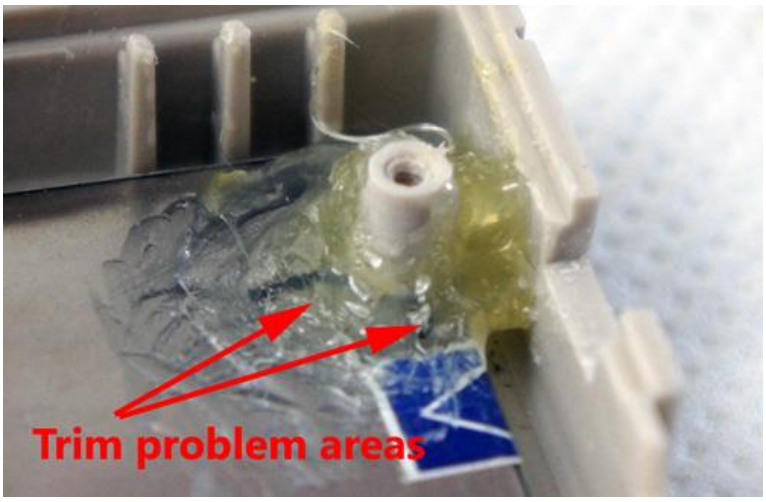


9.1.4.2 Initial Fitment

Check for fitment. The board should not touch any glue.

9.1.4.3 Tidy-up

If there are interferences, use a knife or the hot tip of the glue gun to flatten the problem areas.



9.1.4.4 Final Fitment

The board should fit nicely. Check the USB port and SD card align up correctly. If they do then it is good.

9.1.5 Attempt to Close Entire Case to Check for Fitment

Remove the screw carefully and do another check for fitment. The hole should line up and you should be able to screw in the screw. Make sure the glue is COMPLETELY cold before doing this, and don't overtighten.

9.1.6 Repeat for all Posts

Follow the exact same steps and do this one post at a time. Do not try and do them all at once. The following image shows the approximate keep out areas for each post. You may find it easier to tape the ribbon connector down as pictured with a bit of kapton tape. Always use the actual main board as a guide on where to avoid.

9.2 Check for Fitment Again

At this point you should be able to fully close the shell, with all 6x screws. Trim the posts where necessary.

9.3 Glue Screen Fully

Providing everything is working and fits nicely, you can now apply more glue to the edge of the LCD to hold it firmly in place. Do so around all the edges except where the power switch is.

10 Phase 6 –Prepare Battery Bay Door (optional):

10.1 Glue Magnets

In this optional step, the battery door catch will be removed and magnets installed. 3mm round by 1mm thick magnets were used in this guide.

The main purpose of this is that the catch protrudes inside the case significantly, and the battery that I chose gets in the way. By removing the catch and replacing with magnets a larger battery can be used.

Fit magnets on the battery door first, once glued placed the other side magnets onto the glued magnets, then place glue on the back half of case, then close the battery bay door and push down the corners. The magnets will now be perfectly lined up and at the right height!

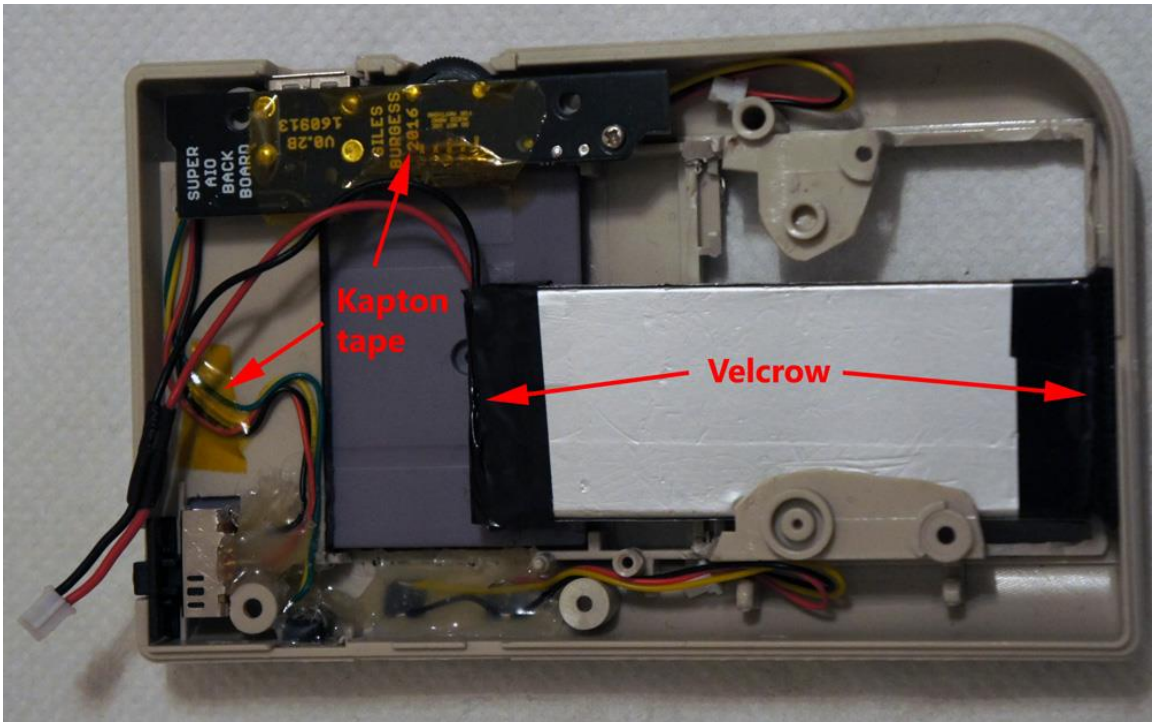
Always sand down the magnets and plastic. Always test fit by stacking the magnets and trying to close the case. It may be required to trim some of the plastic to get the right height!

DO NOT APPLY GLUE TO MAGNET DIRECTLY, apply the glue to the plastic and then place the magnet. The reason is that the heat of the glue will de-magnetise them.

11 Phase 7 – Finalise

11.1 Test Fit Battery Placement and Blank Cartridge

In this guide I chose a long and slim battery due to the huge speaker used. Ideally you should get a battery that fits in the battery bay alone, and choose a more sensible speaker! The lower down the battery is, the better the balance of the console (no one likes a heavy screen). In order to fit my battery, I glued in a blank cartridge and then applied Velcro to the top and button of the battery. It was a perfect fit! It is recommended to leave a bit of space near the top and button of the case for the wires to lie in.

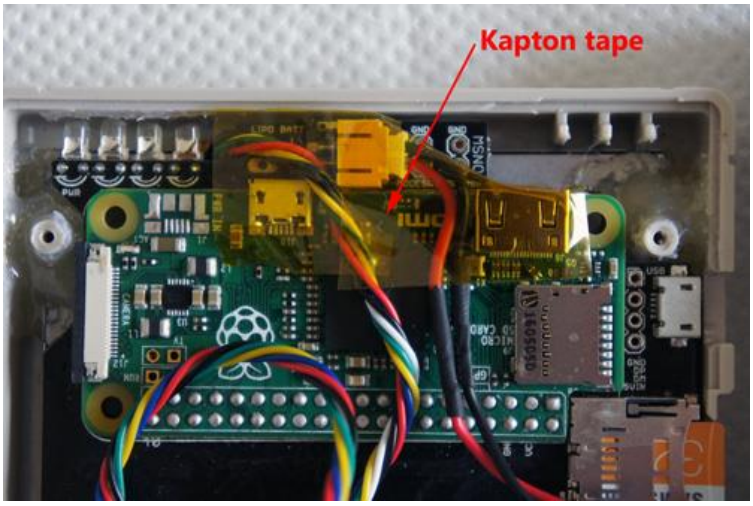


Check for fit and check for closing. Note the crazy bit speaker that gets in the way!

11.2 Plan Wire Placement

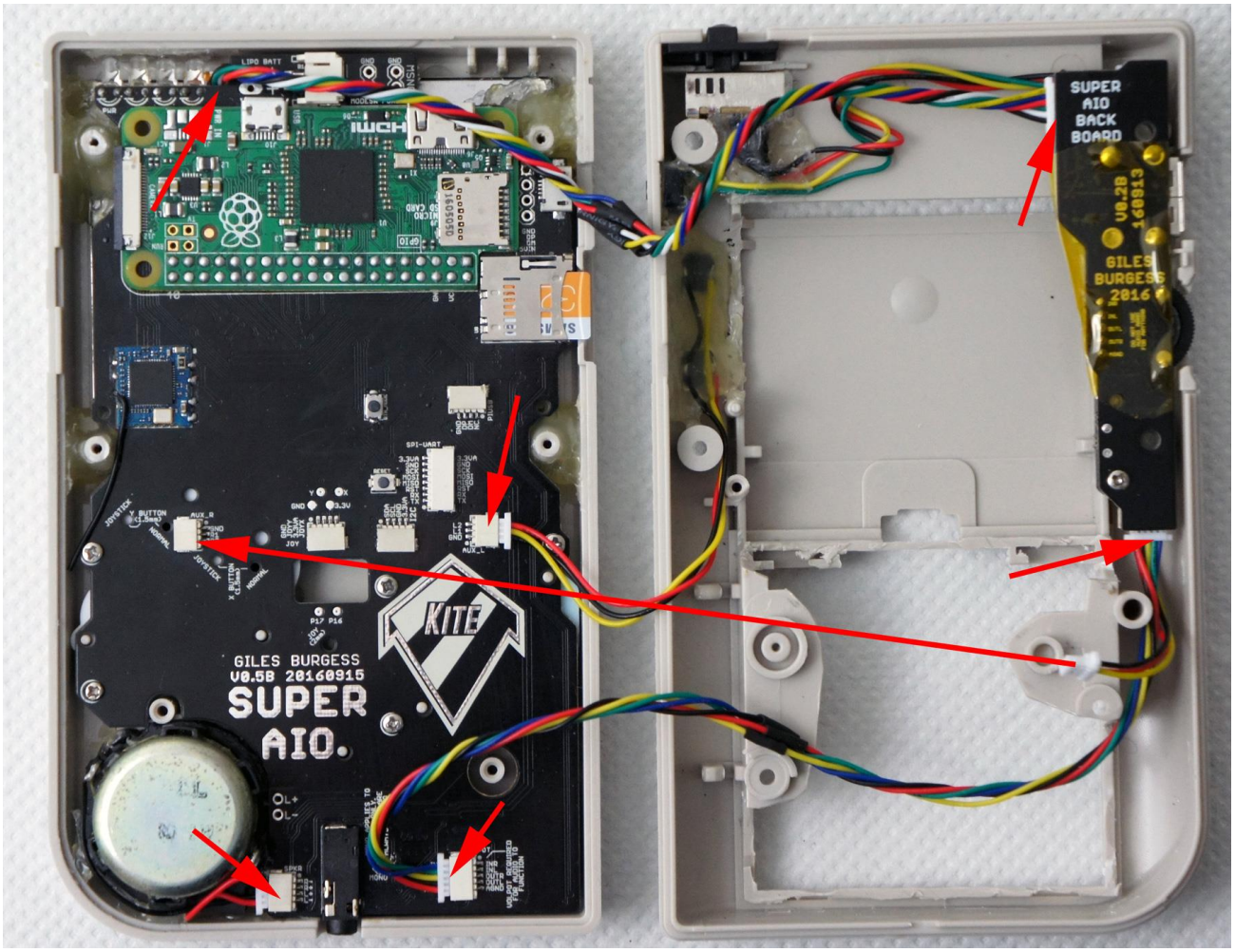
With everything pretty much ready, plan where the wires are going to lay.

It is a good idea at this point to kapton tape the battery connector so that the battery wires go between the connector and the HDMI port (otherwise if the wires go on top of the HDMI port the case might not close).



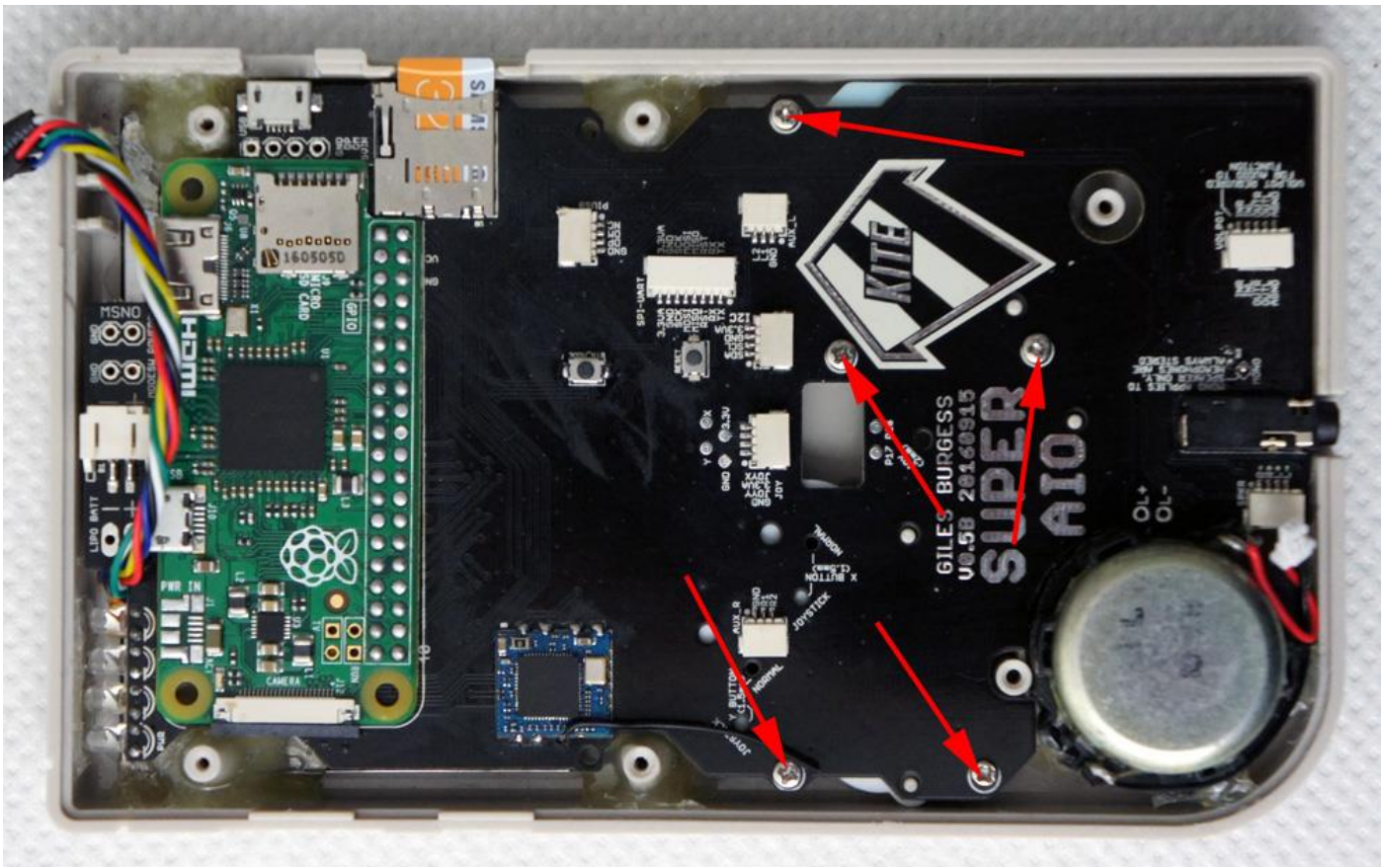
The following image shows the two halves side by side and what wires connect to where. The last wire (the R buttons) needs to be carefully connected while the cases are nearly closed. A pair of needle nose tweezers work well here. *NOTE: Ignore the missing USB connector, also final version of PCB has the back board connector location diff*.

It should be possible to lie the cases next to each other and work on it as shown in the image below.



11.3 Install Buttons and Membranes

You may have already done this, but the very final thing to do assuming everything works is to add the buttons and membranes and screw all the screws that hold the main board in. The following images show this.



11.4 Test All Functionality

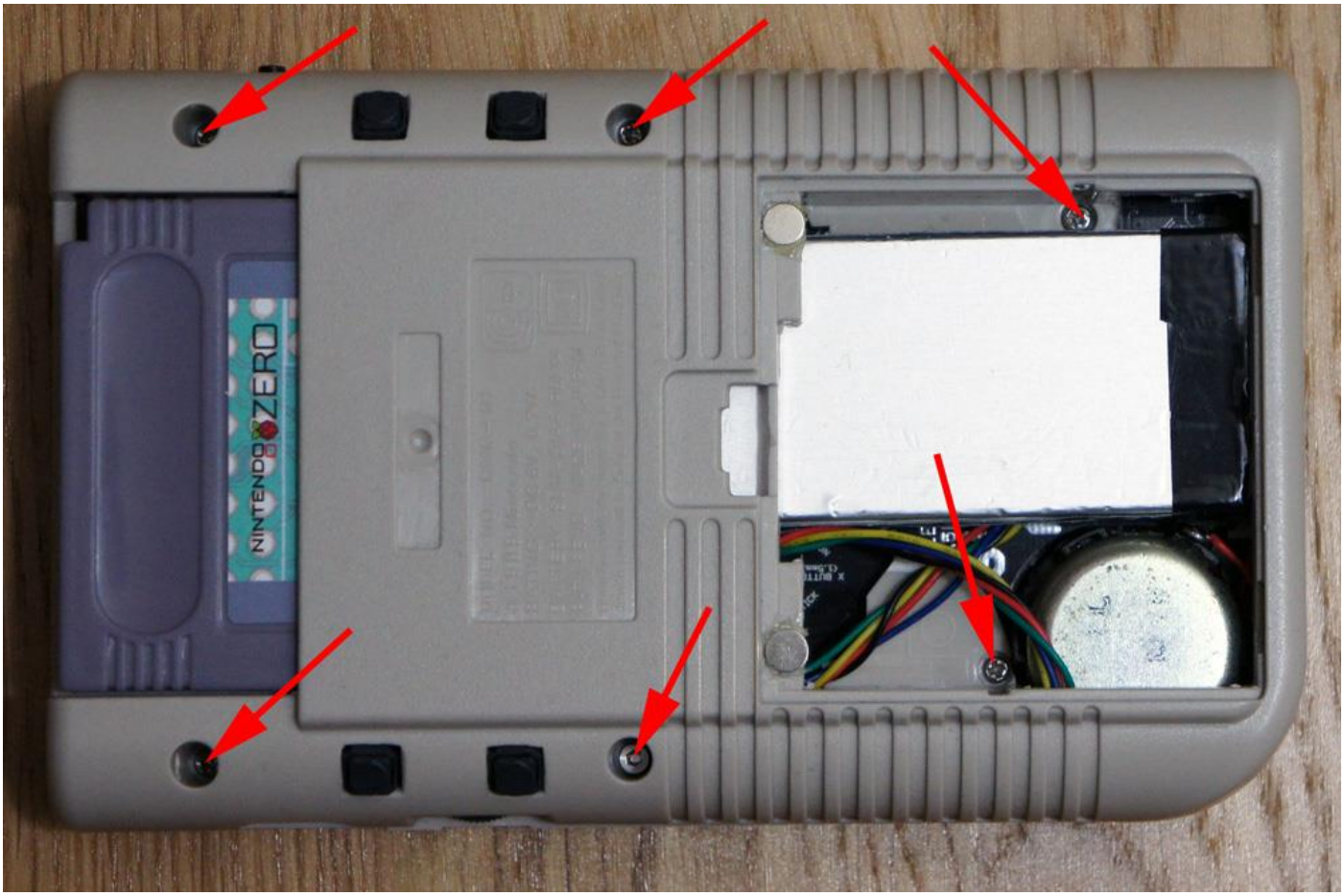
Test everything!

11.5 Affix Screen Surround

Using some double sided tape, apply the tape to the CASE and then place the screen over the top. Make sure to remove all dust and clean the inside of the LCD and glass. With some care it should look like the following image.

11.6 Screw Case Closed

The final part is to close the case and screw in all screws. Don't overtighten the top 4 because even though they are firmly glued you don't want to ruin the hard work. With all 6x screws the case will be very solid.



The project is complete!

11.7 Finished Project

12 Software Installation

12.1 Pre-made Image

The follow steps detail the EASIEST way to get the software running, by using a pre-made image that has everything installed in the correct place.

12.1.1 Files

File Location: https://github.com/geebles/Super-AIO/releases

- retropie-4.1-rpi1_zero_saio-20170223-4.zip
  - Main 'normal use' image
- retropie-4.1-rpi1_zero_saio_tester-20170223-4.zip
  - Test image, runs a test application on boot to test for USB and LCD

12.1.2 Install Steps

1. Download 'Win32DiskImager' or similar
2. Download .zip as per above links
3. Extract the .img from the .zip (it will end up being ~2Gb in size)
4. Insert SD card to PC
5. Open 'Win32DiskImager' and point it at the .img file
6. Pick the correct drive letter for your SD
7. Press 'write'

12.1.3 Boot Procedure

On first boot, a blue screen will be shown briefly as it resizes the image to fill the entire SD card, this is normal. It will then reboot and load up RetroPie. The first boot may take a while, and I have noticed that SSH isn't started correctly on the very first boot, so when booted all the way up to the main menu you should configure your input and then press start -> quit -> restart system.

12.2 On-top of Existing Image

The following steps well walk through how to install the SAIO software onto a STANDARD RetroPie image. This will enable:

- DPI LCD
- USB Audio
- Safe Shutdown
- Battery bar monitor

12.2.1 Files

File Location: https://github.com/geebles/Super-AIO/releases

- "Source code (zip)"
  - Download and extract the folders 'release/saio' and 'release/tester'

12.2.2 Install Steps

The following steps are required:

1. Insert SD into computer
   a. Edit 'config.txt' and add the following to the END of the file (use 'Notepad++' for this):
      i. # SAIO Config
      avoid_warnings=2 #Needed for 3.3v

```
dtoverlay=gpio-poweroff,gpiopin=22,active_low="y" #Safe shutdown

#320x240 DPI LCD
dtoverlay=dpi18 #Enable DPI overlay
overscan_left=0
overscan_right=0
overscan_top=0
overscan_bottom=0
enable_dpi_lcd=1
display_default_lcd=1
display_rotate=2
dpi_group=2
dpi_mode=87
framebuffer_width=320
framebuffer_height=240
dpi_output_format=24597 #rgb mode
hdmi_timings=320 1 20 30 38 240 1 4 3 10 0 0 0 60 0 9600000 1
```

   b. Make a new folder called 'saio' and extract the contents of the 'release/saio' folder here
2. Place SD in SAIO, and power on
   a. If using wifi, you can perform the following steps using SSH (download 'putty') using the credentials 'pi' and password 'raspberry'.
   b. If using a USB keyboard, press 'F4' to drop emulationstation to the command line.
3. Run the following commands EXACTLY as they appear here:
   a. `cd /home/pi`
   b. `Git clone https://github.com/geebles/Super-AIO`
   c. `cd Super-AIO/release/saio/`
   d. `sudo dpkg -i python-serial_2.6-1.1_all.deb`
   e. `python saio-osd.py`
      i. This will test that the script works, the battery voltage will be shown and the icon on screen
      ii. Press CTRL + C to stop it
   f. `crontab cronSAIO.txt`
   g. `sudo cp asound.conf /etc/`
   h. `sudo reboot`