This project is for a Raspberry Pi based music player that I call an Art Deco Jukebox. The design of the case pays homage to the ‘tombstone’ table top radios of the 1930s and 40s as well as the full size Wurlitzer jukeboxes of the 1950s and 60s.

All the files for this project are available here; https://github.com/BigjBehr/JukeBox

An Instructable for this project can be found here; https://www.instructables.com/Art-Deco-Jukebox/

Features of the Art Deco Jukebox are;

- Addressable LEDs are used to replace the ‘bubble tubes’ used by Wurlitzer. This allows for a wide range of animations to be displayed.
- A TFT LCD is used to display information about the RPi CPU temperature, the currently playing music as well as the music source; NAS (Network Attached Storage), USB or SD card.
- The top chamber forms an infinity mirror.
- Bluetooth (Classic or BLE) and IR remotes are supported for simple control of the jukebox.
- WiFi is used to obtain music from a local NAS device.
- A stereo audio DAC HAT is used to provide quality music reproduction.
- Flexible case design to accommodate various combinations of RPi and DAC boards.
    - The case was designed to accommodate all Raspberry Pi ‘Zero’ and ‘B’ series boards.
    - The case allows for RPi Zero boards to be mounted in two places so that Zero series or ‘B’ series DAC boards can be used.
- An optional MSGEQ7 audio spectrum analyzer can be added to make the LEDs dance to the music. The addition of the MSGEQ7 allows for the LEDs to be used as a ‘color organ‘.
- The RPi or an optional Raspberry Pi Pico can be used to drive the addressable LEDs.
- If not using an RPi Pico then an ADS1115 ADC board is used to interface to the MSGEQ7.
- All plastic case parts are 3D printed.

This project does not have a built-in power amplifier. It will not drive speakers directly. It is intended to be used with either a home stereo system or with a set of powered computer speakers. The exception here is that some DAC boards for the RPi do have built-in amplifiers. One of the boards I purchased has a low wattage amplifier and came with a pair of small speakers. There are some, more expensive DAC boards, that have high power amplifiers built-in. These are meant to drive speakers directly. Most RPi

DAC boards have a pair of standard RCA jacks for connection to a stereo system and a headphone jack. The headphone jack may have a low wattage amplifier intended to drive a set of headphones. The choice of DAC, amplifier combination is entirely up to you, your ears and your wallet.

Most music player software written for the Raspberry Pi (RPi) are aimed at using Internet radio, podcasts or music services like Spotify, Tidal or Pandora. These programs typically use playlists and a web interface for control. This project does not do any of those things.

Music is sourced primarily from a NAS (Network Attached Server) or a USB storage device or the left over space on the micro SD card that boots the system. Control is done by using a Bluetooth (Classic or BLE) remote or an IR remote. There is also a touch button at the top front of the case. What the button does is determined by the context at the time of the button press.

All of the case parts were designed using OpenSCAD and are 3D printed. I have included STL files for all the 3D printed parts. There are different STL files for cases that use different RPis. Likewise there are different back panel STL files for different combinations of RPi and DAC board. I have also included the OpenSCAD source file so you can modify the back panel to accommodate the DAC board of your choice. Tips for 3D printing the case parts are in the 3D Printing sections. If you use the provided STL files you will not need OpenSCAD. OpenSCAD is only required if you need to modify an existing 3D printed part.

I used a metallic, silk filament (silk gold or silk copper) to 3D print all the clamps and the ‘bands’ & clamps of the Grill Insert. I used the same color for the grill part of the Grill Insert and the Double LED Cover Stripe. Of course, you are free to use your own color schemes.

Most of the hard work required to build one of these Jukeboxes has been done for you. However, some skill with hand tools, soldering and 3D printing as well as some experience with Raspberry Pis will be very helpful.

Please do not ask me to make modifications to the code or 3D printed parts for you. Think of it as a learning experience. You are gaining knowledge. Not to mention the thrill of personal achievement. If you have a question or need help I will try to provide assistance.

For this document the phrase *Raspberry Pi or RPi* is used to indicate the Raspberry Pi Single Board Computer (SBC) being used. Pico is used to indicate the Raspberry Pi Pico microcontroller breakout board being used.

There are many high quality guides available on the Internet for how to install and configure an operating system (OS) for a Raspberry Pi. There are also guides published by the Raspberry Pi Foundation for how to setup Microsoft's free Visual Studio Code for programming the Raspberry Pi Pico as well as the Pico SDK for C/C++ programming. I am not going to waste my time attempting to reproduce these excellent guides here. Use what is available.

Electronic Parts List:

- One Raspberry Pi, either a Zero 2 W or 'B' series board. Exception is RPi5B is not supported, RPi Zero 2 W is the preferred board.
- One 2.4 inch, SPI, 320 X 240, TFT LCD using an ILI9341 driver.
- One meter string of SK6812 side emitting, addressable LEDs with a pitch of 60 LEDs per meter. 58 LEDs are used.
- A string of thirteen WS2812B LEDs from a string with a pitch of 60 LEDs per meter.
- A stereo audio DAC HAT, Zero series or 'B' series with a GPIO pass through header.
- A micro SD card setup with Raspian Bullseye Lite.
- One barrel style, panel mount power jack.
- One 4 amp, 5V power brick with mating barrel jack. If a RPi4B is used then a 27W PD power brick (for RPi5B) with a USB-C connector can be used and the barrel jack can be eliminated.
- Air Mouse BLE 5.2 Remote or similar Bluetooth remote or an IR remote.

If you opt to use an SBC that is not a Raspberry Pi (Banana Pi, Orange Pi, Beagle Bone, etc) then you are on your own. I do not own any other SBCs so I do not know what OS to use or if the GPIO pins are compatible.

Optional Electronic Parts List:

- Either an RPi Pico (any model) or ADS1115 ADC board.
- MSGEQ7 audio spectrum analyzer board.
- A TTP223 Touch Switch board.
- 38KHz IR Receiver VS1838B or similar (only if using IR remote).
- A 38KHz IR remote.

I used a full size, first generation RPi Pico. It has four mounting holes. I have some RP2040-Zero boards that are smaller and less expensive, but they lack mounting holes. If you use a non-standard RP2040 board you can always use double sided, foam tape to hold it in place. Same goes for any board that does not have mounting holes in the designated places.

All DuPont connectors have a pitch of 0.1 inch (2.54mm).

Passive Parts:

- 22awg stranded hookup wire in Red, Black and Orange. These are power wires and should be a heaver gauge than the signal wires.
- 24awg stranded hookup wire in various colors.
- 22awg solid hookup wire
- A dual row, 40 pin (two rows of twenty) DuPont style connector shell and appropriate female crimps.
- A single row, 10 pin DuPont style connector shell and appropriate female crimps.
- If using a Pico add a second, single row, 10 pin DuPont style connector shell and appropriate female crimps.
- A single row, 14 pin DuPont style connector shell and appropriate female crimps.
- One single row, 3 pin DuPont style connector shell and appropriate female crimps. Add another if using an IR remote.
- A single row, 5 pin DuPont style connector shell and appropriate female crimps.
- A dual row, 20 pin (two rows of ten) DuPont style header (male pins).
- Seven, 2 pin DuPont style connector shells and appropriate female crimps. If not using a Pico then add three more. If using IR and no Pico and not using DAC IR receiver mount's power then add one.
- One, three pin male header (to replace phone jack on the MSGEQ7 board).
- One, three pin, right angle male header (for TTP223 board).
- Two, twenty pin male headers (for Pico). Only the first ten pins on each side of the Pico are used. You could use two, ten pin headers instead. If using ten pin headers then solder to the pins closest to the USB connector end of the board. The headers should be on the top (component) side of the Pico.
- One peel-and-stick aluminum heatsink, 14mm X 14mm X 6mm.

Optional Passive Parts:

- These parts are only needed when a RPiZ2W is used with a 'B' series DAC board.
  - One four wire, panel mount USB-A type socket.
  - One, male, micro USB connector.

Mechanical Parts:

- Fifteen Decorative Brass #2 X ¼ inch self-tapping screws for use on the outside of the case.
- Twenty Two M2 X 5mm self-tapping screws for use on the inside of the case and the back panel. Can also be used in place of the #2 brass screws.
- M2.5 X 11mm threaded standoffs. If you use a RPi5B then you will need different length M2.5 standoffs. The lengths will vary depending on your RPi5B cooler height.

- Four M2.5 X 5mm machine screws. 5mm is the minimum length required. Any length up to 8mm will work. Keep in mind that these are fine threads, so longer screws will take more turns to tighten in tight places. Shorter screws are your friend.
- Four M2 X 5 self tapping screws (only needed if using an RPi Pico).
- Either a 4 inch square plastic mirror, cut to fit or a piece of ‘one way mirror film’ approximately 55 X 90mm (used to make a mirror on the mirror holder).
- A piece of ‘one way mirror film’ approximately 80 X 55mm (used to make a one-way-mirror for the top chamber window).
- A small piece of double sided foam tape approximately 10 X 10mm (used to hold the TTP223 touch switch board in place).
- Four peel ‘n’ stick rubber feet.

The parts list calls out for the use of DuPont style connector shells with crimp pins. If you do not have the tools or skills required to crimp your own wires then you can either buy a bunch of pre-made DuPont female-to-female jumpers or simply solder the wires to the boards (not recommended). If you buy the jumpers and the shells, it is easy to remove the one pin shell and insert the crimp into a larger, multi pin shell. For power wires for the LED strips, a red and a black jumper can be cut in half to provide a set of power wires for two LED strips. It is easy enough to do all the wiring using single jumpers. The problem with this approach is that if you need to remove or replace a board, you have to remove and replace all the wires and get them back on the correct pins. Using the multi pin shells avoids this issue.

If stacking a ‘B’ series DAC on an RPi Zero series board, you will need two M2.5 X 5mm machine screws and two M2.5 square or hex nuts or two 3D printed 1.6mm spacers to account for the thickness of the RPi board. The screws are used in the two front holes of the RPi Zero board. The nuts or spacers are screwed on to the threaded parts of two of the standoffs. The nuts or spacers are there to level out the ‘B’ series DAC HAT.

A word of caution. I purchased several MSGEQ7 board kits from Aliexpress for about $8.00 each. Every single one came with a bad MSGEQ7 chip. I ended up buying good chips from Digikey to replace the bad ones.

I found several vendors selling MSGEQ7 boards. Most of the sites were selling the same board as I bought, as a kit or all assembled. The prices varied wildly. The MSGEQ7 board comes with a 1/8 inch phone jack for audio input. The case does not have enough space to use a phone plug. I modified the MSGEQ7 board by soldering a three pin header on top of or in place of the phone jack.

USB jacks on your computer will not supply enough power to run the Jukebox with all of the addressable LEDs present. Use the barrel style Power socket with a +5VDC power supply capable of at least 4 Amps (20W). The 27W PD supplies sold for use with a RPi5 work very well. However, you will need some way to convert USB-C to micro USB (these are readily available on Amazon). You could use a USB-C panel mount socket to replace the barrel jack style power socket.

3D Printed Parts:

- One Case Shell, selected to match the RPi board being used.
- One Back Panel, selected to match the RPi board and the DAC HAT being used.
- One Double LED Cover, printed in white filament.
- One Double LED Cover Stripe.
- One Single LED Cover, printed in white filament.
- One Grill Insert, selected to match the IR receiver being used or no IR receiver.
- One Top Chamber Window, printed with clear filament.
- One Top Chamber.
- One Mirror holder.
- Four Double LED Cover Clamps.
- Two Top Double LED Cover Clamps.
- Optional, one Circle Guide.
- Optional, one Burnishing Tool.

The Circle Guide & Burnishing Tool are used to help get the one-way mirror film onto the Top Chamber Window.

The section on 3D printing has tips for 3D printing the parts.

Required Tools:

- #1 Philips head screwdriver or whatever you need for the screws you bought.
- Wire cutters.
- Needle nose pliers.
- Wire stripper.
- 3D printer with a print bed of at least 190 X 130mm or a 3D printing service to print your parts.
- Lots of patience.

Optional Tools:

- M2.5 Tap with Tap handle.
- 3/16 Spin Tight (hex nut driver, for tightening standoffs).
- Crimper for DuPont crimps.
- Soldering Iron and solder with ‘No Clean’ flux.
- Hot glue gun and a hot glue stick or super glue or 5 minute epoxy.

- Only needed to finish wood filled filament
  - Tac Cloth.
  - Gel Stain.
  - 1 inch foam brush.
  - Water based, Clear Polycoat. I used a clear gloss. Some people prefer a clear matte finish. I used water based because it does not smell and is easier to cleanup with just soap & water.

Software Tools:

- Putty or a similar program. Used to SSH into headless Raspberry Pi system.
  - https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html
- WinSCP or similar program. Used to transfer files to/from the Raspberry Pi.
  - https://winscp.net/eng/download.php
- Microsoft's Visual Studio Code. Used for programming the Pico.
  - https://code.visualstudio.com/Download
- A plain text editor. PsPad is my plain text editor of choice for use with Windows.
  - https://www.pspad.com/en/download.htm
- OpenSCAD. Free to use CAD package. Used to design all the 3D printed parts of this project. Only required if you need to modify an existing 3D printed part.
  - https://openscad.org/
- Raspberry Pi Imager. Used for making bootable SD cards for RPis.
  - https://raspberrytips.com/raspberry-pi-imager-guide/
- SD Card Formatter. Used to erase & reformat SD cards.
  - https://www.sdcard.org/downloads/formatter/
  - https://www.sdcard.org/pdf/SD_CardFormatterUserManualEN.pdf

These are the software tools that I used during development. If your development station uses MAC OS or Linux then the utilities that you use may have a different name, but should provide the same basic operations as the ones I used with Windows. All the utilities that I used are free to download and use.

RPi Pico vs ADS1115:

The RPi Zero 2 W is capable of running the LED animations and playing music at the same time. However, the RPi Zero 2 W does not have a built-in ADC. Therefore, an external ADC is required to collect data from the MSGEQ7. I chose the ADS1115 I2C ADC.

The alternative is to use an RPi Pico to drive the LEDs. The Pico has a built-in ADC, so if you use a Pico then the ADS1115 is not needed. The code for the Pico has more LED animations than the code that drives the LEDs from the RPi.

Why use a Pico?

Two reasons, the first is cost. A first generation (RP2040 based) Pico costs $5.00. An ADS1115 board will cost anywhere from $2.00 to $8.00 depending on where you buy it. The second reason is performance. The Pico drives the LEDs at 100FPS. The WS2812B driver used by the RPi has a frame rate of 6.6FPS.

Mirrors:
The top chamber of the JukeBox can be assembled with mirrors to make an infinity mirror. With an infinity mirror, one row of LEDs will look like many rows of LEDs.

The mirror holder has two sides. One side has ridges that are used to accurately place a cut-to-size, peel-n-stick plastic mirror. If you 3D print the mirror holder on a smooth build plate then you can put one-way mirror film on the smooth side. Then using a sharp hobby knife, trim off the excess film. This is the easiest way to get the back mirror for the top chamber. However, it does not make the best mirror.

I bought a package of 4 X 4 inch peel-n-stick plastic mirrors from Amazon. I cut one mirror down to 49X89mm. Then stuck it to the mirror holder, using the ridges to position the mirror properly. I then trimmed the parts of the mirror that extend outside the mirror holder. I used the angled sides of the mirror holder as cutting guides. I originally tried to use a glass mirror. However, I could not cut the glass without shattering it or injuring myself. For these reasons I do not recommend using a glass mirror.

Glass mirrors reflect the most light, plastic mirrors are close to glass mirrors. Mirrors made with the ‘one way mirror film’ are not as reflective, but will work here.

Greater reflectivity results in a better looking infinity mirror (greater depth).

Why use ‘no clean’ flux?
The normal rosin core solder that is recommended for electronic soldering will ‘rot’ the copper wires over time. This is due to the corrosive nature of the flux. To prevent your solder joints from ‘rotting’, use ‘no clean’ solder. The ‘no clean’ flux does not cause the same ‘rot’. If you do use standard rosin core solder you should clean off the excess flux after soldering. This can be done with household cleaning products, water and an old toothbrush. Do not power up what was just washed until it is completely dry.

Post Printing Finishing for Wood Filled Filament:

Skip this if you did not use a wood filled filament to 3D print the case.

The gel stain, sandpaper, tack cloth, brush and polycoat are only needed if you use a wood filled filament and you wish to stain it. If you buy a spray on polycoat then the brush is not needed.

Oil based polycoat, varnish or shellac can be used. Check on a test piece first as some oil based finishes can eat the plastic.

I wanted my prototypes to look like they have a wooden case. I 3D Printed the prototypes using a wood filled PLA (Geeetech Black Walnut filled PLA, ~$22.00 for a 1Kg spool). After printing I lightly sanded the sides of the case with 220-320 grit sandpaper. Sand only along the layer lines, do not sand across the layer lines or on the front. I then used the tac cloth to clean up the sanding dust. I used a gel stain to stain the case a dark color (dark cherry). When the stain dried, I was impressed with how wood-like the case looked. Once stained, the micro scratches made by the sandpaper along with the layer lines gave the piece the look of wood grain. I did not sand the front of the case as I printed on a textured build plate and did not want to ruin the texture of the case front. I did stain the case front to match the sides. When staining, make sure to stain the inside edges of the LCD cutout and along the edge of the backside of the case. You do not need to stain the inside of the case as it is never visible. Allow the stain to dry over night. I threaded a twist tie through a couple of the cooling vents on the bottom of the case. This allowed me to hang the case by the twist tie while the stain dried. I found that if I screwed the mirror holder in place, I could hold on to the mirror holder while staining the case or applying the polycoat.

I used a gel stain because I tried to use a penetrating stain on a test piece and found that the penetrating stain did not penetrate the wood filled plastic. Gel stains do not require penetration into the wood fibers, so they work great here. Very easy to apply and wipe off.

FYI, you can purchase a 2oz bottle of gel stain for less than a dollar from Hobby Lobby. The catch is they do not have many colors to choose from.

Alternative Wood Look Case:

An alternative way to get a wood look would be to use either peel-and-stick wood grain shelving paper or a real wood PSA veneer. Apply only to the sides of the case, not the front face. If you use a wood veneer then you will need to stain it after applying. Caution, do not use a veneer that has heat activated glue, you could melt your case.

Remote Control:

The Raspberry Pis with onboard WiFi also support Bluetooth. I bought two Bluetooth remotes from Aliexpress for around $3.00 each. One is BLE (Bluetooth Low Energy) and the other is Bluetooth Classic. Both remotes can also be used as IR remotes. Once they are paired with a Raspberry Pi, they stop sending IR commands. I chose these remotes because they were inexpensive and had all the buttons I required and a few extra. Both remotes also support a ‘mouse mode’ whereby they will send motion data in place of button data when in ‘mouse mode’. This functionality is not required nor used.

If you choose to use an IR remote then you will need to add an IR receiver Most IR remotes work with a 38KHz carrier frequency. Make sure that the IR receiver you use matches the carrier frequency of the remote you plan on using.

There are three versions of the Grill Insert, one without an IR receiver, one for a plain IR receiver and one for an IR receiver with a Faraday cage (wrapped in metal). Choose the Grill Insert that matches your IR receiver or modify the existing Grill Insert to accommodate the IR receiver you bought.

The default is to use an Air Mouse 5.2 BLE remote. Each remote requires a key translation table to translate the key codes from the remote into the standardized key codes required by the Raspberry Pi. Edit ***jukebox.cfg*** and change “HID_Remote01.txt” to the name of your translation file. Three sample files have been provided, one for each of the Bluetooth remotes and one for a Bluetooth remote using IR mode. The files are in JSON format. Edit the file to change the key codes from the remote to match the key codes from your remote. You can extend the file to include more keys. Just be aware that the Python script only has handlers for Power, Volume up/down, Pause/Play, Skip, Rewind and Mute (same as Pause). The Python script parses all fifteen keys on the Bluetooth remote and provides empty handlers for each unused key.

Filename	Remote	Type
HID_Remote01.txt	Air Mouse BLE 5.2	Bluetooth BLE
BPR1S.txt	Boxput BPR1S	Classic Bluetooth
AirMouse.toml	Air Mouse BLE 5.2	IR

Files are provided to use the Air Mouse remote as either BLE or IR.

Getting Started:

You should decide on which Raspberry Pi model you want to use and select an audio DAC HAT. These choices will determine which case to 3D print. If you choose an RPi Zero 2 W and a ‘B’ Series DAC HAT then the RPi Zero 2 W is mounted on the set of bosses closest to the front of the case. This will result in the micro USB connector on the RPi Zero 2 W being unaccessible from the back panel. Due to this issue, a variant of the RPiZ2W case has a cutout on the side for a panel mount USB-A port.

Raspberry Pi Model	Audio DAC Footprint	Case STL to Print
RPi Zero 2 W	‘Z’ Series	ArtDecoJukebox-RPiZ2W
RPi Zero 2 W	‘B’ Series	ArtDecoJukebox-RPiZ2W-with-USB
RPi 3B	‘B’ Series	ArtDecoJukebox-RPi3B
RPi 4B	‘B’ Series	ArtDecoJukebox-RPi4B
RPi 5B	‘B’ Series	ArtDecoJukebox-RPi5B

I have provided several Back Panel STL files for different combinations of Audio DAC HAT and RPi board. If your combination is not available it means that you will need to design your own Back Panel. Modify the ArtDecoJukeBox.scad file to create your own custom Back Panel. ArtDecoJukeBox.scad has a top level module for each 3D printed part. These top level modules make heavy use of the Decorator software pattern.

Raspberry Pi Model	Audio DAC Board	Back Panel STL to Print
RPi Zero 2 W	Innomaker DAC-Mini	ArtDecoBackPanel-Z2W-DAC-Mini
RPi Zero 2 W	WaveShare WM8960 Audio HAT	ArtDecoBackPanel-Z2W-WM8960
RPi Zero 2 W	IQAudio Pi DAC-Pro	ArtDecoBackPanel-Z2W-PiDAC-Pro
RPi 2B, 3B	IQAudio Pi DAC-Pro	ArtDecoJukebox-RPi3B-PiDAC-Pro
RPi 4B	IQAudio Pi DAC-Pro	ArtDecoJukebox-RPi4B-PiDAC-Pro
RPi 5B	IQAudio Pi DAC-Pro	ArtDecoJukebox-RPi5B-PiDAC-Pro

The Back Panel has text on it to label the various connectors that poke through. By default, the text is indented. The text on the back panel is provided as a separate STL file. If your slicer and printer support it, you can merge the back panel & back panel text in the slicer. Assign a contrasting color to the text so it will stand out. Just align the text with the indents. Slice it and look at the first few layers to check your alignment. When it is all good, 3D print it.

The Back Panel covers the phone jack that is on the RPi3B & 4B boards. This was done to avoid confusion as to where to plug in your headphones. The HDMI and USB connectors are exposed. The HDMI connectors are exposed, but not needed. The exposed USB power connector can be used or the power barrel jack can be used, just not both at the same time.

The RPi Zero 2 W is the clear choice. It has a quad core, 64 bit CPU, WiFi and Bluetooth. The cost is $15.00. The RPi3B has about the same performance as the RPi Zero 2 W, with added USB & Ethernet ports. However the price is $35.00. The RPi4B and RPi5B have greater performance at a greater price ($55.00 and $65.00).

At the time of writing, the RPi5B is not recommended for this project. The main reason is due to incompatible GPIO. The RPi5B moved the GPIO to the RP1 southbridge chip. The gpiozero library works with the RPi5B for simple GPIO input and output. However, there are no compatible SPI drivers for the ILI9341 TFT LCD. If you use a RPi5B then the LCD will not work.

A secondary reason is Bookworm. Bookworm requires that third party Python libraries be installed in a Python Virtual Environment (PVE). You have to enable the PVE before you can run your Python code and you must run it in the PVE directory. I personally have not figured out how to automatically enable the PVE and start the Python script on boot up. Not going to boor you with the details here. I do have bash files for installing the Python libraries into a PVE.

Raspian Bullseye Lite (headless) is used as the OS. When using a 64 bit CPU, I prefer to use a 64 bit OS.

When the term ‘HAT’ is used by the manufacturer, it implies that there is a serial EPROM on board that the RPi can read to automatically setup the system for use with the HAT. Some DAC boards are HATs and others are not. They all work. There are some very inexpensive, generic DAC boards that are not designed to be plugged on to the 40 pin GPIO connector. The Python script supports these DACs. They only require power, ground and the three I2S GPIO pins. Volume control is supported by using SoftVol. The boards with better DACs generally use I2C and I2S. I2C is used to setup the DAC and I2S sends the digital audio to the DAC. Volume is controlled by the DAC driver using I2C.

I tested boards with; PCM5102, PCM5122, PCM5242, WM8960 DACs. All worked fine. If the DAC board will be stacked on top of the Raspberry Pi then it needs to have a pass through GPIO header. Also look for DAC boards that when mounted will have their audio output connectors poke out the back of the case.

Your choice of Raspberry Pi board and DAC board will determine which variation of case and back panel to 3D print. All ‘B’ series RPi boards have the same mounting holes in the same places. All of the RPi ‘B’ series boards have the same arrangement of USB and Ethernet connectors except for the RPi4B which reverses the order of the connectors. RPi2B & RPi3B have the same arrangement of HDMI, USB power and audio jack. The RPi4B and the RPi5B use different HDMI and USB connectors on the side. All RPi Zero boards have the same mounting hole arrangement and the same HDMI, USB & USB power arrangement.

The back panel is unique for each combination of RPi board and DAC board. There are no standards for placement of the audio connectors on a DAC board. Plus the length of the standoffs used will also affect the placement of the audio connectors. I have provided basic back panel variations for each of the RPi ‘B’ series boards and one for all RPi Zero ies boards. I tested using three different DAC boards. I have provided back panel designs for each of these DAC boards in combination with an RPi Zero 2 W board.

The RPi5B is the odd man out here. Due to the massive heat sink/fan combination required by the RPi5B you will need to use taller than 11mm standoffs in order to have sufficient air flow around the heat sink. If you stack an NVME interface board on top of the RPi5B and then add a DAC board to the stack, the end result is that the audio connectors are higher than with any other RPi board.

The JukeBox displays the RPi CPU temperature on the TFT LCD. The room I use it in has an ambient temperature of around 80F. The JukeBox reports the CPU temperature at around 58-60C. I always add a peel-and-stick aluminum heatsink to all my RPi Zero 2 Ws.

Choose a micro SD card to boot from.

The micro SD card provides mass storage for the RPi. The boot loader, OS, swap file and the user’s file system are all on the boot media. The RPi4B and RPi5B can also boot from a USB mass storage device. The RPi5B can also boot from an NVME SSD connected via the RPi5B’s PCI bus.

The performance of any RPi booting from an SD card is tied to the quality and performance of the SD card. Slow cards will yield a slow system. I learned this the hard way. Buy only class 10, name brand cards. Cheap SD cards from China are not always what they claim to be. I have had very good results with SanDisk Ultra 32GB micro SD cards. These are fast and reliable.

3D Printing Tips

Several of the 3D printed parts require supports when being printed. The simplest thing to do is to 3D print the model and supports with the same filament (most single print head 3D printers do this). When supports are printed this way, sometimes the supports get too attached and are hard to remove or leave scaring or a droopy underside.

If your 3D printer supports it, you can print the supports using a different filament that does not stick well to the filament you are 3D printing your model with. For example, PLA and PETG tend not to stick to each other.

I 3D printed all of the parts for my prototypes, except for the top chamber window, on a Bambu Lab P1P with an AMS (Automatic Material System). The AMS is similar in function to Prusa's MMU (Multi Material Unit). Both of these devices allow for the automatic changing of filament while 3D printing. Several other 3D printer makers are also offering similar devices for their printers.

I tried 3D printing with an 'interface layer' of different material. I had mixed results with this technique. While it did reduce the number of filament changes, the 'interface layer' 3D printed on top of the support material did not always stay in place. The lack of adhesion was the issue.

I did find success with printing the supports, 'from the build plate only'. In this case the two plastics used only had to stick to the build plate, not to each other. Keep in mind, the more layers used by your supports means more filament changes. So not good, in terms of waste, for 3D printing tall supports.

Whenever I am going to 3D print a large model that takes many hours to print, I start by cleaning the print bed and applying some of Bambu Lab's 3D Printing Adhesive (it came with the printer) to the build plate. I do not want to find out that a corner lifted and ruined my multi-hours long print job. Take an extra minute and make sure your print head is clean (not covered in melted plastic) and that the build plate is clean and level, and that you did everything you could to insure maximum build plate adhesion. You can try using a brim or 'mouse ears' in the corners to keep them from lifting. You will need to remove the brim or 'mouse ears' after 3D printing.

You should 3D print the case first. Everything mounts to the case. By 3D printing the case first you can mount the LEDs and electronics and wire it all together while the remaining 3D parts print.

3D Printing the Case

The case is the largest and longest part to 3D print. I wanted my cases to look like they were made of wood, so I used a wood filled PLA filament.

These are the settings I used in Bambu Slicer.

Layer Height: 0.2mm

Support

- Enable Support: Checked
- Type: normal(manual)
- On build plate only: Checked
- Filament for Supports:
  - Support/raft base: select filament you are using for supports
  - Support/raft interface: select filament you are using for supports
- Advanced:
  - Top Z distance: 0mm

Others:

- Prime tower:
  - Enable: Unchecked (no prime tower)

I used a 0.2mm layer height to speed up the 3D printing and to enhance the wood like look. I also disabled the Prime Tower, I find that is not needed as the P1P purges before each filament change. The case was 3D printed using PLA and PETG for supports and the support interface. Under ‘Supports’ I set the ‘Top Z Distance’ to zero to get the nicest shelves possible. If using the same filament for supports and support interface then leave the ‘Top Z Distance’ value alone (use default).

My P1P took close to eight hours and about 200g of filament to 3D print the case.

The case was designed to be 3D printed face down on the build plate. I like the look of things printed on a textured build plate, so that is what I used. The case has three channels where LED strips are to be inserted. Each channel has a shelf along the outside of the channel. The shelf is positioned such that the body of the LEDs in the strip rest on the shelf and the flexible circuit board is pressed into the channel. It was intended to be an interference fit (a tight fitting piece) so that the strip does not easily fall out. The top of the two outer channels have small locator blocks. The center LED of each of the 25 LED and 23 LED strips should be captured by the blocks. Use ‘Painted On Supports’ to place the supports only on the shelves on either side of the trench. This is easily done by selecting smart fill and then clicking on the shelves inside each of the three channels.

If you 3D print the case without supports on the shelves in the LED channels, you will have great difficulty cleaning up the channels so that the LED strips fit in. The issue is worst in the curved part of the channel. Use supports, but only on the shelves not in the deep part of the channel, you will never get all of the support material out.

All of the features inside of the case were designed to be 3D printed without supports.

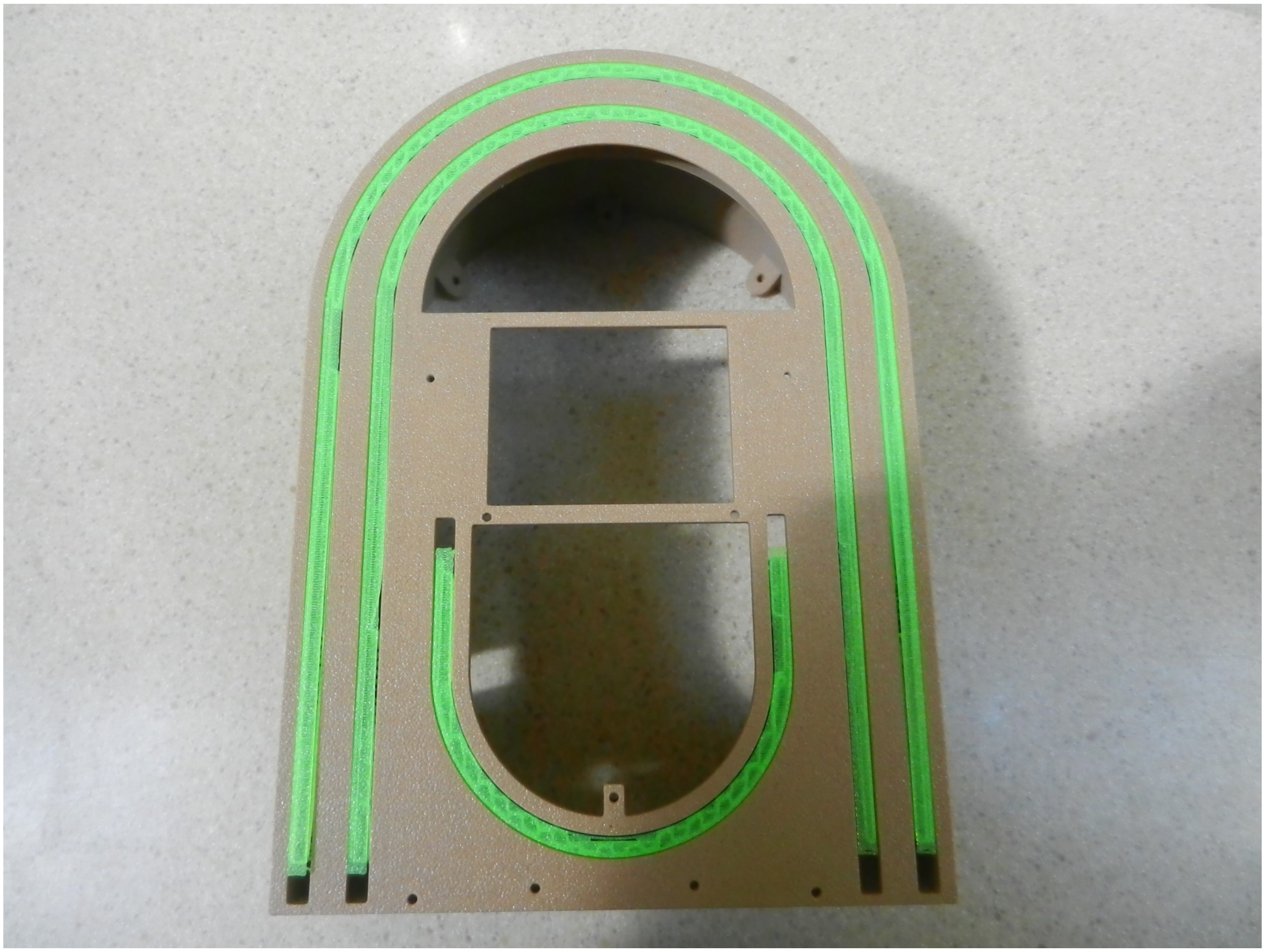


Figure 1, 3D Printed Case with supports (in green), front view.

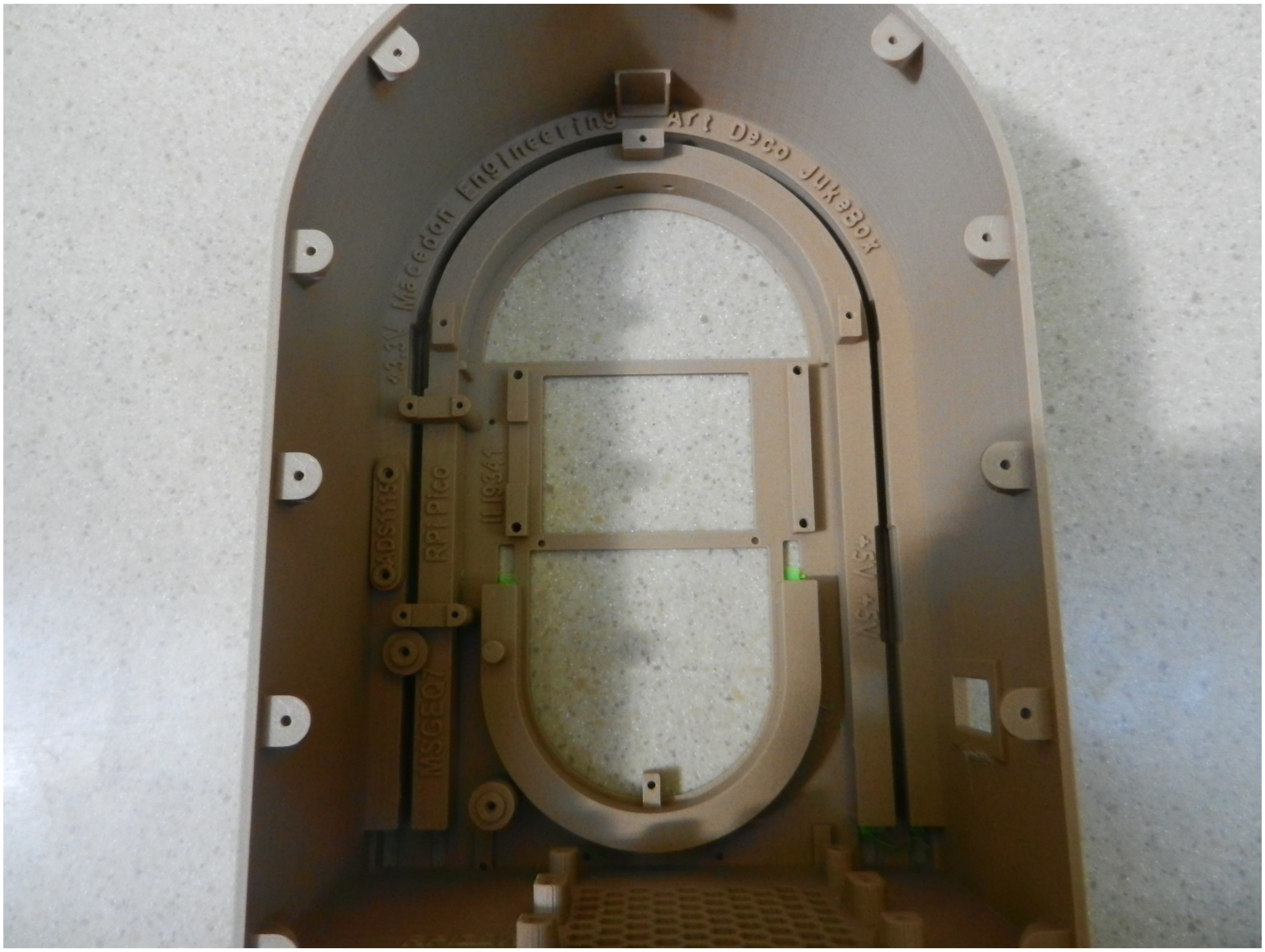


Figure 2, 3D Printed Case with supports, inside view.

3D Printing the Double and Single LED Covers.

These parts should be 3D printed using white filament. Use the same slicer settings as the case, except reduce the layer height. The lower layer height enhances the 3D printed curve of the domed part of the LED cover. More layers results in a rounder dome.

Layer Height: 0.16mm

Why white ?

When white filament is 3D printed with a thickness around 1mm, it will be somewhat translucent, the LEDs will be able to shine through. If any color but white is used, it may block or degrade some colors. For example, red filament will allow red light through, but will block blue and green. White is also used because it allows for the LED light to be diffused, ie; spread out into a ‘blob’ of light as opposed to a pin point of light.

Do not use clear filament for the LED covers. When multiple layers of clear filament are 3D printed on top of each other, the result is typically a milky white color. The LEDs can easily shine through, however it makes a terrible diffuser. Try for yourself and see which you prefer.

Both of the LED covers are 3D printed with the domed part on top. This means that supports are needed on the wide flat areas underneath. Use ‘Painted On Supports’ to place the supports only on the wide flat areas This is easily done by selecting smart fill and then clicking on the wide flat areas on both sides of the half pipe. The little legs that are forcing the use of supports are needed to ensure that the LED covers are aligned properly and provide an interference fit to help keep them in place until the clamps can be added. DO NOT select ‘Supports Everywhere’. Support material on the inside of the domed part will be impossible to clean out and may show up as dark spots in the diffuser.

I 3D printed the LED covers with white PLA using PETG for supports and support interface. Under ‘Supports’ I set the ‘Top Z Distance’ to zero to get the nicest underside possible. The layer height was dropped to 0.16mm. I wanted more layers so that the domed shape would look best. I also disabled the Prime Tower.

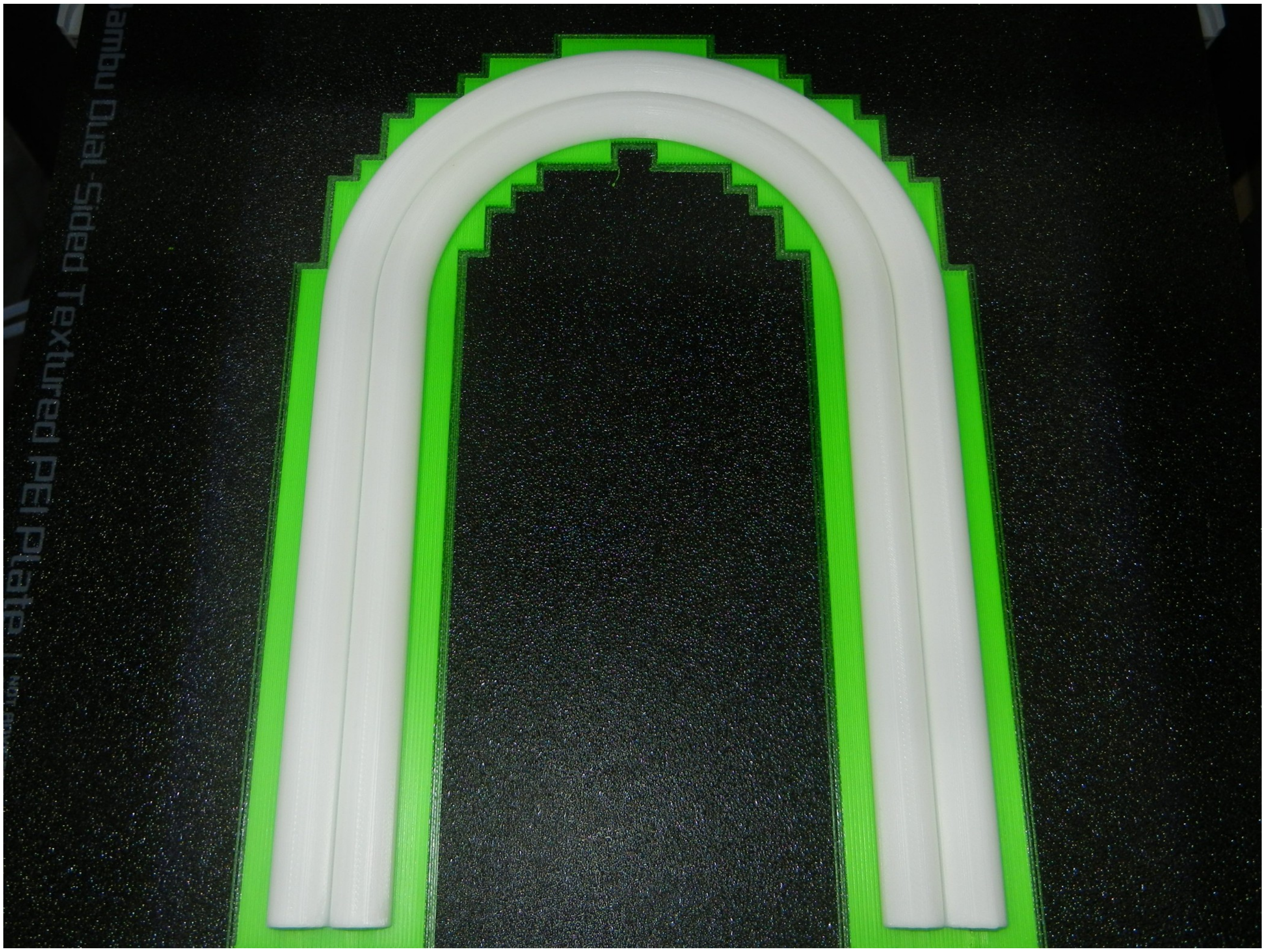


Figure 3, 3D Printed Double LED Cover with supports (in green), top view

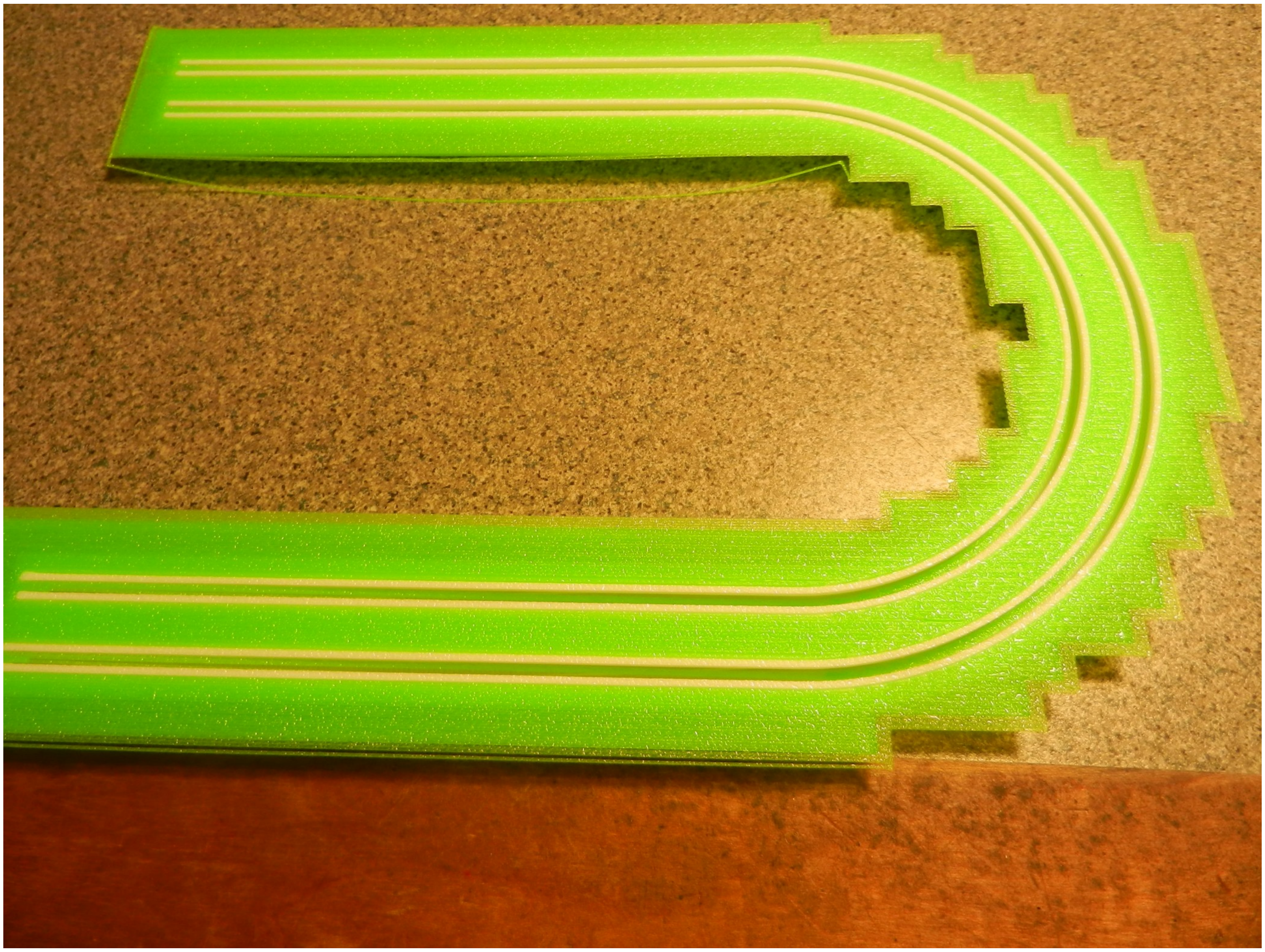


Figure 4, 3D Printed Double LED Cover with supports (in green), bottom view

3D Printing the Grill Insert.

If you are using an IR remote then select the Grill Insert that fits the IR receiver you are using. Generally two styles of IR receiver are available, naked and wrapped in a Faraday cage. The Faraday cage style is less susceptible to noise & RF interference. Supports are required in three places. Supports are not needed under the curved LED cover clamps. In general, if the area has a screw hole, it needs to be supported.

I 3D printed my Grill Inserts with a filament color for the underlying grill and the same metallic, silk filament that was used for the LED cover clamps. The filament change is done on the first layer where the broad ‘straps’ and clamps start printing.

Used the same slicer settings as the LED covers. The lower layer height will make the dome of the clamps look rounder.

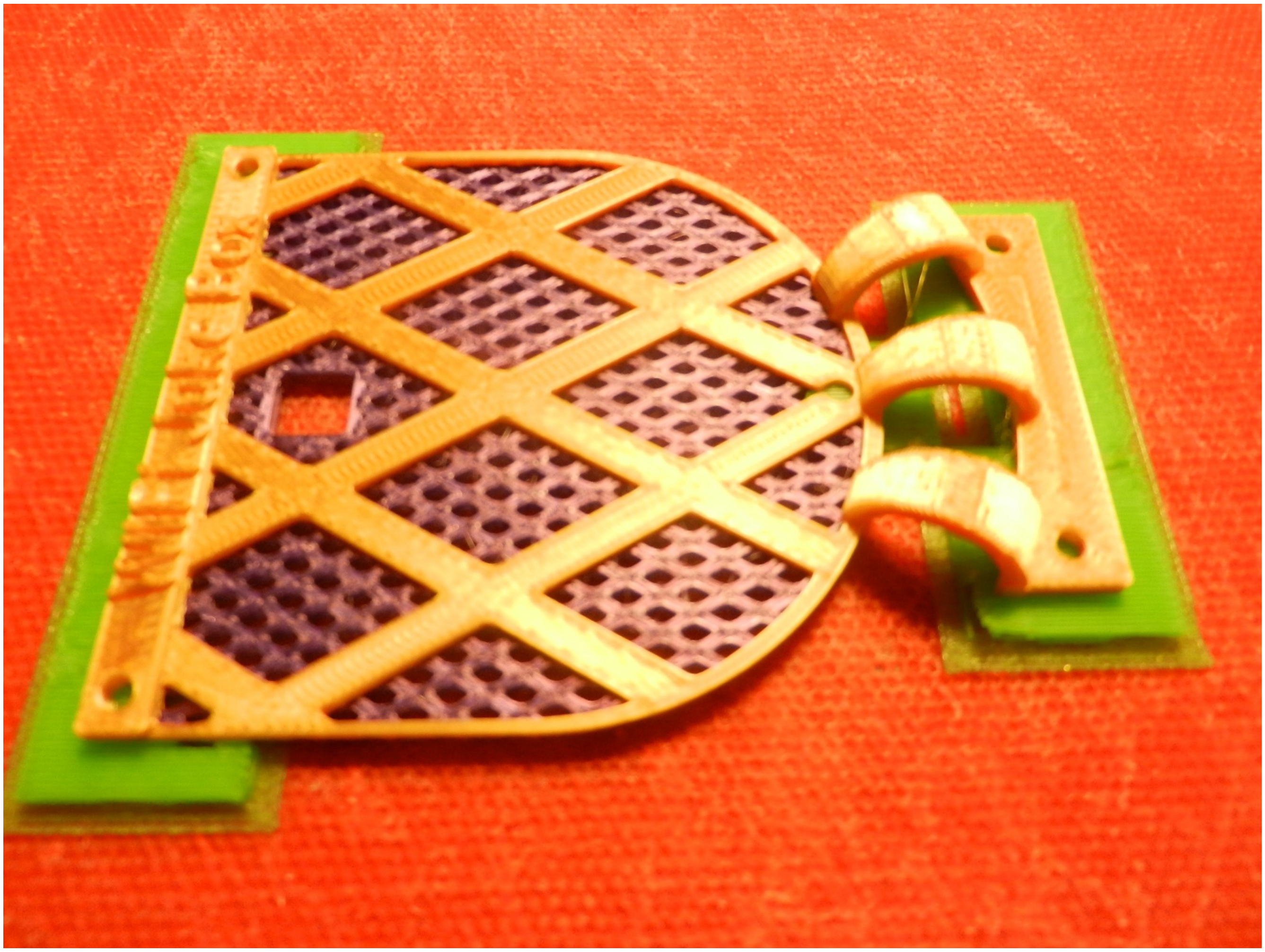


Figure 5, Grill Insert with IR Receive cutout and supports (in green).

3D Printing the Top Chamber Window.

The top chamber window should be 3D printed with a clear filament. There are several videos on the internet with tips on how to 3D print with clear filament to get transparent parts. The top chamber window was designed to have just two layers for the transparent part of the window. Be careful when removing the part from the print bed so that you do not break the window. Allow it to cool completely before removing from the build plate. This will avoid deforming the part while removing. Supports are required around the perimeter of the round part.

I printed several Top Chamber Windows on a Prusa MK4. I used the Prusa because the spool of clear filament that I have is not compatible with the AMS on my P1P.

How you print the window affects how it functions. The Prusa Slicer that I used generates a gcode file that moves the print head at a 45 degree angle to the horizontal (X axis) for the broad areas of the window. The next layer prints at a 90 degree angle to the previous layer. This is done by the slicer to increase the strength of the part. The window only has two layers where it needs to be the most transparent. If the window is printed in the default orientation, the effect of the two layers being printed at an angle is to make the light from the LEDs to appear to be angled spotlight beams. If you rotate the window 45 degrees about the Z axis on the build plate, now the print lines are vertical and horizontal in reference to the flat part of the window. The effect on the LED light is very different.

Layer Height: 0.2mm
Reduce all print speeds to half. Movement that does not lay filament can remain at default settings.

3D Printing the Back Panel.

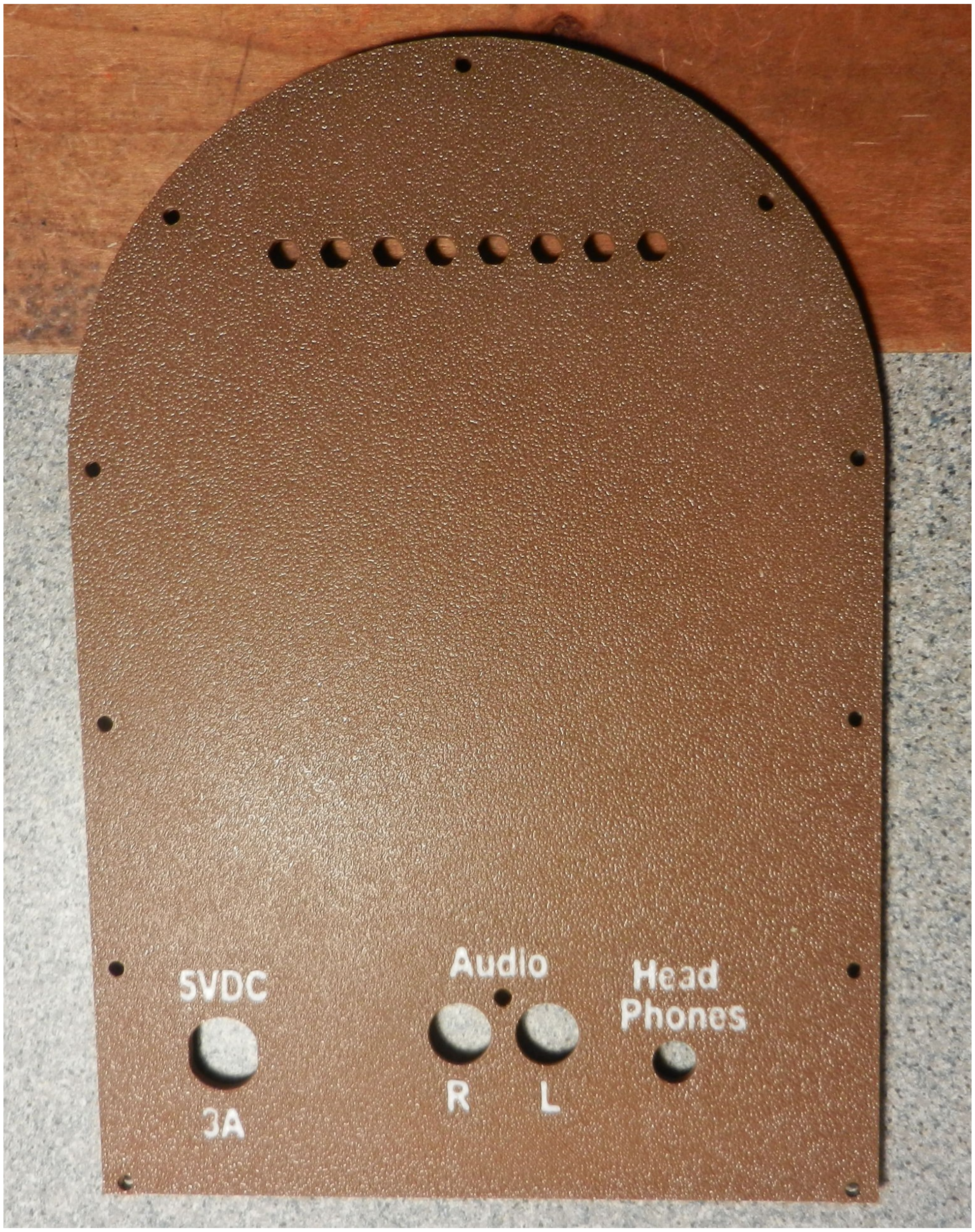
The Back Panel has cutouts for the audio DAC connectors and the RPi connectors. It also has text near the cutout. The Back Panel is 3D printed face down. The side with the ribs is the side that should be up. By default, the text is etched in to the Back Panel. If you would like the text to be filled in with a contrasting color and your 3D printer of choice supports it then you need to merge BackPanel.stl with BackPanel-text.stl. Use your slicer of choice to load the Back Panel STL and the Back Panel-text STL. Then reposition the text to align with the etched text. Slice and check the first few layers for alignment of the text and the empty text space. When you have it aligned, print it. You may also want to save it as a project (.3mf file). Then if you want to print another load the project.

I have provided STL files for several combinations of RPi board and DAC board. If your combination is there then use it. If not then you will need to design your own Back Panel. You will need to move the holes & text for the RCA & headphone jacks to align with the DAC HAT that you are using.

Layer Height: 0.2mm

The Prime Tower is not needed. No supports are required.

Figure 6, Back Panel with text.



3D Printing Everything Else.

The remaining parts do not require any special consideration. 3D print them however you like in whatever colors you like. No supports are needed.

Figure 7, 3D Printed LED Covers, Grill Insert and Clamps.

Note: Figure 7 is missing the Double LED Cover Stripe.

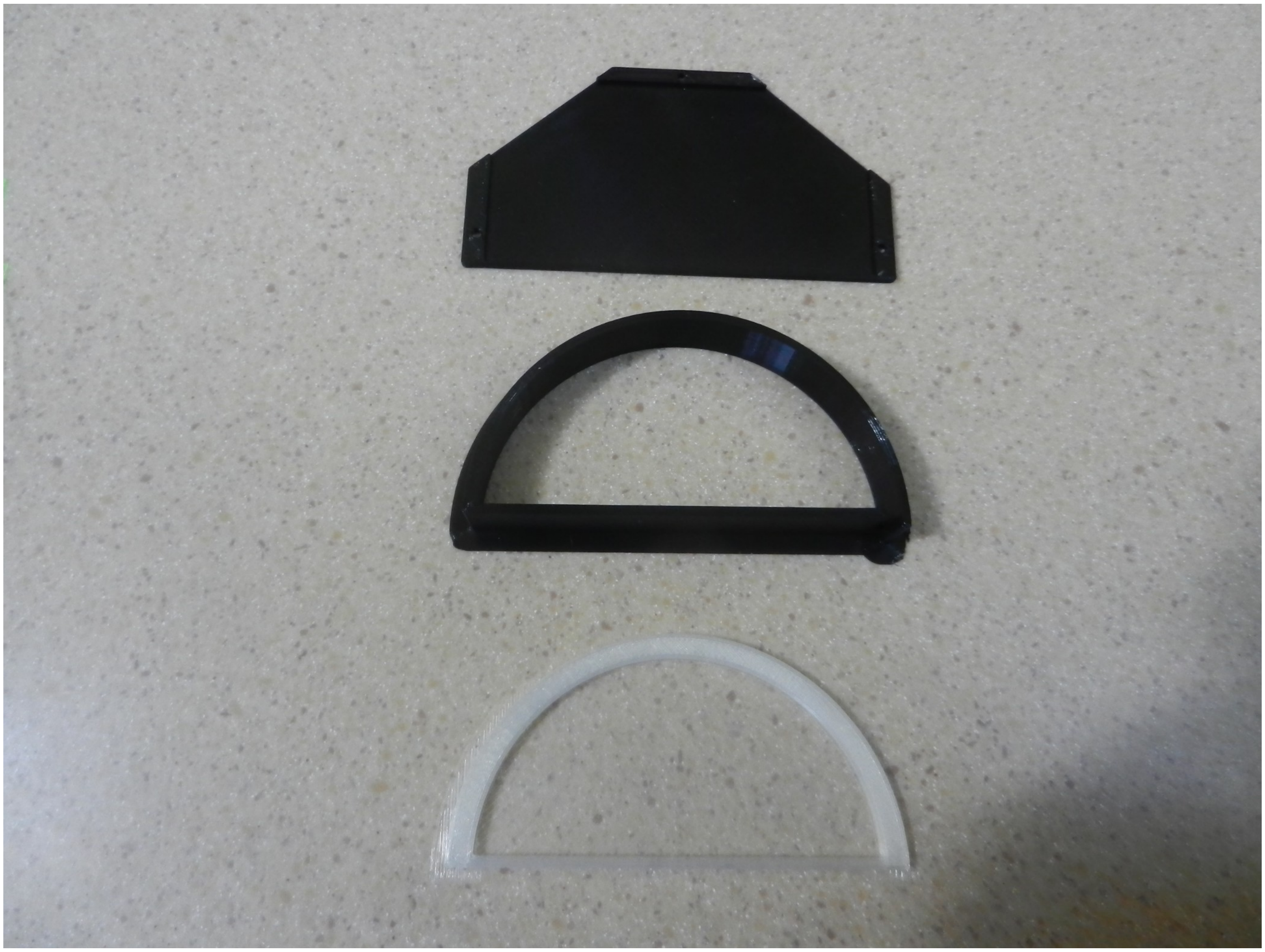


Figure 8, 3D Printed Mirror Holder, Top Chamber and Top Chamber Window.

Modifying the OpenSCAD source file:

The file ArtDecoJukebox.scad is the source file for all the 3D printed parts. There is a list of parts to 3D print. Uncomment (remove the leading '//' from the line with the part name) the part you want to 3D print and comment out (add '//' in front of the part name) to not include a part. Only one part should be uncommented at a time. Then click on the Render button. When the part finishes rendering, click the STL button to generate the STL file to print. You only need to do this if you need to create a custom version. For example, you want to use an IR receiver that is physically a different size. Somewhere around line 206, two values are defined for the dimensions of the IR receiver; IRX and, IRY. Change IRX and IRY to the dimensions of your IR receiver. All dimensions are in millimeters.

Around lines 222 to 230 are a set of true/false values. These select which DAC board is being used. The one being used should be true, all others must be false (!false is same as true).

Around line 242 is the statement; RPiX = RPIZ2W; This statement selects which RPi variant is being used. Change ‘ RPIZ2W’ to one of the other board names to select that board. Selecting the board name here sets where the board mounting standoffs are located as well as any side cutouts for USB & Ethernet connectors and any Back Panel cutouts related to the RPi board selected.

There are other true/false values that should be changed to add/remove or adjust the size of other cutouts.

USBASOCKET:
When true will result in a rectangular cutout in the case side for a panel mount USB-A socket. This is only used when a RPiZ2W is used with a ‘B’ size DAC board.

IR:
Set this true if using an IR receiver.

IRFARADAY:
Set this true if using an IR receiver with a Faraday cage (metal enclosure).

TEST & SHOWASSEMBLY are used during debug and should be left as ‘!true’ or ‘false’.

Preparing the Raspberry Pi.

If your RPi does not have the forty pin GPIO header soldered in place then add one now.

The Raspberry Pi has many tutorials and videos on the Internet that guide you through how to erase, format and install the Raspian OS on a micro SD card. Make use of them.

I do all my work on a Windows PC. I do not own a Mac or a Linux computer (other than the Raspberry Pis). The programs I use to work with the Raspberry Pi are all Windows programs. I am sure that there are equivalent programs on the Mac and Linux, I do not know their names nor how to use them.

I use a Synology DS214 NAS device. The mount parameters in the install-NAS.py file are specific to my NAS device. You will need to edit this file to set the correct parameters for your NAS device or server. You need to set the IP address, login and password. Leave the other parameters as they are. If having trouble getting your NAS mounted, consult the mount command man pages or the help parameter.

The JukeBox code was developed on an RPi Zero 2 W running 64 bit Raspian Bullseye as the OS.

The JukeBox program is a Python script. The script uses a number of third party Python libraries as well as standard Python libraries. The source code files for the JukeBox include detailed notes on what libraries need to be installed and the Linux commands to install them. You can follow the notes and manually install the libraries.

During development, I found myself erasing the SD card and re-installing everything a lot. I created several Python and Bash scripts to automate the process of installing libraries and modifying system files. I eventually folded almost all of the scripts into one script named; ***setupAll.sh***. This Bash script will invoke other Python & Bash scripts to get the job done. All of the required scripts and other files are in a separate directory named "***setup***".

The file, '***jukebox.cfg***' contains information about what parts are used. This information is used during the installation to select the correct Linux drivers to install. You should edit the file using a plain text editor. The file is in JSON format. Set the name of the key file used by your remote, the DAC board you are using and if a Pico is used. The file is also used at run time to select some software features.

At this point you insert the SD card into your RPi. The RPi does not have to be mounted in the case to setup Raspian for this project. You can power up your RPi and perform the steps below.

The following steps assume you are using a RPiZ2W.

1. Use SD Card Formatter to reformat a suitable micro SD card.
2. Use Raspberry Pi Imager to install 64 bit Raspian Bullseye Lite on the micro SD card you just formatted.
    1. Edit the settings in the Imager program to provide the username & password to login to your RPi, SSID & password for your WiFi, select your wireless country, timezone & keyboard layout. Click on Save. Proceed with the OS installation.
3. Place the freshly minted micro SD card in your Raspberry Pi and power it up.
4. When the green LED stops flashing, the RPi has finished booting.
5. You can attach a USB keyboard and monitor to your RPi or operate it remotely using Putty and SSH (you will need the network IP address).
6. Log in to your RPi and validate it is working.
7. You can use ***ifconfig*** to determine the IP address of your RPi. Type; '***ifconfig***' then press Enter.
8. Open WinSCP and log into your RPi. Set the left pane to show the '**setup**' directory from the code downloaded. The right pane will show the contents of the RPi directory that uses your login as it's name ('/home/***login***'). Copy the contents of the '**setup**' directory to your RPi. When the transfer is complete, close WinSCP.
9. The ***jukebox.cfg*** file is a plain text file in JSON format that is used during the installation to setup the correct DAC driver, remote control device, display and if a Pico is used. You need to edit this file to set the parameters to match your hardware choices.
10. In the Putty window, type; '***nano jukebox.cfg***' then press Enter. Make any required changes then save & exit nano.
11. In the Putty window, type; '***sudo bash setupAll.sh'*** then press Enter.
12. When the bash script finishes it will indicate how long it took to do the installation and then reboot the RPi.
13. When the RPi starts to reboot, close the Putty window.
14. When the RPi finishes rebooting, use Putty to log back in.
15. Type; '***aplay -l'*** then press Enter. You should see only your DAC listed.
16. Type; '***sudo bash Cleanup.sh***' then press Enter. All of the no longer needed setup files will be deleted from the RPi.
17. Open WinSCP.
    1. Login to your RPi.
    2. Change the left side window to the '**jukebox**' directory.
    3. Copy the contents of the 'jukebox' directory to your RPi (/home/login).
    4. Close WinSCP.

Prepare the Pico.

If you are using an ADS1115 then skip this section.

1. If you have not done so yet, solder two 20 pin male headers to your Pico.
2. The headers should be soldered on top (component side).
3. Download and install ***Microsoft Visual Studio Code***. This is the compiler used to program the Pico. https://code.visualstudio.com/
4. Follow the directions in the Raspberry Pi Foundation’s guide; ‘***Getting Started With the Raspberry Pi Pico Series***’. You will need to download and install the ‘***Pico C/C++ SDK***’. https://datasheets.raspberrypi.com/pico/getting-started-with-pico.pdf
5. Run Visual Studio Code. Open the folder; ‘***Pico***’. Compile and download it to your Pico.
6. You should program your Pico before mounting it in the case. It will be difficult to use the USB port while mounted in the case. If you have a Pico Debug Probe you can use it to program the Pico while it is in the case.

Preparing Your NAS System, USB drive or SD card.

The Python script running on the Raspberry Pi expects the music repository to be organized as;

Artist
- → Album
  - → Songs
- → Album
  - → Songs

Artist
- → Album
  - →Songs

This organization was selected as the easiest, most efficient to work with. It keeps the list lengths short, making it faster to create a new list of songs or albums. If you do not organize your music in the same way, the Python script may not detect your music.

The Python Script looks for either MP3 or FLAC files to play. MP3 is the most commonly used format, but uses a lossy compression technique. FLAC uses a lossless compression technique. MP3 files will be smaller in size than FLAC files for the same songs. FLAC files may sound better.

The TFT display will show the name of the artist, album and song being played. If you do not organize your music repository as shown above then the TFT display may not show the information correctly.

Assembly:

Start by 3D printing the case you have selected. While the case prints, you can go ahead and prepare some subassemblies.

You should test your LED strips prior to cutting them up.

Throughout the wiring I followed wire color standards for the power wires. Orange wires indicate +3.3V power, red wires indicate +5V power, black wires indicate ground. I recommend that you do the same.

I am not providing a tutorial on crimping wires. If you own a crimping tool, I figure you know how to use it. If not, consult the instruction booklet that came with the tool or look it up on the Internet.

1. **Prepare the Power Barrel Jack Socket.**
    1. Determine which solder points are for the +5V and Ground wires.
    2. Solder a 6 inch, red, 22awg wire to the +5V solder point.
    3. Solder a 6 inch, black, 22awg wire to the Ground solder point.
    4. The other ends of the black & red wires should have female DuPont crimps on them.
    5. Stuff the female crimps into a two pin DuPont shell.

Figure 9, Power Barrel Jack Socket Assembly.

2. **Prepare the power distribution block.**
    1. You will be preparing a ten position power distribution block. The basic idea here is to short all the pins in each row to each other, but not to the other row. You cannot solder the solid wire on the outside of the header. If you do or your soldering is too sloppy, the header will not fit into it's designated place in the case. Take your time and be neat.
    2. Use a small vise to hold the dual row header with the short legs up.
    3. If you do not have a vise then use whatever you have. A pair of vise grips would work.
    4. Cut a length of solid copper wire slightly longer then the header.
    5. Bend the wire to have a small hook on one end.
    6. Wrap the hook around one of the short posts on one the end of the header.
    7. Stretch the wire along one row of pins, in between the two rows.

Figure 10, Starting Power Distribution Block.

8. Solder the end without the hook to the end pin.
9. Solder the pin next to the pin with the hook wrapped around it.
10. Trim the hook such that there is no wire on the outside of the pin. Solder the wire to the pin.
11. Working from the center towards each end, solder the wire to the pins. Work quickly to avoid un-soldering any adjacent pins

Figure 11, One row complete.

12. When you finish a row, do a connectivity test. Each pin in the row should be electrically the same. Ensure that the row you just finished is not shorted to the other row.
13. Repeat for the other row of the header.
14. If the case has been 3D printed and the power distribution block is ready, you should test fit it into it’s designated place. Clean up your solder joints if they do not fit. A file can be used to reduce the solder on the outside of a row.
15. Set the finished power distribution block aside for now.

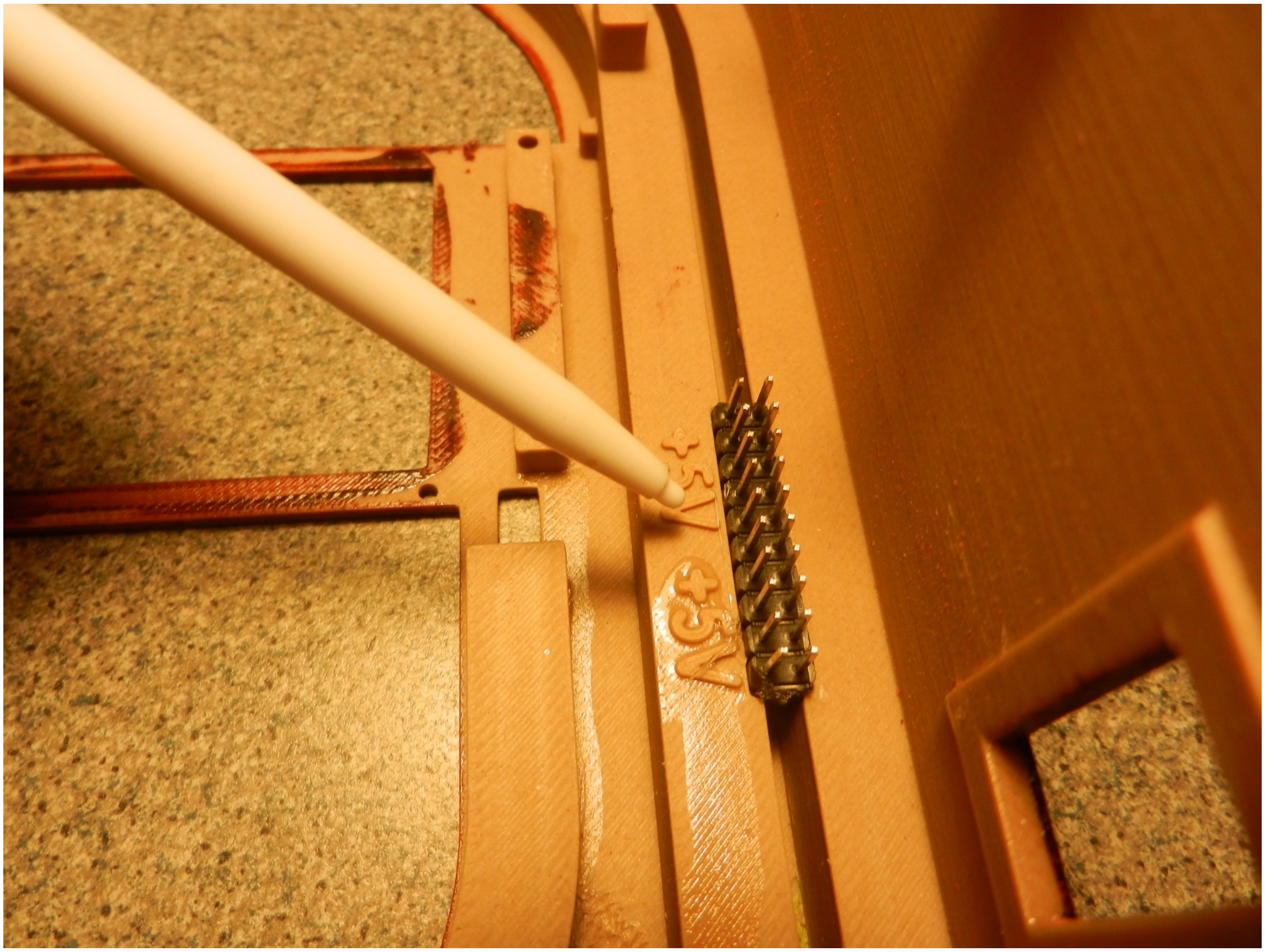


Figure 12, Shows +5V Power Distribution Block mounted in Case

3. **Prepare the ILI9341, MSGEQ7, Pico or ADS1115 boards.**
   1. The Pico and ADS1115 boards are an either or situation. Both are never used.
   2. ***ILI9341 Board***
      1. If your ILI9341, 2.4 inch, SPI, 320 X 240, TFT LCD board came with the fourteen pin male header soldered in then you are done.
      2. Otherwise, solder a fourteen pin male header on the back side of the board (side without the glass). See figure 12

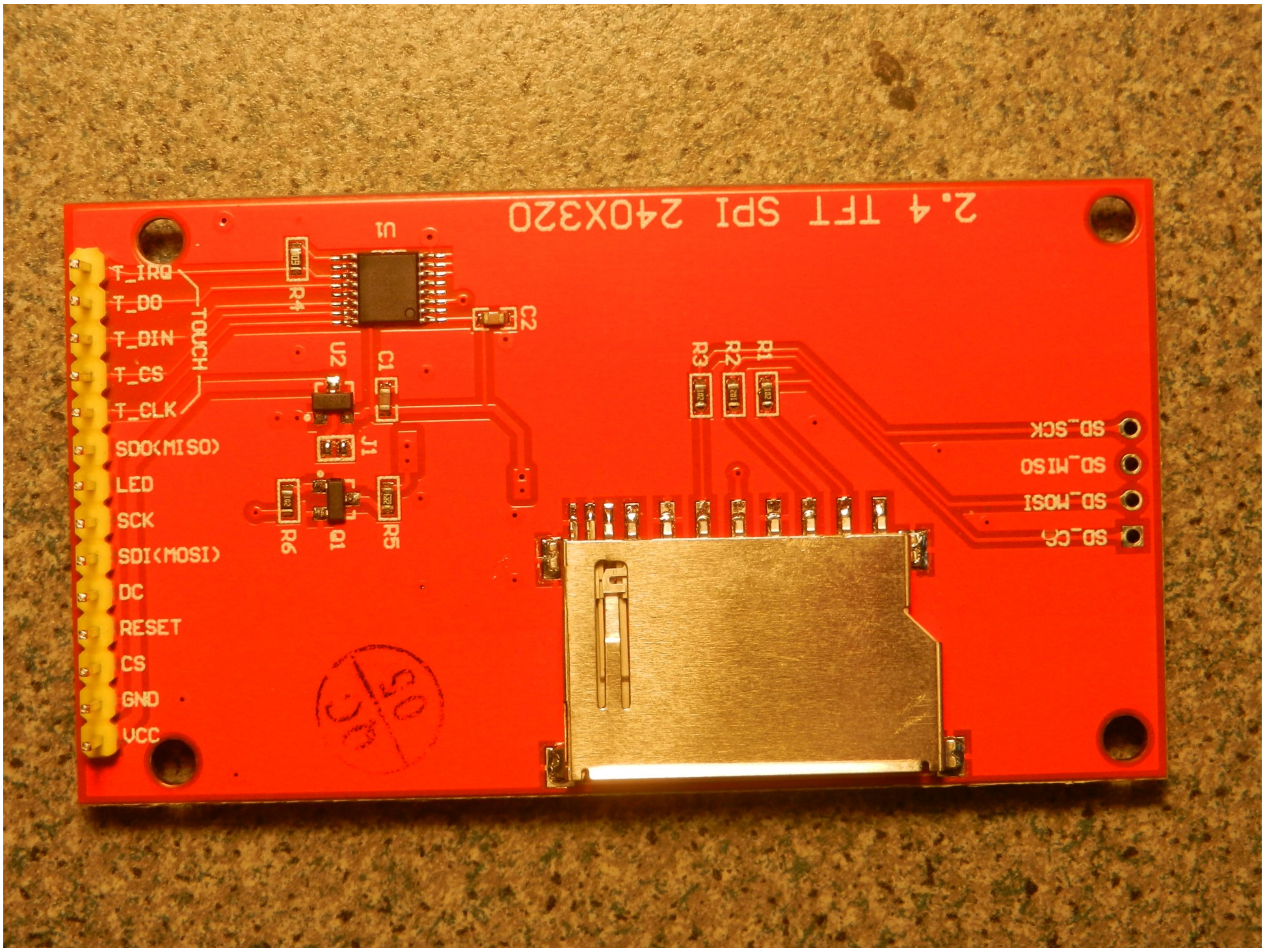


Figure 12, ILI9341 LCD with header.

3. ***MSGEQ7 Board***
    1. Not all MSGEQ7 boards are the same. The audio out from the DAC board needs to be connected to the right and left channel inputs of the MSGEQ7 board. Ideally you need a three pin male header to accept the three pin shell from the DAC board audio out. If your board looks like the one in the picture then these directions will work otherwise, you will need to locate the right and left audio channels on your board and add the three pin male header. Hint: there are two 22K resisters that are side-by-side, one end of these resisters are the audio channel inputs. You can trace the signal back to the phone jack.
    2. If you bought your MSGEQ7 board as a kit then assemble it now. Leave out the phone jack.
    3. If your MSGEQ7 board already has a five pin header the skip over the next step.
    4. Solder a five pin male header to the component side of the board. See figure 13.

5. If your board has a phone jack then either remove it or add the three pin header on top of it.
6. Solder a three pin male header on top of the phone jack or in the holes for the phone jack.
7. If your board has a potentiometer on it then set it for maximum signal to be passed.
8. Set the sub-assembly aside.

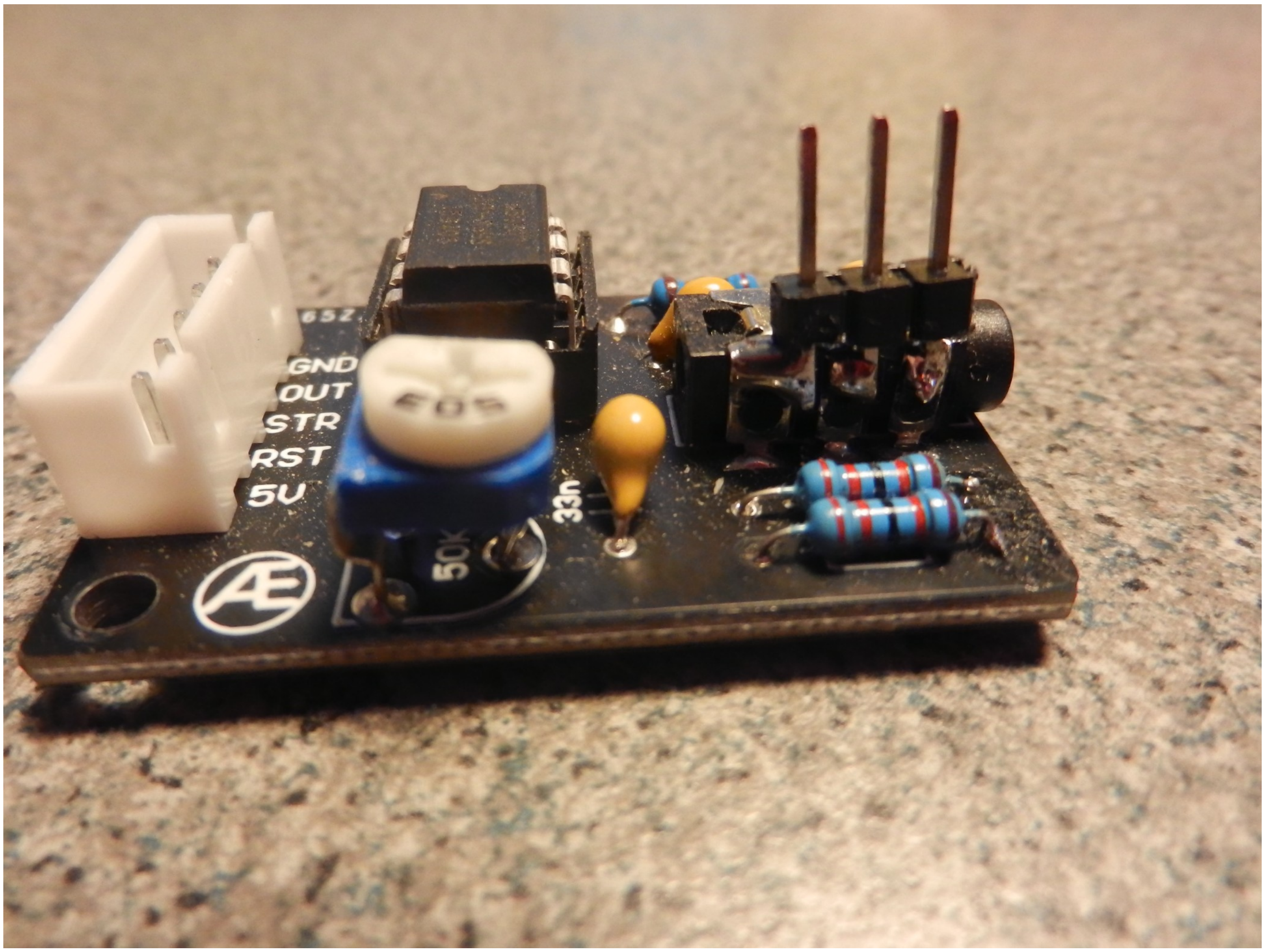


Figure 13, MSGEQ7 board. Note my board has a different style five pin connector on it also notice the three pin header soldered to the phone jack.

4. ***Pico Board***
   1. Not all Pico boards have the same footprint. These directions are for the full sized Pico board from the Raspberry Pi Foundation. If your board is different then you will need to figure out how to mount the board and may

have to change the wiring to accommodate your board. Double sided foam tape is your friend.

2. If your Pico board does not have male headers installed then solder them in now. The headers should be on the component (top) side of the board.
3. The RPi Pico has two rows of holes for two twenty pin headers. The JukeBox only uses the first ten holes on each side (the ten nearest the USB connector). You can use ten pin headers or twenty pin headers.
4. The RPi Pico has a place for a three pin debug header. If you have a Pico Probe then you should add this header.
5. Case constraints prevent plugging in to the USB port when the Pico is mounted in place. For this reason you should program your Pico before mounting it. If you have the Pico Probe or equivalent then you can use that to program your Pico in place.
6. If you need to update the Pico's firmware while in the case;
    1. You can remove the screws holding the Pico in place then you can angle it to attach a USB cable.
    2. Make sure to unplug the power wires from the +5V Power Distribution Block.
7. When done with the firmware update;
    1. Remove the USB cable from the Pico.
    2. Reposition the Pico and screw it down. Just snug the screws.
    3. Reattach the power wires to the +5V Power Distribution Block.

    8. Set the sub-assembly aside.

5. ***ADS1115 Board***
    1. Not all ADS1115 boards have the same footprint or pinout. These directions are for a board that matches the one shown in figure 14. If your board is different then you will need to figure out how to mount it and may have to change the wiring.
    2. If your ADS1115 does not have a ten pin male headers already soldered in then add one. The header should go on the component (top) side of the board.
    3. Set the sub-assembly aside.

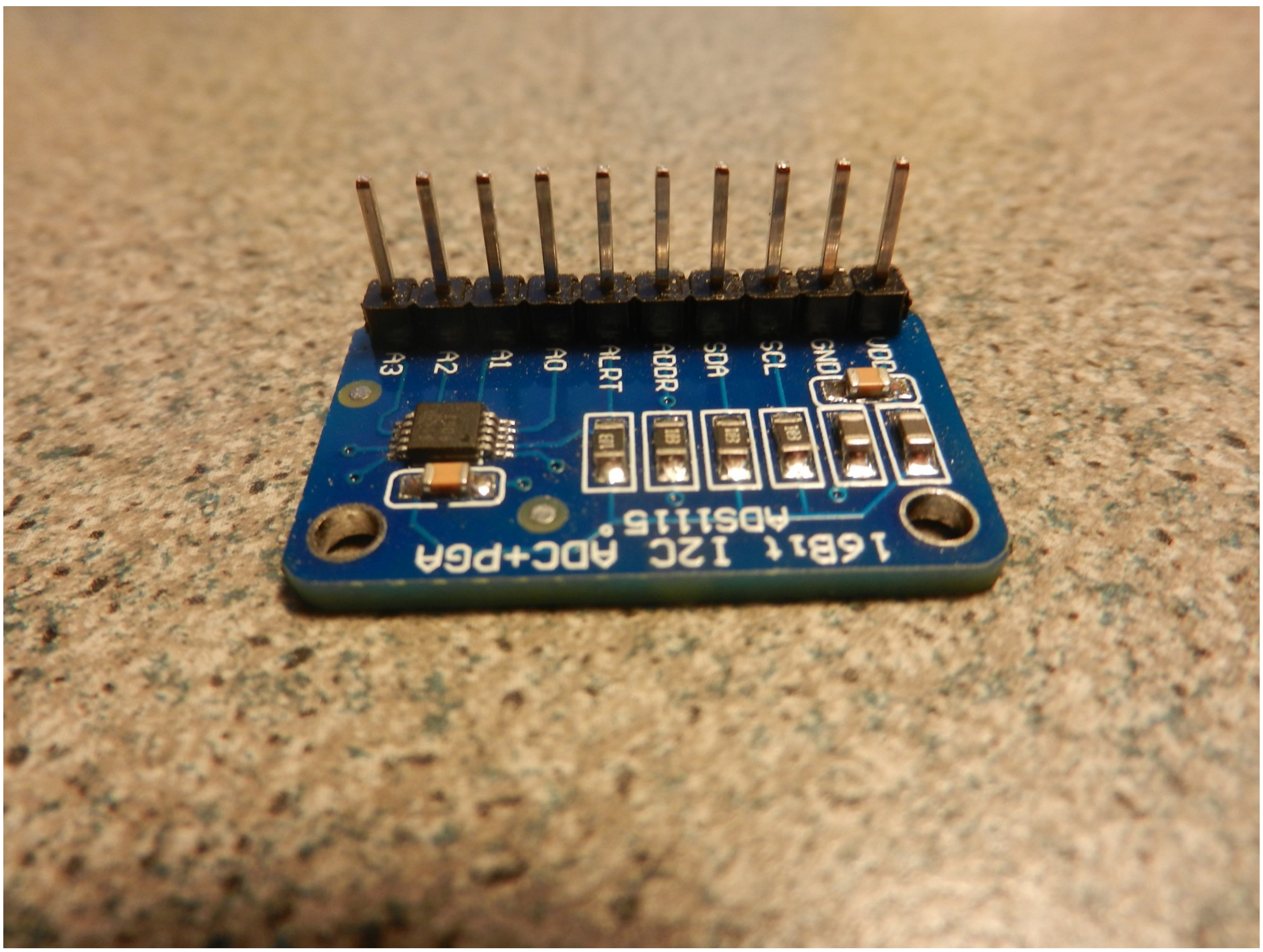


Figure 14, ADS1115 board

4. **Prepare the addressable LED strips.**

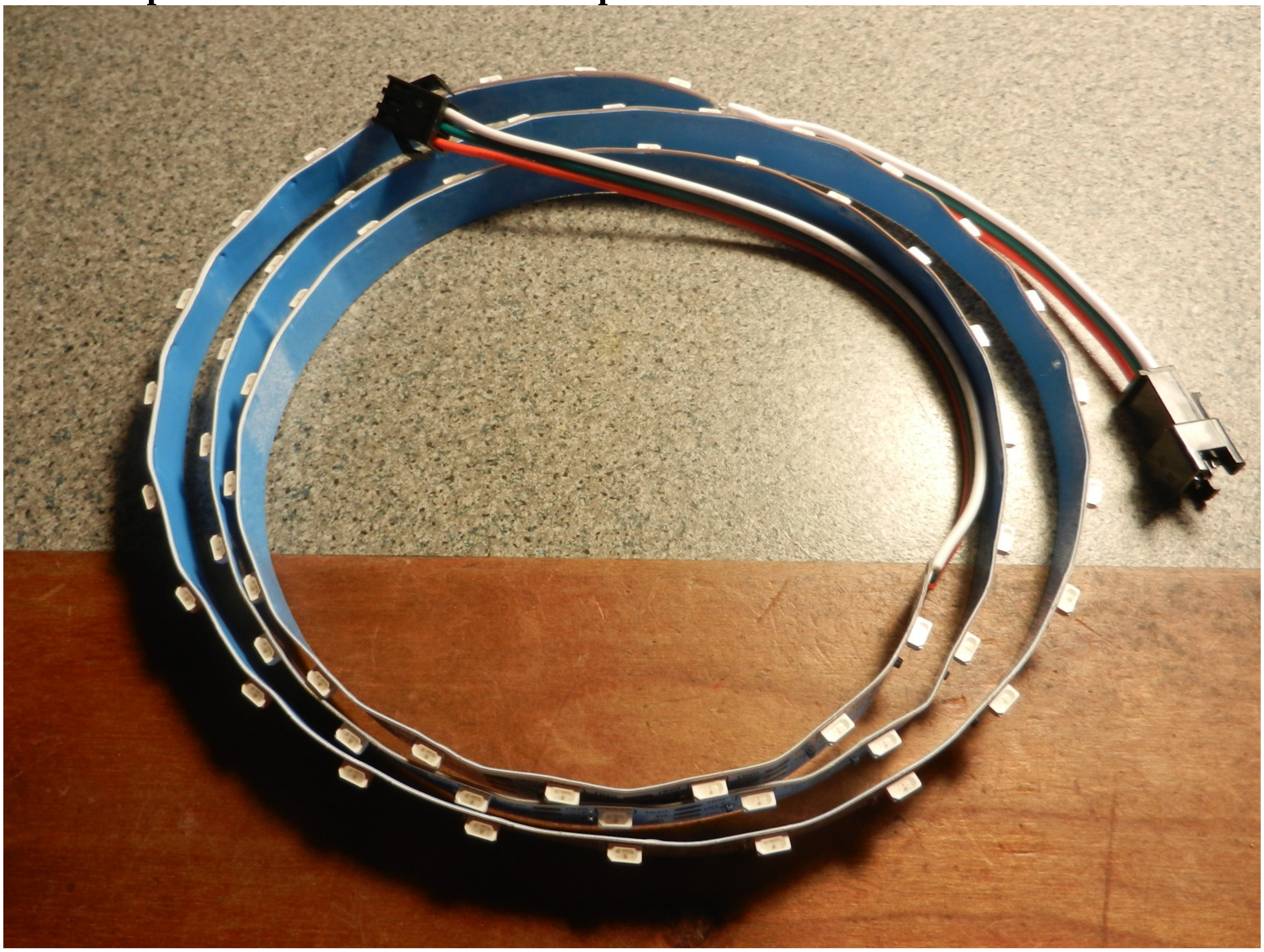


Figure 15, SK6812 side emitting LED strip with a pitch of 60 LEDs per meter.

1. The preparation of the LED strips assumes that you are using strips with a pitch of 60 LEDs per meter. If your pitch is different then you will need to adjust the number of LEDs in each of the sub-strips.
2. The LED strips have an input end (‘DIN’ or ‘DI’) and an output end (‘DO’).
3. Remove the heat shrink from the output end of the SK6812 side emitting LED strip.
4. Un-solder the three wires from the output side of the strip. Set the three wires with connector aside. You may need it later.

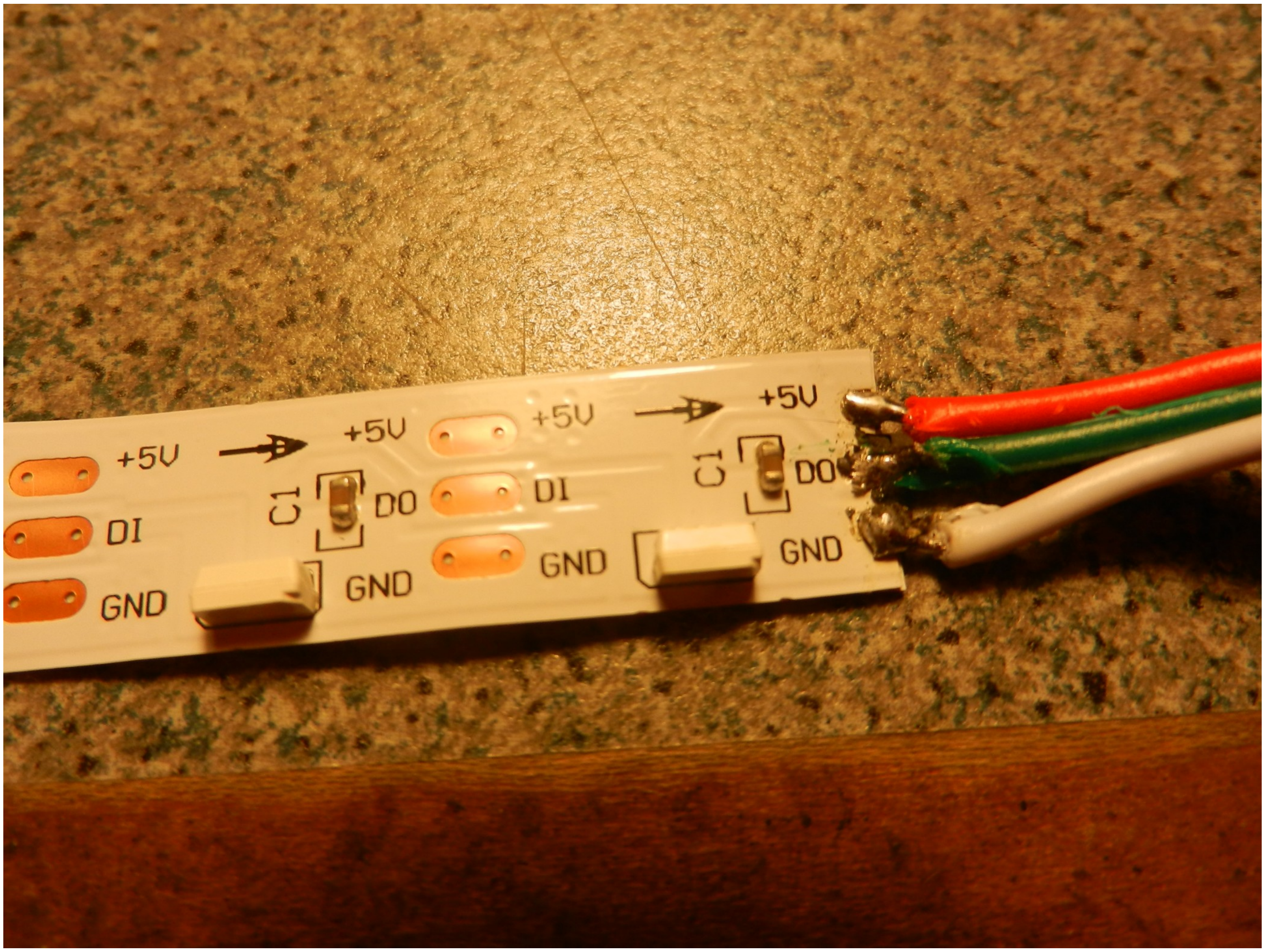


Figure 16, Output end of SK6812 LED strip.

5. Carefully cut off a strip of ten LEDs from the output end.
    1. Count off ten LEDs from the output end.
    2. Try to cut as close as you can to the cut line on the strip. Your strip may not have a cut line.
    3. You want the solder pads on each side of the cut to be about the same size.

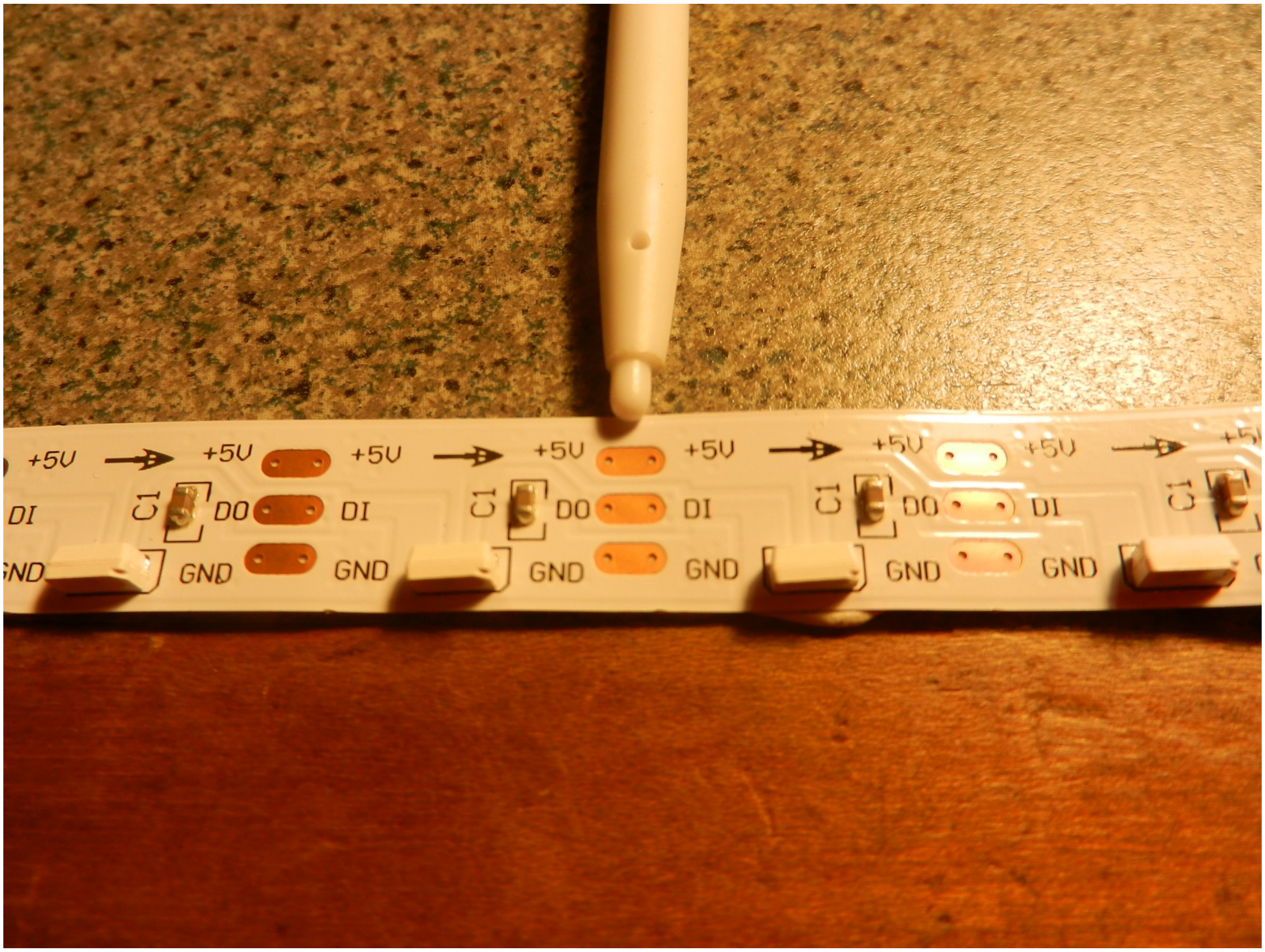


Figure 17, Where to cut the LED strip.

   4. Cut a piece of 22awg red wire, 2 inches long, strip about 1/8 inch from one end. Twist the wire strands together and tin it (that means to heat the exposed wires with your soldering iron and add a little solder). The other end must have a female DuPont crimp on it.
   5. Cut a piece of 22awg black wire, 2 inches long, strip about 1/8 inch from one end. Twist the wire strands together and tin it. The other end must have a female DuPont crimp on it.
   6. Solder the red wire to the +5V pad on the output side of the ten LED strip.
   7. Solder the black wire to the GND pad on the output side of the ten LED strip.
   8. Put the ten LED strip aside.

6. Carefully cut off a strip of 25 LEDs from the output end.
   1. Count off 25 LEDs from the output end.

        2. Try to cut as close as you can to the cut line on the strip. Your strip may not have a cut line.
        3. You want the solder pads on each side of the cut to be about the same size.
        4. Cut a piece of 22awg red wire, 3 inches long, strip about 1/8 inch from one end. Twist the wire strands together and tin it. The other end must have a female DuPont crimp on it.
        5. Cut a piece of 22awg black wire, 3 inches long, strip about 1/8 inch from one end. Twist the wire strands together and tin it. The other end must have a female DuPont crimp on it.
        6. Solder the red wire to the +5V pad on the input side of the ten LED strip.
        7. Solder the black wire to the GND pad on the input side of the ten LED strip.
    7. Carefully cut off a strip of 23 LEDs from the output end.
        1. Repeat all steps used to prepare the 25 LED strip, using the 23 LED strip.
        2. Put the 23 LED strip aside.
    8. Carefully cut off a strip of thirteen WS2812B LEDs from the input end of the strip.
        1. Starting from the input end of the WS2812B LED strip, count off thirteen LEDs.
        2. The small strip you are creating will not have another strip attached to it's output end. Ignore the cutoff line and cut as close as you can to the LED while retaining the bypass capacitor (the tiny rectangular thingy next to the LED body).
        3. Validate that the three wire cable removed from the output end of the SK6812 strip will mate with the connector on the thirteen LED WS2812B strip. If it does not then replace the three wire cable on the thirteen LED strip with the three wire cable from the input side of the SK6812 strip or remove the three wire cable from the output end of the WS2812B LED strip. Wire it using the original color scheme which is typically; red -> +5V, green -> signal and white -> GND.
        4. Put the thirteen LED strip with attached cable aside.

5. **Optional, prepare the USB-A panel mount socket.**
    1. If not using a USB-A panel mount socket then skip these steps.
    2. Do not shorten the four wires attached to the USB-A panel mount socket.
    3. In Figure 18-A, the part circled in blue is not used (the wires do not fit).
    4. Make sure you put the shell on the wires first. The rectangular opening should face away from the USB-A socket.
    5. Solder the wires to the micro USB plug. See Figures 18-B & 18-C for where to solder each wire. The blue wire is the D+ signal, the white wire is the D- signal.

6. This link shows the micro USB pinout and wiring; https://www.neverstopbuilding.com/blog/wiring-micro-usb-pinout
7. After soldering and testing, slide the micro USB connector into the shell until it stops.
8. Press the small rectangular piece into place. Note, it only goes on one way.

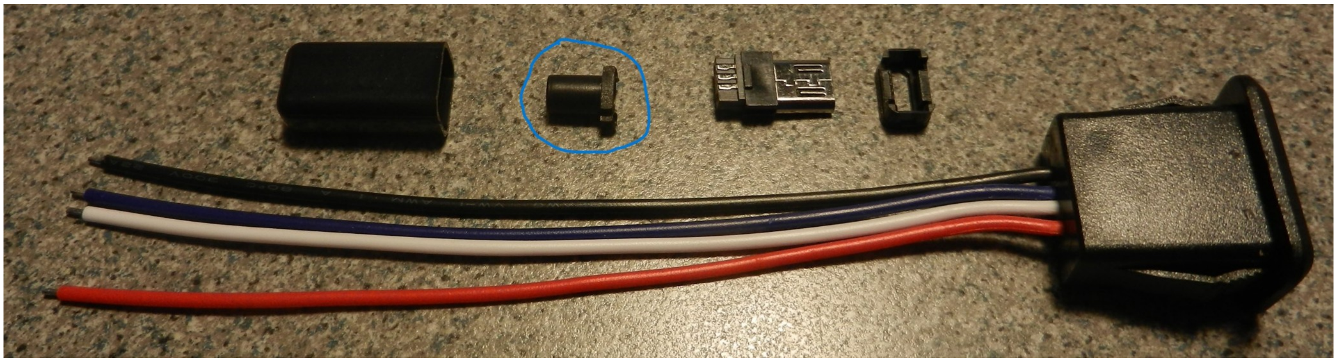


Figure 18-A, USB-A to micro USB Parts.

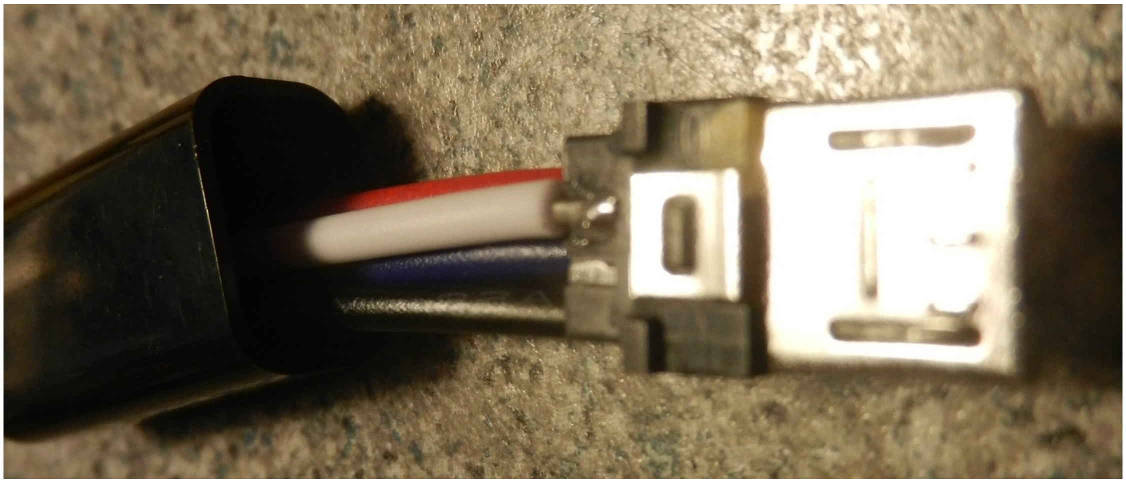


Figure 18-B, USB-A to micro USB Wiring, Top.

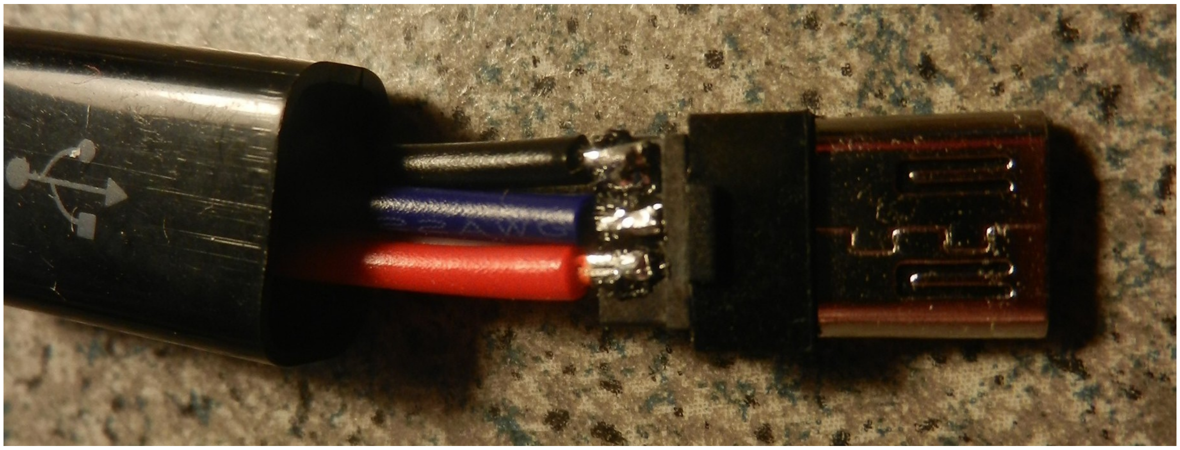


Figure 18-C, USB-A to micro USB Wiring, Bottom (blue in the middle).

6. **Prepare the main cable harness.**
   The GPIO header on the Raspberry Pi is at the center of the wiring harness. In most of the steps that follow you will be adding wires to a dual row, 20 pin DuPont connector shell. If using single wire jumpers then just attach the jumper to the appropriate pin. The rule is; one pin, one wire.

   There are two different assemblies for this project. One uses a Pico and the other uses an ADS1115 I2C ADC.

   1. If you are using female-to-female DuPont jumper wires and are not changing to the multi-pin DuPont connector shells then skip these steps.
   2. If you are using female-to-female DuPont jumper wires, then remove the single wire DuPont connector shell from each end. To remove the shell, use a hobby knife to lift the little tab up. While holding the tab up, pull the wire and crimp from the shell. It should come out easily, if not you are doing something wrong.
   3. The following steps detail how to build the main wiring harness that interconnects all of the circuit boards used and the power distribution block. Many of the steps are using the same connector shell from a previous step.
   4. ***The ILI9341 TFT LCD wiring.***
      1. You will need a red wire, a black wire and six other wires (8 wires all together) that are 6 Inches long, a 14 pin single row DuPont shell and a dual row, 20 pins per row DuPont shell and many female DuPont crimps. Each DuPont shell has a small triangle on one side. The triangle indicates pin one. The dual row shell will be used repeatedly in subsequent steps.
      2. Strip about 3/32 of an inch from each end of all eight wires. Using your crimper tool, attach a female crimp to both ends of all eight wires.
      3. You are going to insert the crimped end of the wires into the two DuPont shells. The 14 pin shell mates with the TFT LCD board and the dual row shell mates with the Raspberry Pi's GPIO header. The dual row shell has all the odd numbered pins on the same side as the little triangle. The even numbered pins are on the other side.
      4. Insert the wires into the pin positions given in the following table. The last six pins of the 14 pin shell are empty. The red wire is for +5V and the black is for GND.

14 Pin Shell Pin	LCD Signal	Dual Row Shell Pin	RPi GPIO
1	Vcc (+5V)	3	+5V
2	GND	13	GND
3	CS	25	CE1/GPIO7

4	Reset	15	GPIO23
5	DC	16	GPIO22
6	SDI(MOSI)	20	MOSI/GPIO10
7	SCK	24	SCK/GPIO11
8	LED	34	GPIO13

5. ***The Touch Switch wiring.***
   1. You will need an orange wire, a black wire and one other wire (3 wires all together) that are seven Inches long, a three pin, right angle DuPont header, a three pin single row DuPont shell, the dual row, 20 pins per row DuPont shell from the previous step and several female DuPont crimps. Each DuPont shell has a small triangle on one side. The triangle indicates pin one.
   2. Solder the three pin, right angle header to the TTP223 board on the top (component) side. The pins should point away from the board.
   3. Attach female DuPont crimps to the both ends of all three wires.
   4. Insert the wires into the pin positions given in the following table. The orange wire is for +3.3V and the black is for GND.

3 Pin Shell Pin	TTP223 Signal	Dual Row Shell Pin	RPi GPIO
1	GND	10	GND
2	I/O	17	GPIO24
3	Vcc (+3.3V)	2	+3.3V

6. ***RPi to +5V Power Distribution Block wiring.***
   1. You will need a four inch piece of 22awg red wire and a four inch piece of 22awg black wire, several DuPont female crimps, a two pin DuPont shell and the dual row shell from the previous step.
   2. Attach female DuPont crimps to both ends of both wires.
   3. Insert the wires into the pin positions given in the following table. The red wire is for +5V and the black is for GND.

Dual Row Shell Pin	RPi GPIO	2 Pin Shell Pin	+5V Power Distribution Block
1	+5V	1	+5V

5	GND	2	GND

7. ***This next set of steps is for assembly with a Pico.***
   The Pico has forty pins, twenty on each long side. With the USB connector pointing away from you, the pins are numbered starting with the top left pin, one through twenty. The pins on the right side are numbered starting from the bottom right, as twenty-one through forty.
   1. ***Pico +5V Power wiring.***
      1. You will need one, seven inch piece of 22awg red wire and one, seven inch piece of 22awg black wire, several DuPont female crimps, a two pin DuPont shell and the dual row shell from the previous step.
      2. Insert the wires into the pin positions given in the following table. The red wire is for +5V and the black is for GND.

10 Pin Shell, Right Side	Pico Right Side	2 Pin Shell Pin	+5V Power Distribution Block
1	40 (VBUS)	1	+5V
3	38 (GND)	2	GND

   2. ***Pico to RPi wiring.***
      1. You will need two five inch pieces of 24awg wire, one ten pin DuPont shell, several DuPont female crimps and the dual row shell from the previous step.
      2. Prepare both ends of both wires with female crimps.
      3. Insert the wires into the pin positions given in the following table. There are now two, ten pin shells in the harness, Pico left and Pico right.

10 Pin Shell, Left Side	Pico Left Side	Dual Row Shell	RPi GPIO
9	GP6	35	GPIO16
10	GP7	30	GPIO5

   3. ***Pico to MSGEQ7 wiring.***
      1. You will need one five inch piece of 22awg orange wire, one five inch piece of 22awg black wire, three pieces of 24awg wire, one five pin DuPont shell, a bunch of DuPont female crimps, the dual row shell and the two ten pin shells from the previous steps.

2. Prepare both ends of all five wires with female crimps.
3. Insert the wires into the pin positions given in the following table. The Pico right shell has red and black wires.

10 Pin Shell, Left Side	Pico Left Side	10 Pin Shell, Right Side	Pico Right Side	5 Pin Shell	MSGEQ7
		8	33 (GND)	1	GND
		10	31 (ADC0)	2	OUT
7	GP5			3	STB
6	GP4			4	RST
		5	36 (3V3)	5	5V

The MSGEQ7 board may be labeled as using 5V. This project powers the MSGEQ7 board with 3.3V. This is due to the Pico’s analog input being limited to 3.3V. The MSGEQ7 is rated to operate at 3.3V.

8. ***This next set of steps is for the assembly with a ADS1115.***
The ADS1115, MSGEQ7, TTP223 Touch Switch and the IR receiver all require +3.3V. However, the Raspberry Pi only has two pins with +3.3V. Therefore, you must add the six position +3.3V power distribution block. Follow the previous directions for making the ten position +5V power distribution block except start with a dual row, six pins per row header. Glue the assembled +3.3V Power distribution block into it’s place on the inside, top left, above where the Pico goes.

   1. ***RPi to +3.3V Power Distribution Block.***
      1. You will need a three inch piece of 22awg orange wire and a three inch piece of 22awg black wire, several DuPont female crimps, one two pin DuPont shell and one ten pin DuPont shell
      2. Attach female DuPont crimps to both ends of both wires.
      3. Insert the wires into the pin positions given in the following table. The orange wire is for +3.3V and the black is for GND.

Dual Row Shell	RPi GPIO	2 Pin Shell	+3.3V Power Distribution Block
18	3.3V	1	+3.3V
26	GND	2	GND

2. ***ADS1115 to 3.3V Power Distribution Block wiring.***
    1. You will need a three inch piece of 22awg orange wire and a three inch piece of 22awg black wire, several DuPont female crimps, one two pin DuPont shell and one ten pin DuPont shell
    2. Attach female DuPont crimps to both ends of both wires.
    3. Insert the wires into the pin positions given in the following table. The orange wire is for +3.3V and the black is for GND.

10 Pin Shell	ADS1115 Pin	2 Pin Shell	+3.3V Power Distribution Block
1	Vdd (+3.3V)	1	+3.3V
2	GND	2	GND

3. ***ADS1115 to RPi wiring.***
    1. You will need three, five inch pieces of 24awg wire, several DuPont female crimps, the ten pin DuPont shell and the dual row shell from the previous step.
    2. Attach female DuPont crimps to both ends of all the wires.
    3. Insert the wires into the pin positions given in the following table.

10 Pin Shell	ADS1115 Pin	Dual Row Shell Pin	RPi GPIO
3	SCL	6	SCL/GPIO3
4	SDA	4	SDA/GPIO2
6	Alert	8	GPIO4

4. ***MSGEQ7 to RPi wiring.***
    1. You will need two, five inch pieces of 24awg wire, several DuPont female crimps, one, five pin DuPont shell and the dual row shell from the previous step.
    2. Attach female DuPont crimps to both ends of all the wires.
    3. Insert the wires into the pin positions given in the following table.

5 Pin Shell	MSGEQ7	Dual Row Shell Pin	RPi GPIO
3	STB	35	GPIO16
4	RST	30	GPIO5

5. ***MSGEQ7 to 3.3V Power Distribution Block wiring.***
    1. You will need a four inch piece of 22awg orange wire and a four inch piece of 22awg black wire, several DuPont female crimps, one two pin DuPont shell and the five pin DuPont shell from the previous step.
    2. Attach female DuPont crimps to both ends of both wires.
    3. Insert the wires into the pin positions given in the following table. The orange wire is for +3.3V and the black is for GND.

5 Pin Shell	MSGEQ7	2 Pin Shell	+3.3V Power Distribution Block
1	GND	2	GND
5	+3.3V	1	+3.3V

6. ***ADS1115 to MSGEQ7 wiring.***
    1. You will need one, two inch piece of 24awg wire, several DuPont female crimps, the five pin DuPont shell and the 10 pin shell shell from a previous step.
    2. Attach female DuPont crimps to both ends of the wire.
    3. Insert the wire into the pin positions given in the following table.

5 Pin Shell	MSGEQ7	10 Pin Shell	ADS1115
2	Out	7	A0

7. ***Optional, for use with Pico Probe.***
    1. You will need one 2.5 inch piece of 22awg or 24awg black wire, two 2.5 inch pieces of 24awg wire, a three pin DuPont shell and female crimps.
    2. Add female crimps to both ends of all three wires.
    3. Insert the wires into the pin positions given in the following table.

Three Pin Shell	Pico Probe Uart Three Pin Shell	10 Pin Shell, Left Side	Pico Left Side
1 (RX)	1 (yellow)	1	GP0 (TX0)
2 (TX)	2 (orange)	2	GP1 (RX0)
3 (GND)	3 (black)	3	GND

7. ***Pico/RPi to SK6812 LED Strip.***

The addressable LED strip is driven by the Pico when it is present or the RPi if the ADS1115 is present.

1. If the Pico is present, insert the DI wire from the 25 LED strip into pin 4 (GP2) of the Pico’s left side 10 pin shell.
2. If the Pico is absent, insert the DI wire from the 25 LED strip into pin 32 (GPIO12) of the dual row shell.

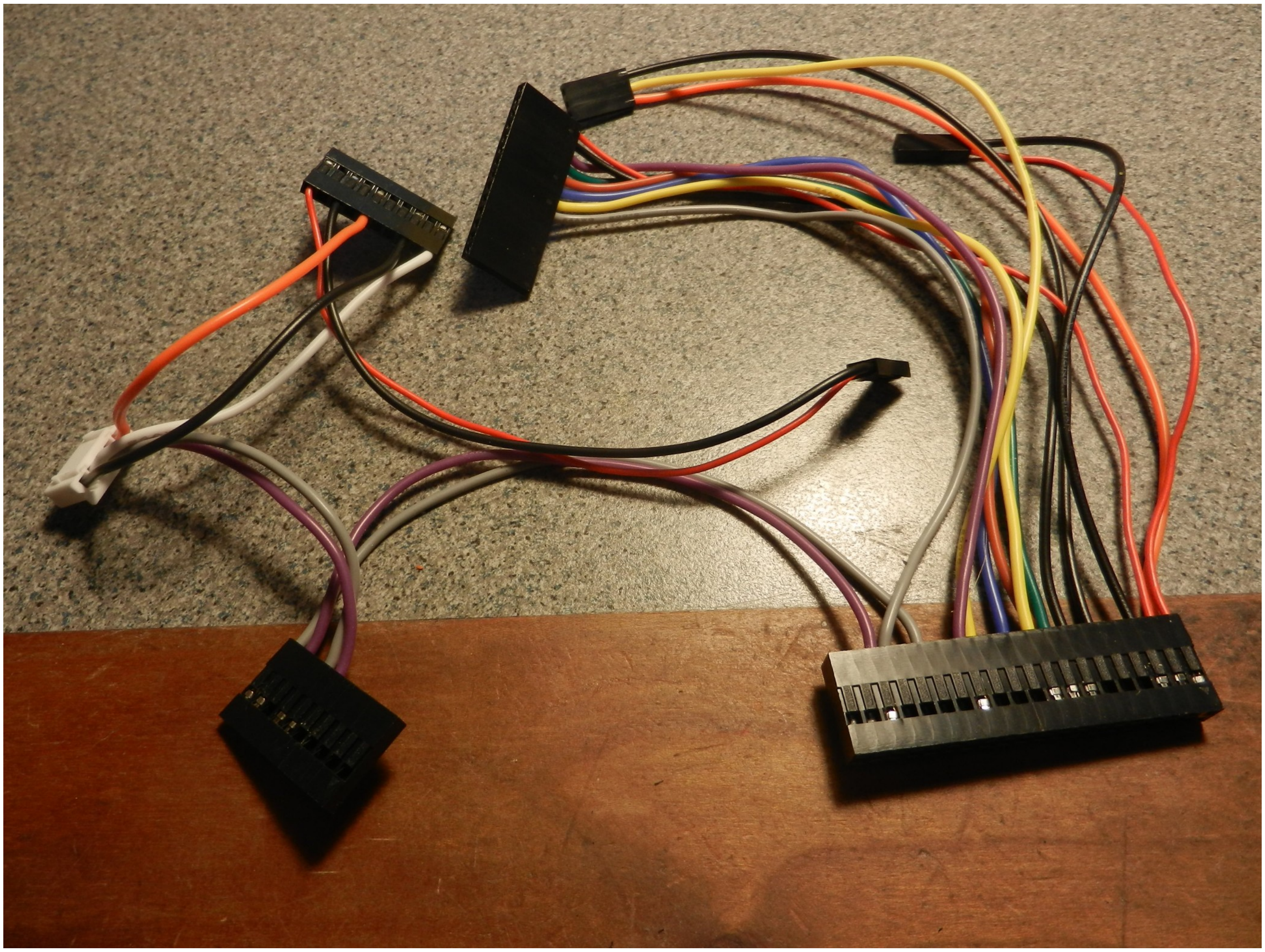


Figure 19, Wiring Harness when using Pico.

8. ***Optional IR Receiver to RPi wiring.***

Do this only if using an IR receiver. The leads of the IR receiver are not long enough to reach from the hole in the grill to the RPi GPIO header, therefore you need to lengthen the leads. There should be a way to disconnect the IR receiver from the main harness so that the grill insert can be removed without having to dangle by the IR receiver’s wires. A three pin DuPont shell can act as a socket that the three leads of the IR receiver can plug into. The wires from the three pin DuPont shell can be added directly to the dual row RPi DuPont shell or inserted into a second three pin shell.

If you are using an ADS1115 then the IR receiver gets power from the +3.3V power distribution block or from the DAC board.
If your DAC board came with an IR receiver soldered to the board then it will need to be removed. You can still use the IR receiver, it just needs to be re-located to the grill opening. Solder a three pin header to where the IR receiver was soldered.
If your DAC board has a place to mount an IR receiver then solder a three pin header there.
If your DAC board has an onboard IR receiver then the receiver's output must be wired to GPIO26. Reference the DAC board's documentation to find out what GPIO pin the IR receiver is wired to.
DAC boards that have a place for an IR receiver typically provide some power supply filtering for the IR receiver. It would be a good thing to use the filtered supply. If your DAC board has a place for an IR receiver and the IR receiver's signal is routed to GPIO26 then you could solder wires to the IR receiver's leads. The other ends of the wires get female crimps and are inserted into a three pin shell.

You will need three 5 inch wires, one black, one orange and one of another color, one or two, three pin DuPont shells and several female crimps. Each wire must have a female crimp on both ends.

Four wiring variations;

1. ***The IR receiver's three wires are all inserted into the dual row shell.***

3 Pin Shell	IR Receiver Pin	Dual Row Shell	RPi GPIO
1	1 - Out	38	GPIO26
2	2 – GND, black	26	GND
3	3 – Vs, orange	18	+3.3V

2. ***The IR receiver's three wires are inserted into a three pin DuPont shell.***

3 Pin Shell	IR Receiver Pin	3 Pin Shell	DAC Board
1	1 - Out	1	1
2	2 – GND, black	2	2
3	3 – Vs, orange	3	3

3. ***The power and ground wires for the IR receiver are inserted into a three pin DuPont shell. The IR receiver's output wire is inserted into the dual row shell.***

3 Pin Shell	IR Receiver Pin	3 Pin Shell	DAC Board IR Header	Dual Row Shell	RPi GPIO
1	1 - Out	Empty	1	38	GPIO26
2	2 – GND, black	2	2		
3	3 – Vs, orange	3	3		

4. ***The power and ground wires for the IR receiver are inserted into a two pin DuPont shell. The IR receiver's output wire is inserted into the dual row shell. Check the pinout of your IR receiver. Adjust wiring to match your IR receiver.***

3 Pin Shell	IR Receiver Pin	2 Pin Shell	+3.3V Power Distribution Block	Dual Row Shell	RPi GPIO
1	Out			38	GPIO26
2	GND, black	2	GND		
3	Vs, orange	1	+3.3V		

9. ***MSGEQ7 to DAC board wiring.***
   There needs to be a two wire cable that carries the analog audio from the DAC board to to MSGEQ7 board's audio input. The issue here is that the DAC board and MSGEQ7 board you are using may not be the same as the ones I have.

   Some DAC boards have a place to add a header to get access to the audio right/left outputs. If your board has this then solder the appropriate header into place otherwise cut two wires long enough to reach from the RCA jacks on the DAC board to the audio inputs on the MSGEQ7 board. Strip, tin and solder one of the wires to the center contact of the RCA jack on the bottom of the DAC board. Solder the other wire to the center contact of the other RCA jack. Use some tape or hot glue to affix the wires to the underside of the board, exiting on the side where the MSGEQ7 is located.

1. The MSGEQ7 board that you bought may not be an exact match for the ones that I have. You may have to adjust the wiring of the five pin shell to match your MSGEQ7 board.
2. The two audio output wires from the DAC board should have DuPont female crimps added to them.
3. Insert the wires into the two outside pins of a three pin DuPont shell, the center position should be empty.

Once you have a 3D printed case that you have completed all post 3D printing steps on, you can start the assembly of the Jukebox. Everything mounts to the case. I have put together a few of these during development and have found that if you do the assembly in the order given here, your assembly will be easier.

10. **Place the four peel-and-stick rubber feet in the corners on the bottom of the 3D printed base.**
    1. After affixing the rubber feet, place the Case, upright on a flat surface.
    2. Press down on the inside, bottom of the Case to apply pressure on the rubber feet.
11. **Tap the RPi mounting bosses on the bottom of the case.**
    1. If you have an M2.5 tap and Tap handle you can tap the bosses from the outside of the case.
    2. You can use one of the brass standoffs to tap each RPi mounting boss. This must be done from the inside of the case. Simply screw the standoff into one of the bosses, then unscrew it and repeat until all the RPi bosses are tapped. It may be easier to reach through the grill insert opening to get at the two RPi bosses closest to the front.
12. ***Glue in the +5V Power Distribution Block.***
    1. You will need the 3D printed Case, the previously assembled +5V Power Distribution Block and an adhesive (super glue, hot glue or epoxy).
    2. Test fit the assembled +5V Power Distribution Block into it's slot on the right side, where it says '+5V' in raised letters. It should be a tight fit.
    3. If it does not fit then;
        1. Examine your work. Did you follow the directions in step 2 '**Prepare the power distribution block.'.**
        2. Clean up the block that you made or make another.
    4. If it fits then;
        1. Remove it.
        2. Apply a small amount of glue to the sides of the slot.
        3. Press the assembled +5VPower Distribution Block into place.
        4. If using super glue then continue to press down on the assembled +5V Power Distribution Block for about ten seconds.
13. ***Test Fit The LED strips.***

At this point it is a good idea to insure that each of the LED strips actually fits into their designated holder. The 25 LED strip should be test fitted into the outer most horseshoe shaped holder. Insure that the strip goes all the way in such that the LEDs are resting on the shelf and are below the level of the face. The center LED should be held in place by some locating blocks at the pinnacle of the arch. If you have trouble, remove the strip and try to open up the trouble spot with a sharp hobby knife, sand paper or a small hobby file. Repeat test fitting until the strip fits in without any problems.

1. Repeat the previous step with the other two LED strips.
2. When all three strips of side emitting LEDs are fitted into the case then carefully remove them.

*14. **Finish LED strip sub-assembly.***

1. Solder the end of a 10 inch wire to the pad labeled ‘DI’ on the input side of the 25 LED strip. The other end should have a female crimp on it.
2. Solder one end of a 4 ½ inch wire to the pad labeled ‘DO’ on the 25 LED strip. Solder the other end of the wire to the pad labeled ‘DI’ on the 23 LED strip.
3. Solder one end of the 3 ½ inch wire to the pad labeled ‘DO’ on the 23 LED strip. Solder the other end of the wire to the pad labeled ‘DI’ on the 10 LED strip.
4. Using the three wire cable with the three pin socket on it that was removed from the SK6812 LED strip. Shorten the wires to two inches long. The cables that come soldered to LED strips usually use red, green and white wires. Red is +5V, green is the input or output and white is ground.
5. Strip and tin the green wire. Add DuPont female crimps to the red and white wires.
6. Solder the green wire from the three wire cable to the pad labeled ‘DO’ on the output end of the 10 LED strip.
7. Insert the red and white wires into a two pin DuPont shell.
8. The side emitting LED strips should look like the picture in Figure 20.

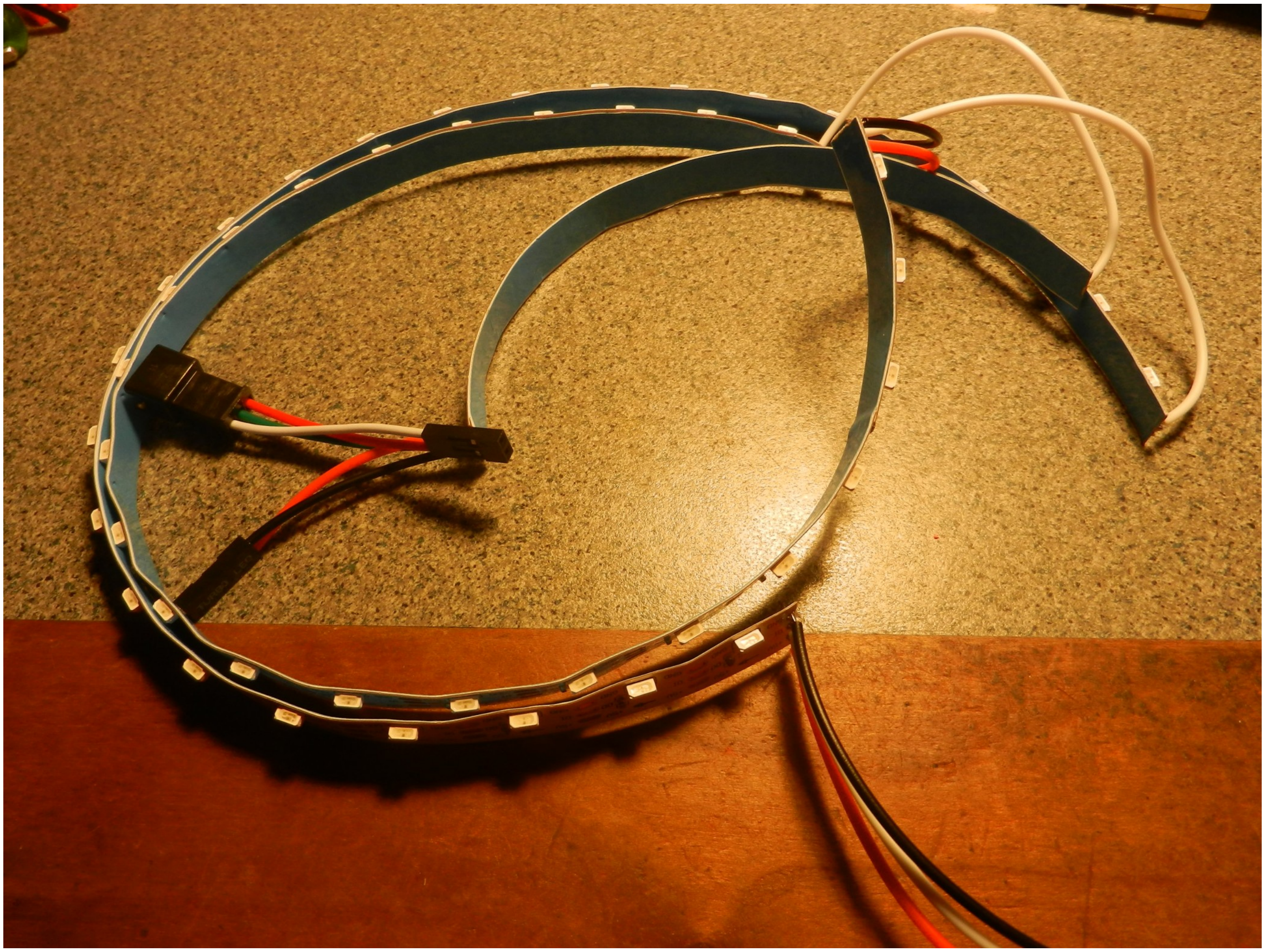


Figure 20, Completed rewire of the side emitting LED strip.

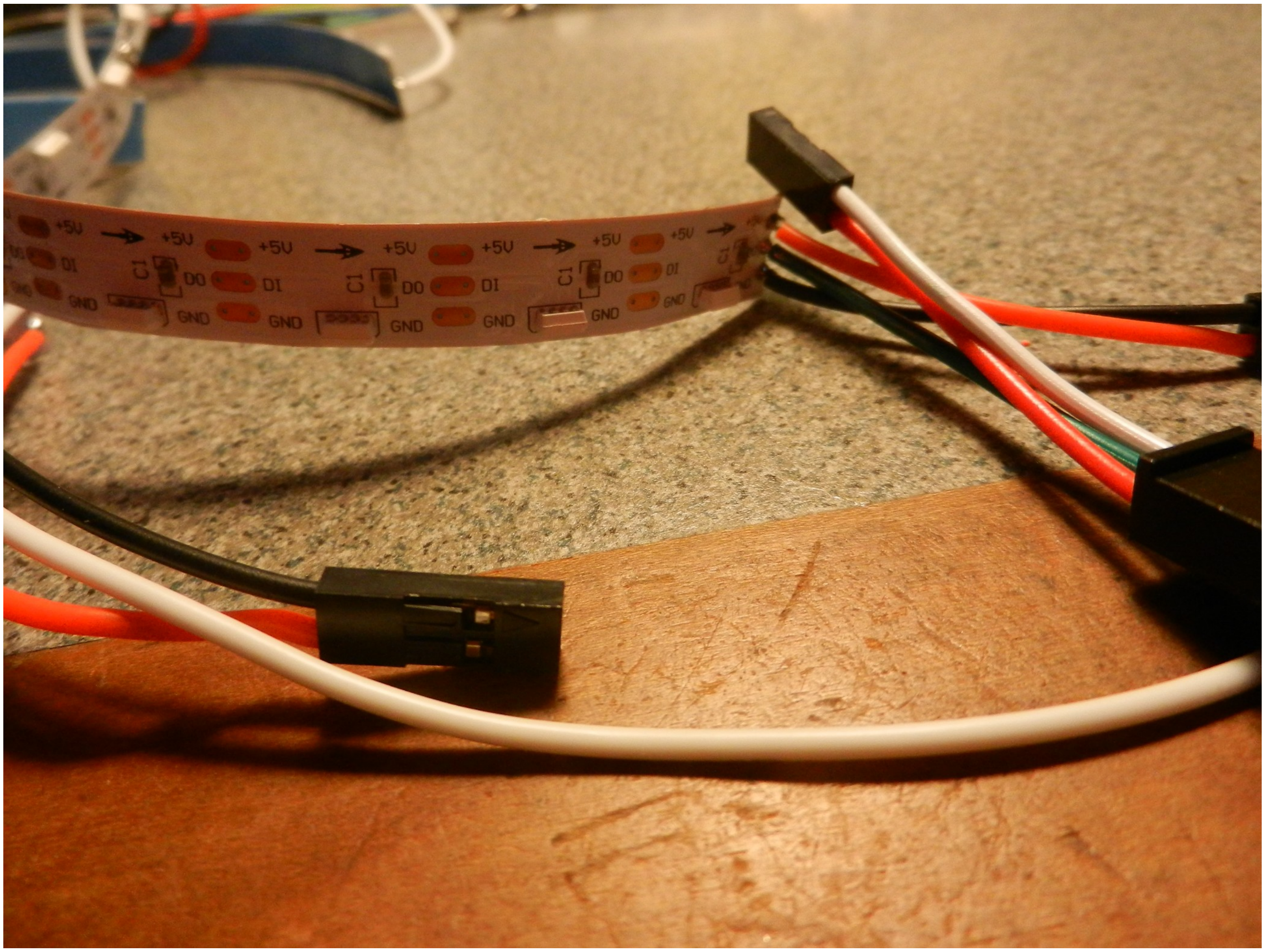


Figure 21, Detail of the output end of the ten LED strip.

9. This would be a good time to make sure that you have everything wired correctly. The red wires are soldered to the +5V pads, the black and white wires are soldered to the GND pads and the wires are on the correct edges of the LED strips.
10. At this point you have completed the side emitting LED strip sub-assembly. It would be a good idea to power up the LED strip and make sure that it all works, before mounting in the case. Follow the steps below to test the LED strip.
    1. Plug all four of the two pin power shells to the +5V power distribution block.
    2. Plug the three pin connector of the 13 LED strip into the mating connector on the 10 LED strip.
    3. Plug the two pin shell from the power barrel connector into the +5V power distribution block.
    4. All of the red wires should be on the same row. All the black & the white wire should be on the other row.

5. Using the previously prepared RPi,
    1. Plug the end of the wire soldered to the DI input of the 25 LED strip into pin 31 (GPIO12) of the GPIO header on the RPi.
    2. Use a jumper wire to connect pin 1 (+5V) of the RPi GPIO header to the +5V side of the +5V Power Distribution Block that the LED strips are plugged into.
    3. Use a second jumper to connect pin 3 (GND) of the RPi GPIO header to the GND side of the +5V Power Distribution Block that the LED strips are plugged into.
6. Power up the RPi.
7. Run the LED strip test Python script. Type; sudo Python3 ledtest.py. All the LEDs of all the strips will light up red, one at a time.
8. If any LEDs do not light up red then check your wiring.
    1. Is the 25 LED strip DI wire on RPi pin 31 ?
    2. Are the LED strips +5V & GND pads wired to the +5V Power Distribution Block with all +5V wires on the same side ?
    3. Are the DO pads of the LED strips wired to the DI pads of the next strip ?

15. ***Mount the side emitting LED strips to the case.***

In the next steps you will be threading the now 58 LED strip through various holes in the case and tucking them into their final resting place. Pay close attention to where and how the LED strip is threaded. The power wires attached to the two longest strips must be passed through along with the strip. It may be easier to pass the power wires through ahead of the strip itself. The wires soldered to the strips should never be pulled on. You run the risk of tearing off a solder pad from the strip. Once torn off, it cannot be replaced. Wires cannot be soldered to LED strips once they are in place. There simply is no space to get a soldering iron in there without melting some plastic. Be very careful!! Notice that the protective cover on the adhesive on the back of the LED strip is not removed. There is no need to use the adhesive.

1. Looking at the front of the case, you should see the three channels that the LED strips are going to fit into. At the end of each channel is a rectangular opening. This opening is sized to allow the SK6812 side emitting LED strip to pass through. It is a tight fit and works best if you pass the strip through angled to maximize the opening. The LEDs rest on the small shelf along the outside of each slot.
2. Turn the case over. Looking in from the back side, you are going to pass the entire LED strip through the rectangular hole on your right side, top of the 10 LED holder (see Figure 19). Thread the strip through, starting with the input edge of the 25 LED strip, followed by the input edge of the 23 LED strip and then the input edge of the 10 LED strip. The three pin connector on the output

side of the 10 pin strip will not fit through the opening. It should remain inside the case.

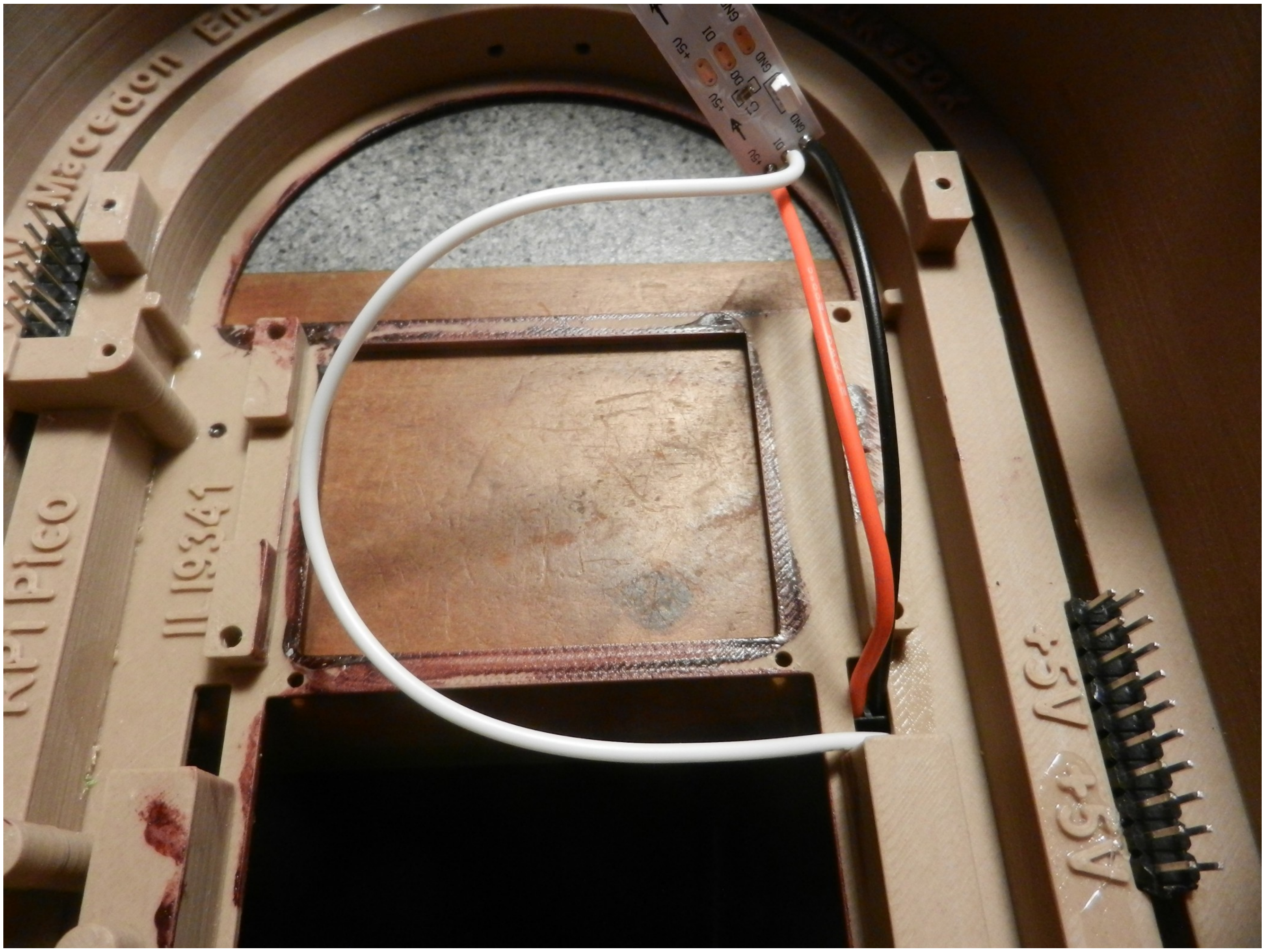


Figure 22, Start here.

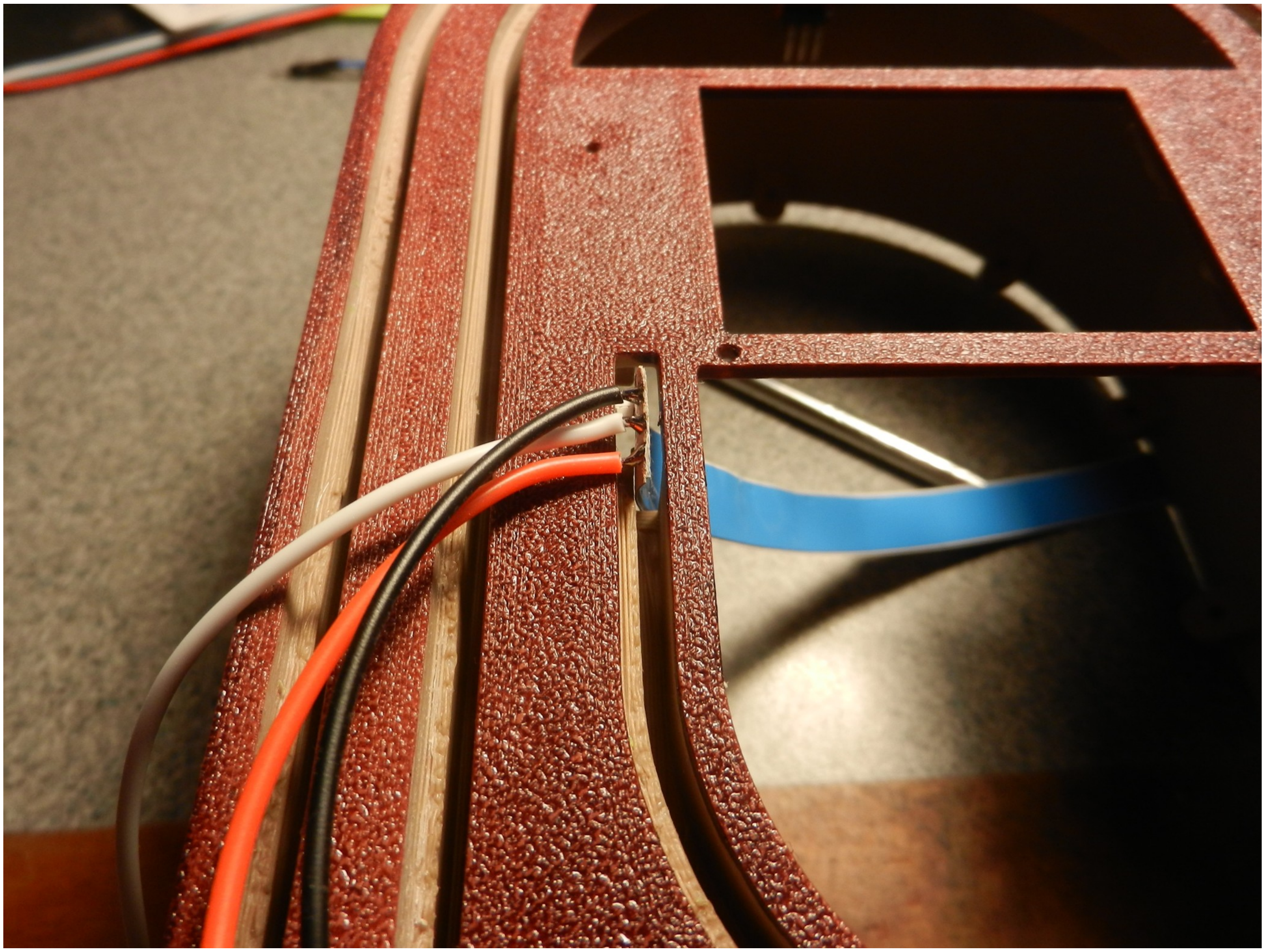


Figure 23, LED strip emerges from the cutout.

3. Turn the case around. From the front (face side), use the rectangular opening at the top of the 10 LED holder to thread the LED strip back into the inside of the case. Like before, start with the 25 LED strip and then the 23 LED strip. You should now be able to press the 10 Led strip into the holder with the LEDs resting on the shelf along the outside edge of the holder.

Figure 24, Pass Led strip to the inside of the case.

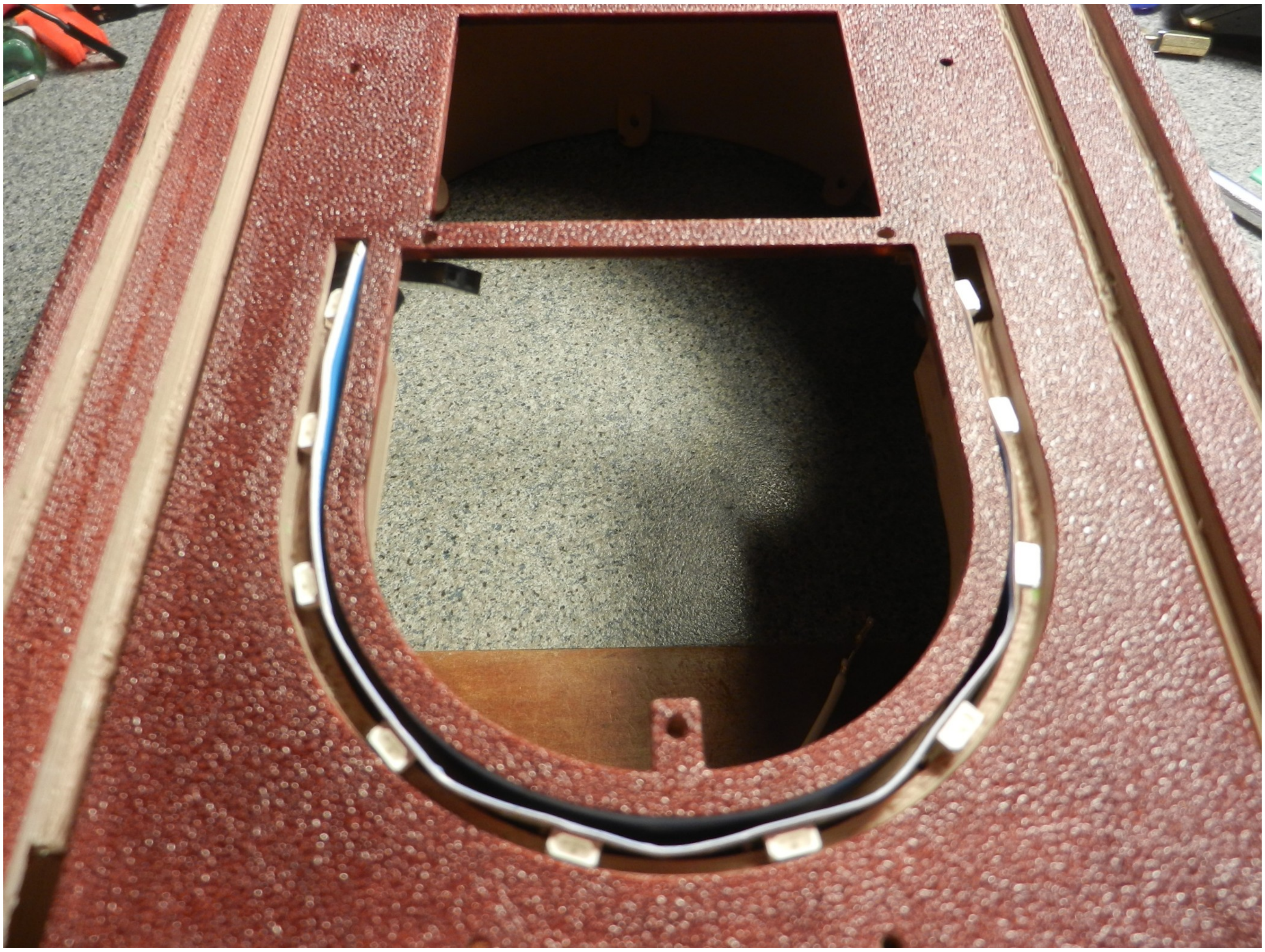


Figure 25, Ten LED strip all tucked into place.

4. Turn the case around, From the inside pass the LED strip through the rectangular hole on the bottom left (your left), inner LED holder. As before, 25 LED strip followed by the 23 LED strip (see Figure 26).

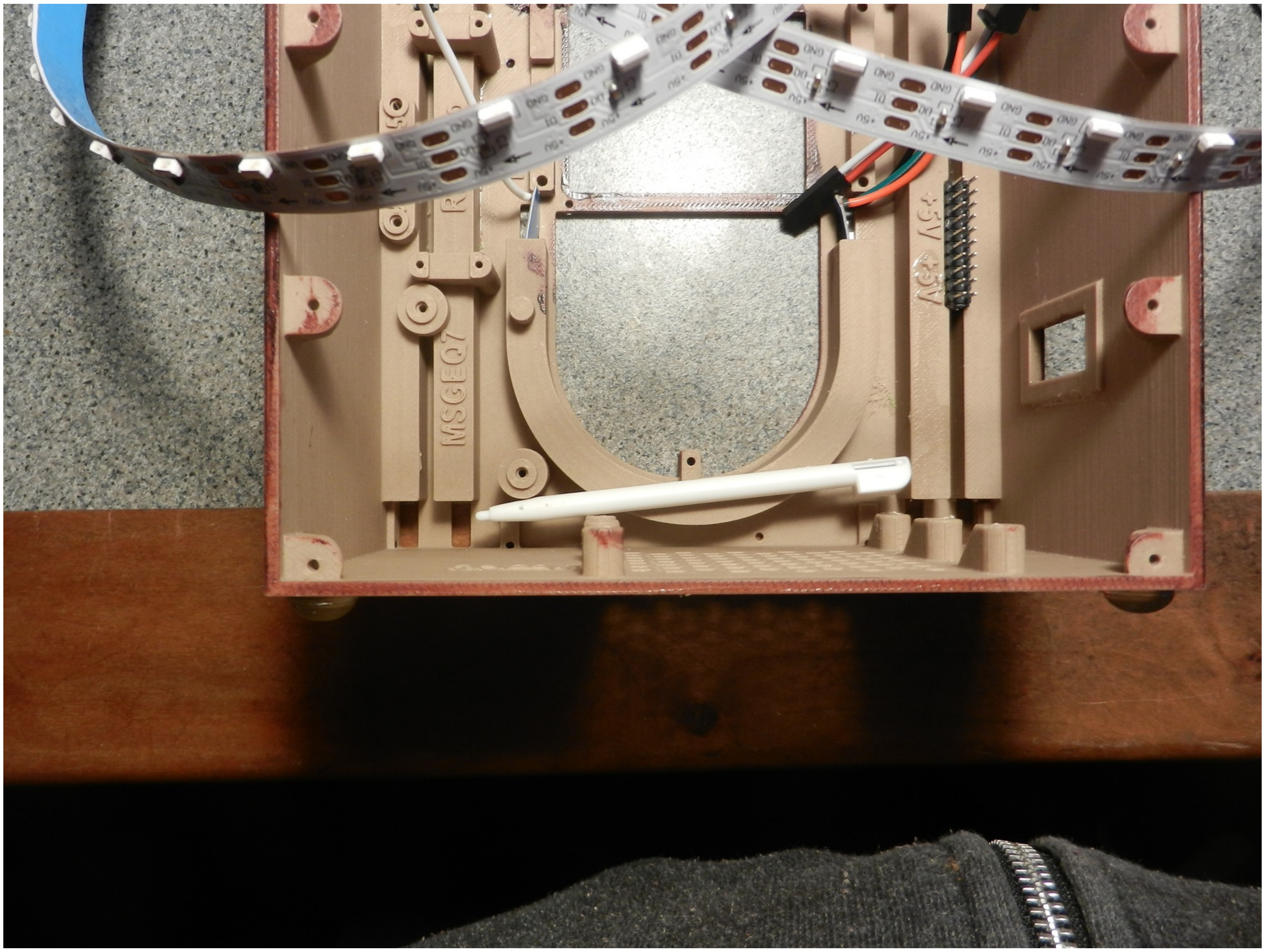


Figure 26, Where to go next.

5. Turn the case around. From the front, pass the 25 LED strip through the inner, bottom rectangular hole on your left. You can now press the 23 LED strip fully into it’s holder. The middle LED of the strip should be held in place by the two locating blocks at the pinnacle of the arch.

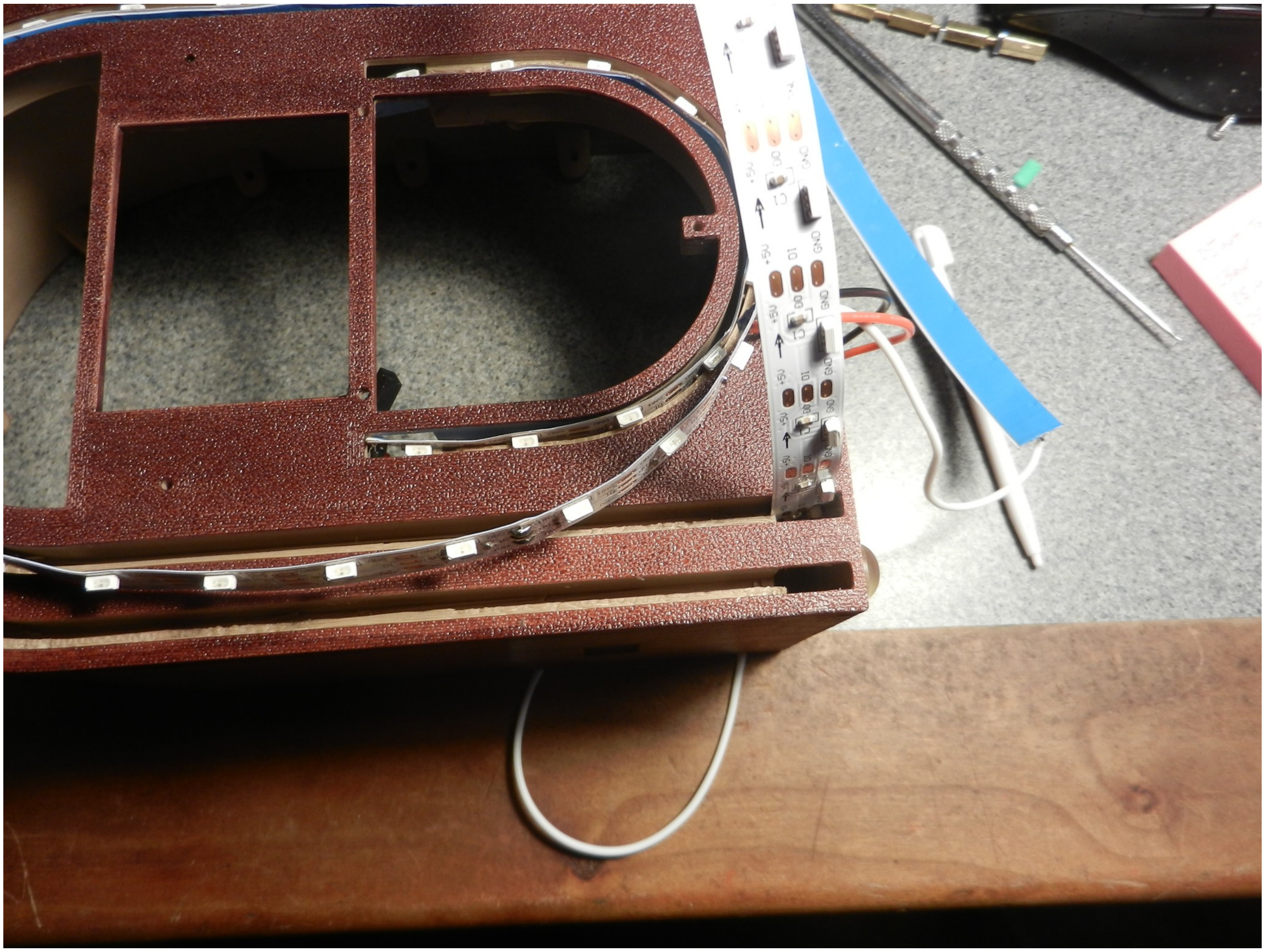


Figure 27, Feed LED strip through here.

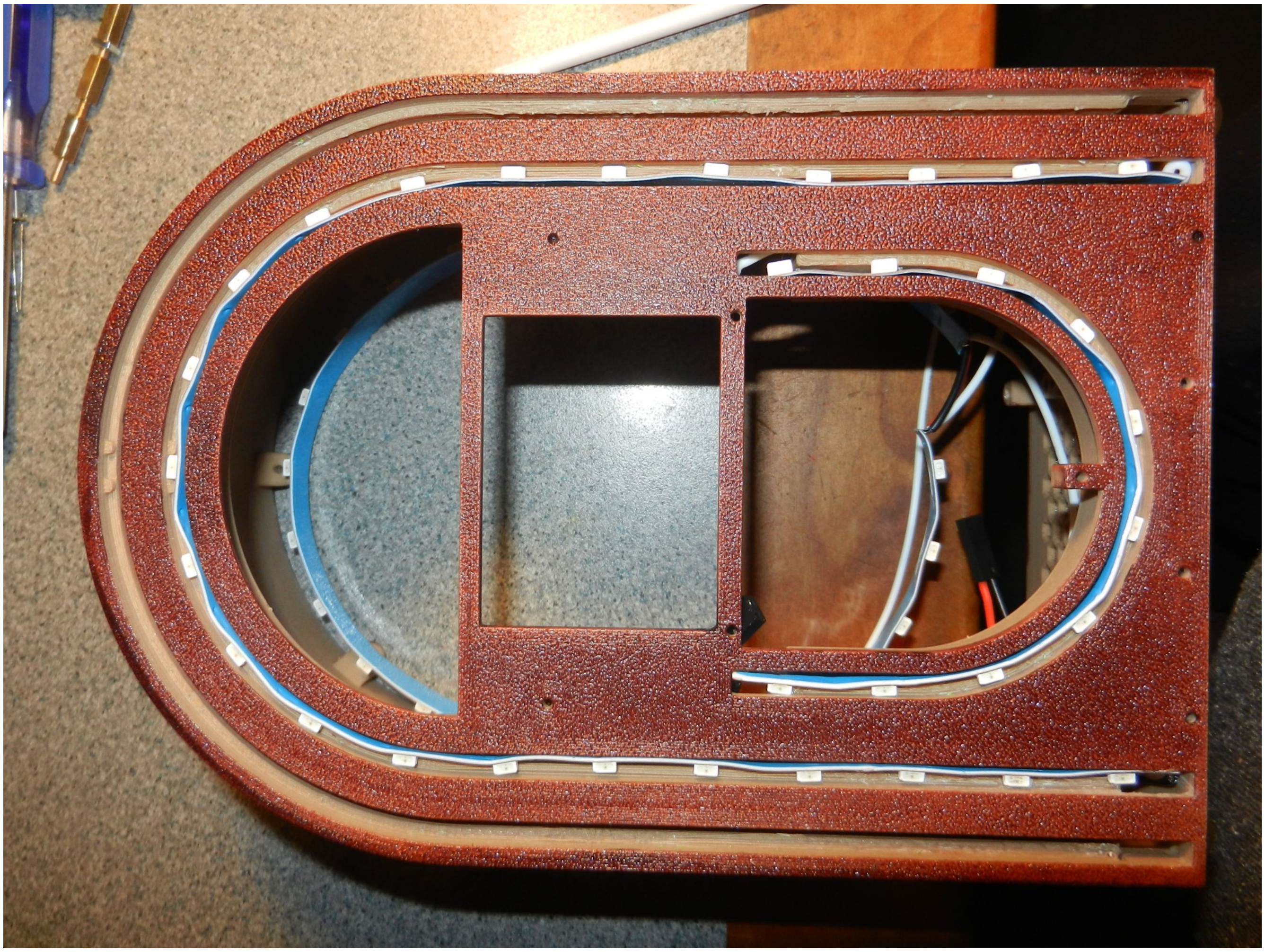


Figure 28, 23 LED strip all neatly tucked in.

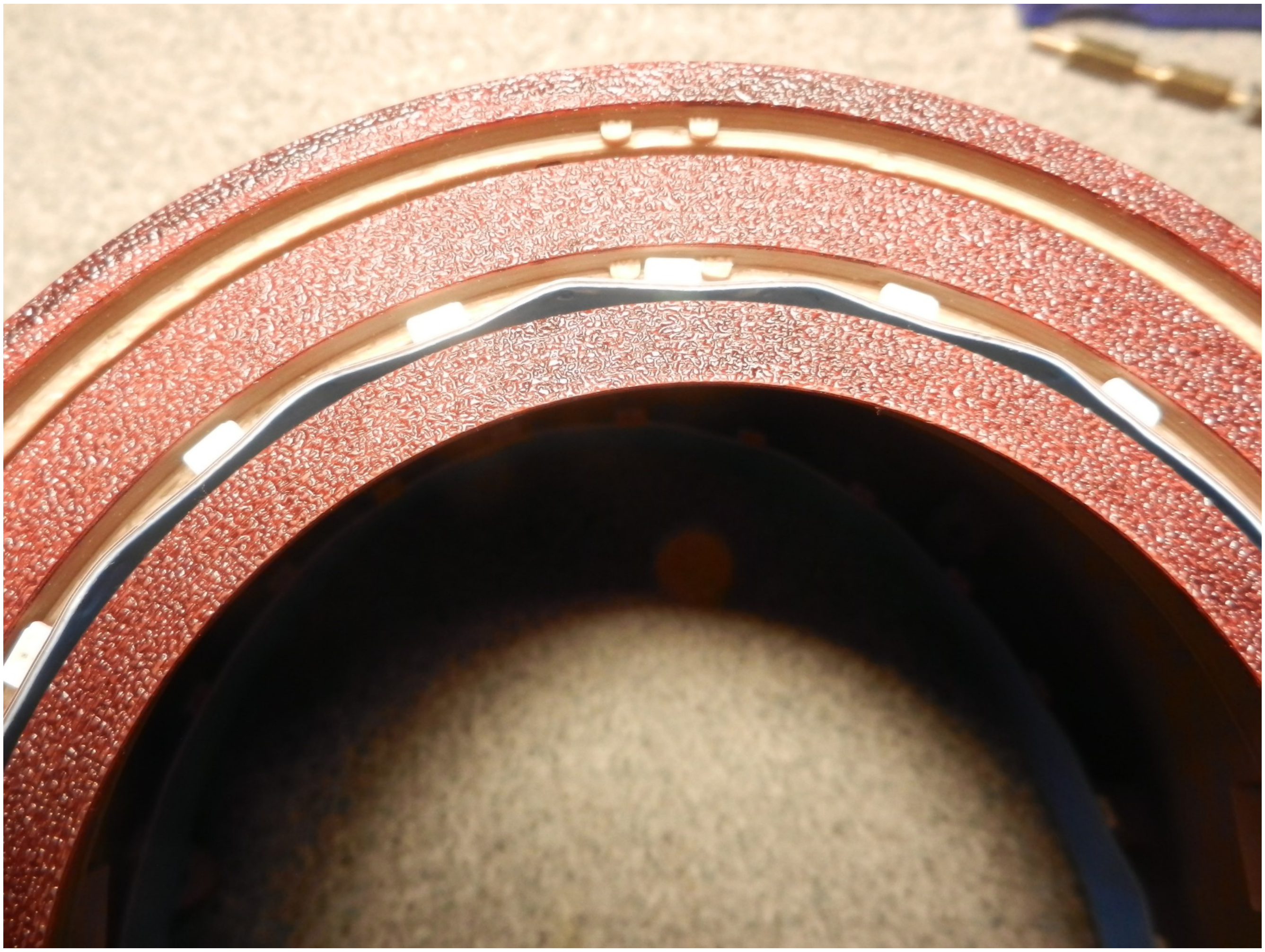


Figure 29, Center LED captured by the locating blocks.

6. Turn the case around. From the inside, pass the 25 LED strip through the outer bottom rectangular hole on your left. The wire connecting the 25 & 23 LED strips should be routed along the bottom of the case between the RPi board mounts and the case front.
7. Turn the case around. From the front, pass the long wire attached to the input edge of the 25 LED strip through the outer bottom rectangular hole. The 25 LED strip can now be pressed into the holder just like you did the 23 LED strip. The center LED should be captured by the locating blocks at the pinnacle of the arch. The long wire should be dressed along the inside bottom of the case and up along your left side to where the Pico goes. Later it will be add to one of the Pico connectors.
8. Looking into the case from the back side, all of the power wires for the LED strips and the three wire connector cable should be plugged into the +5V power distribution block on your right side, about mid way up. Insure that all the red wires are on the same column of pins and all the black wires and the white wire from the three pin connector are on the other column of pins.

9. Congratulations, you have finished the wiring and mounting of the side emitting LEDs.

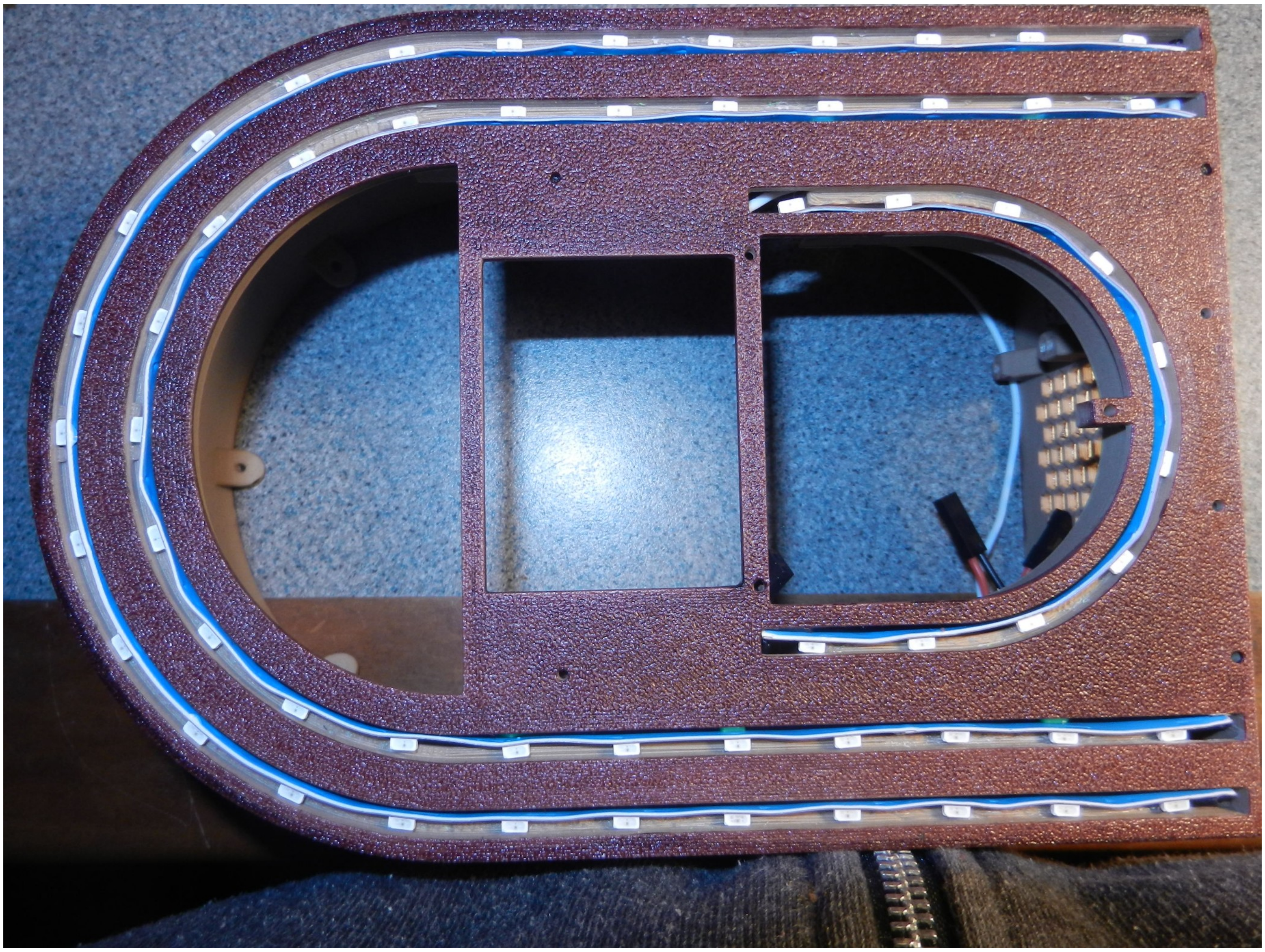


Figure 30, All side emitting LED strips all neatly tucked in.

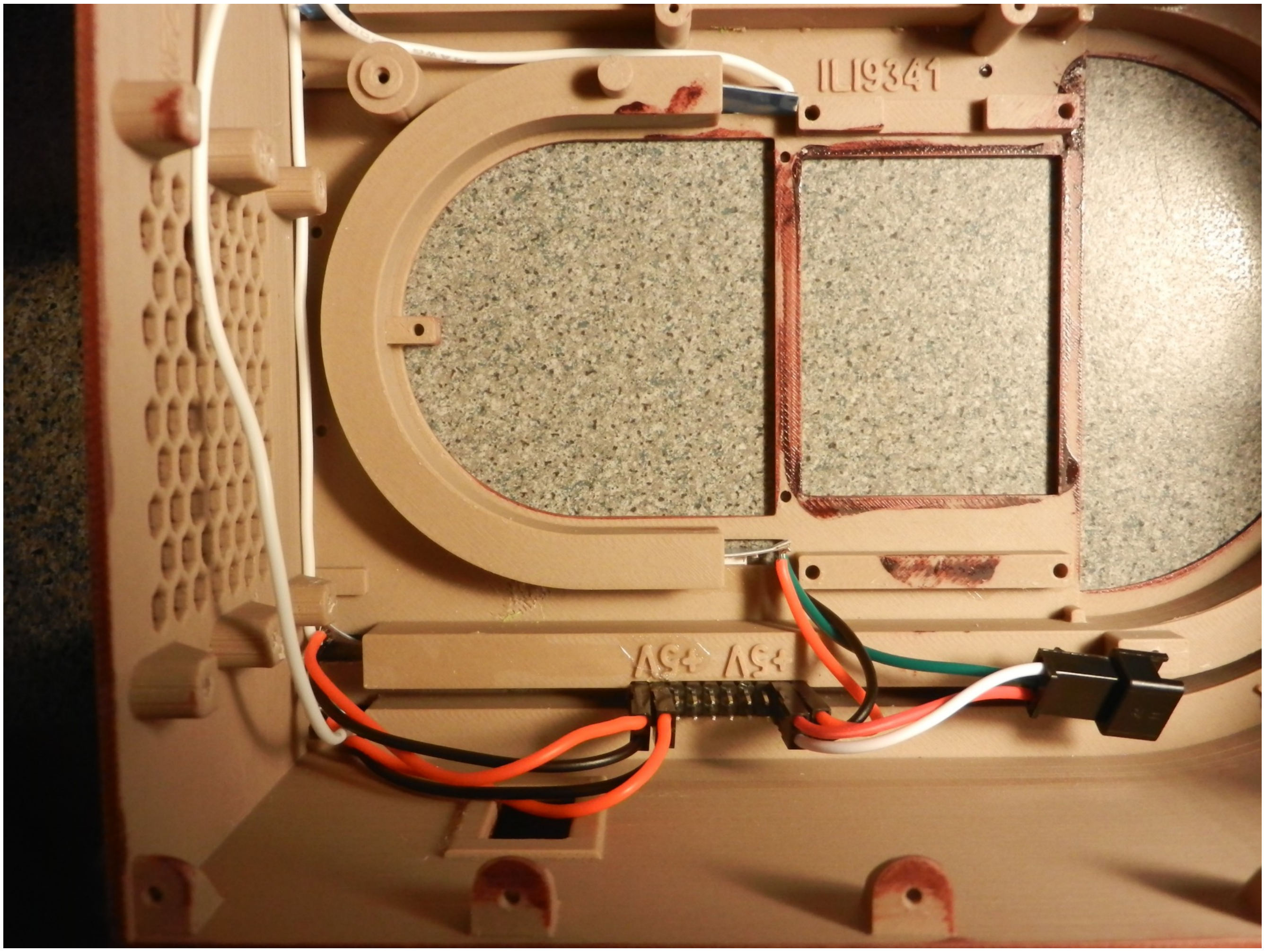


Figure 31, Shows how to route LED strip (white) wires inside case and +5V wiring.

16. ***Mount the 13 LED strip to the inside of the Top Chamber.***
    1. You will need the 3D printed Top Chamber and The strip of thirteen WS2812B LEDs with the three wire cable attached.
    2. Counting from the DI edge, fold the 13 LED strip along the cut line between the eighth and ninth LEDs
    3. Peel back the protective paper from the adhesive strip in the back of the LED strip, starting from the DO end. Peal back to just past the fold.
    4. Set the Top Chamber 3D printed piece in front of you with the slot on your right.
    5. Carefully press the fold into the corner on the inside left corner of the Top Chamber.
    6. Try to center the last five LEDs of the strip to the straight part of the Top Chamber. When aligned press down on the LED strip to stick it in place. The strip should not reach the slot.

7. Peel back the rest of the protective paper and stick the rest of the LED strip along the inside of the arch of the Top Chamber. The wires should pass through the slot. See figure 32.
8. Try to center the strip as much as possible. Press down on the strip to stick it in place.
9. If the adhesive is not holding then apply small amounts of super glue to where the adhesive is failing.

Figure 32, Top Chamber LED strip placement.

17. ***Add one-way mirror film to Top Chamber Window.***
    1. You will need the 3D printed Top Chamber Window, the 3D printed Circle Guide, 3D printed Burnishing Tool, scotch tape and a piece of one-way mirror film approximately 90mm x 45mm.
    2. Lay the piece of one-way mirror film on to a suitable cutting surface.
    3. Place the Circle Guide on top of the one-way mirror film.

4. Using a sharp hobby knife, trace around the outside edge of the Circle Guide to cut out a semi-circle. Use a straight edge or scissors to finish the straight line cut of the semi-circle.
5. The one-way mirror film has a protective plastic film on one side. The side with the protective file is the side that will be pressed against the inside of the Top Chamber Window. Press a piece of scotch tape onto one side of the one-way mirror film, such one end of the tape is on the one-way mirror film and one end is off the one-way mirror film. Using the free end of the scotch tape, pull it off the one-way mirror film. This will remove the protective film. If it does not then you are on the wrong side of the one-way mirror film.
6. Wet the Top Chamber Window with water.
7. Press the side of the one-way mirror film that had the protective film on it against the inside of the Top Chamber Window. The arc of the circular cut should match the arc of the Top Chamber Window.
8. Use the 3D printed burnishing tool to press the film to the window. Pay careful attention to getting the one-way mirror film adhered along the inside of the arc and the flat side. Use a credit card or similar to press down and remove any air bubbles.
9. Use a sharp hobby knife to remove any excess one-way mirror film.

18. ***Attach mirror to Mirror Holder.***
    1. You will need the 3D printed Mirror Holder and a peel & stick plastic mirror cut to 88mm X 50mm or a piece of one-way mirror film cut to 88mm X 50mm. The plastic mirror has a better reflective surface than the one-way mirror film. To get the best possible infinity mirror effect, use a plastic mirror.
    2. ***If using a plastic mirror.***
        1. The 3d printed Mirror Holder has ridges on one side.
        2. Test fit the plastic mirror into the area defined by the ridges. If the mirror is too big then either sand or file the edge until it fits within the ridges.
        3. When the plastic mirror fits within the ridges, peel off the protective layer from the adhesive side of the plastic mirror and stick it in place.
        4. Trim the plastic mirror where it extends outside of the Mirror Holder.
    3. ***If using one-way mirror film (not recommended)***.
        1. Use the flat side of the Mirror holder, not the side with the ridges.
        2. Follow the same technique used to adhere the one-way mirror film to the Top Chamber Window to adhere the one-way mirror film to the flat side of the Mirror Holder.
        3. Trim any excess one-way mirror film from the Mirror Holder.
19. ***Install the Raspberry Pi.***
    Note: When the RPi is mounted in the case it is difficult to remove or insert the micro SD card. Make sure you have the micro SD card in place prior to mounting the RPi
    1. For RPi Zeroes

        1. The bottom of the case should have eight bosses and “RPiZ2W” in raised letters.
        2. If using a ‘Z’ series DAC board.
            1. Mount the RPi using the set of bosses that are closest to the back of the case.
            2. Secure the RPi with four M2.5 X 11mm threaded standoffs screwed into the bosses in the base of the case. Do not over tighten. They just need to be snug.
        3. If using a ‘B’ series DAC board.
            1. Mount the RPi using the set of bosses that are furthest from the back of the case.
            2. Secure the RPi with two M2.5 X 11mm threaded standoffs for the holes near the GPIO header and two M2.5 X 5mm machine screws in the remaining RPi mounting holes. Do not over tighten. They just need to be snug.
            3. Place an M2.5 nut or a 1.6mm spacer on two M2.5 X 11mm standoffs.
            4. Screw the standoffs with nuts/spacers into the bosses closest to the back of the case. Do not over tighten. They just need to be snug.
    2. For ‘B’ series RPis
        1. The bottom of the case should have four bosses and “RPixB” in raised letters. Replace “x” with the board number; 2, 3 or 4.
        2. Angle the RPi into position by pushing the end with the USB connectors through the holes in the side of the case then press down.
        3. Align the RPi onto the bosses on the bottom of the case.
        4. Secure the RPi with four M2.5 X 11mm standoffs screwed into the bosses in the bottom of the case. Do not over tighten. They just need to be snug.
    3. If using the RPi bosses that are closest to the front of the case it can be rather difficult to tighten the standoffs. Reaching through the grill opening helps.
    4. Use the 3/16 Spin Tight to snug the standoffs.
    5. You may have to adjust the height of the standoffs to accommodate your DAC board. For example; the Innomaker DAC-Mini came with 16mm standoffs.

20. ***Install the TTP223 Touch Switch board.***
    1. You will need the TTP223 Touch Switch board with the three pin right angle header prepared earlier and a 10mm X 10mm piece of double sided foam tape.
    2. Stick the piece of foam tape into the rectangular box at the top of the case.
    3. Press on it to make sure it is stuck.
    4. Peel off the protective paper that is on the foam tape.
    5. One side of the TTP223 board has no components on it. This is the side to stick to the foam tape.
    6. Stick the TTP223 board to the foam tape. The soldered pins of the three pin header should not be on the foam tape. Try to align the board with the box. The header pins should point away from the front.

21. ***Install the LCD display.***
    1. You will need the 3D printed Case, an ILI9341 TFT LCD display board, four M2 X 5mm self-tapping screws and a screwdriver.
    2. Place the display board in the place over the case opening. The fourteen pin header should be on the right side, facing up.
    3. Use the four screws to fix the display board in place. Do not over-tighten, snug is good.
22. ***Install the Pico or ADS1115.***
    The 3D printed Case has
    1. ***If using a Pico;***
        1. You will need the 3D printed Case, a Pico, four M2 X 5mm self-tapping screws and a screwdriver.
        2. If your Pico does not have male headers then solder either a ten pin header or a twenty pin header to each side of the Pico. If using ten pin headers, place them in the ten holes nearest to the USB connector end.
        3. Place the Pico on the left side of the Case, in the designated area. The USB connector should be placed facing towards the top of the case.
        4. Use the four screws to hold the Pico in place. Do not over-tighten, snug is good.
        5. The M2 screws are actually slightly oversized. You will need to drive then through the mounting holes in the Pico.
    2. ***If using an ADS1115;***

    1. You will need the 3D printed Case, an ADS1115 board, two M2 X 5mm screws and a screwdriver.
    2. Place the ADS1115 board over the mounting bosses on the left side, near where ‘ADS1115’ is printed in raised letters.
    3. Use the two M2 X 5mm screws to secure the board.

23. ***Install the MSGEQ7.***
    1. You will need the 3D printed Case, the MSGEQ7 board, two M2 X 5mm screws and a screwdriver.
    2. Place the MSGEQ7 board over the mounting bosses on the left side, near where ‘MSGEQ7’ is printed in raised letters.
    3. Use the two M2 X 5mm screws to secure the board.

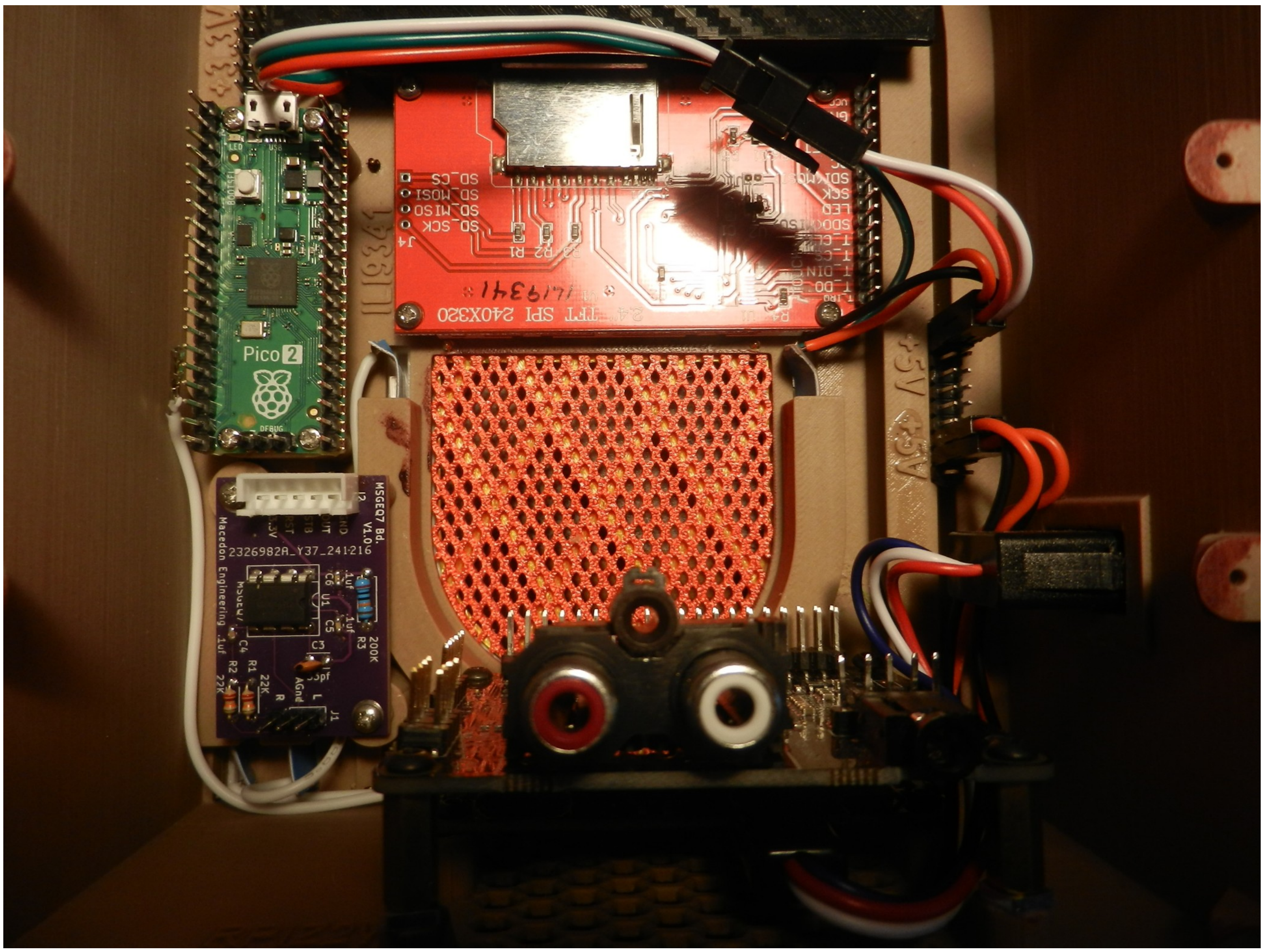


Figure 33, All boards mounted in the case.

24. ***If your case has a rectangular hole for a USB-A port.***
    1. Pass the USB micro plug through the rectangular cutout.
    2. Press the USB-A connector into the rectangular cutout until is sets flush against the case.

3. Route the wires as shown in Figure 34.
4. Plug the micro USB plug into the USB socket on the RPi.

Notice in Figure 34 how the USB cable is routed and attached to the RPiZ2W. The RPi is mounted on the bosses closest to the front of the case. Note the nuts under the front standoffs. This build uses a ‘B’ sized DAC board.

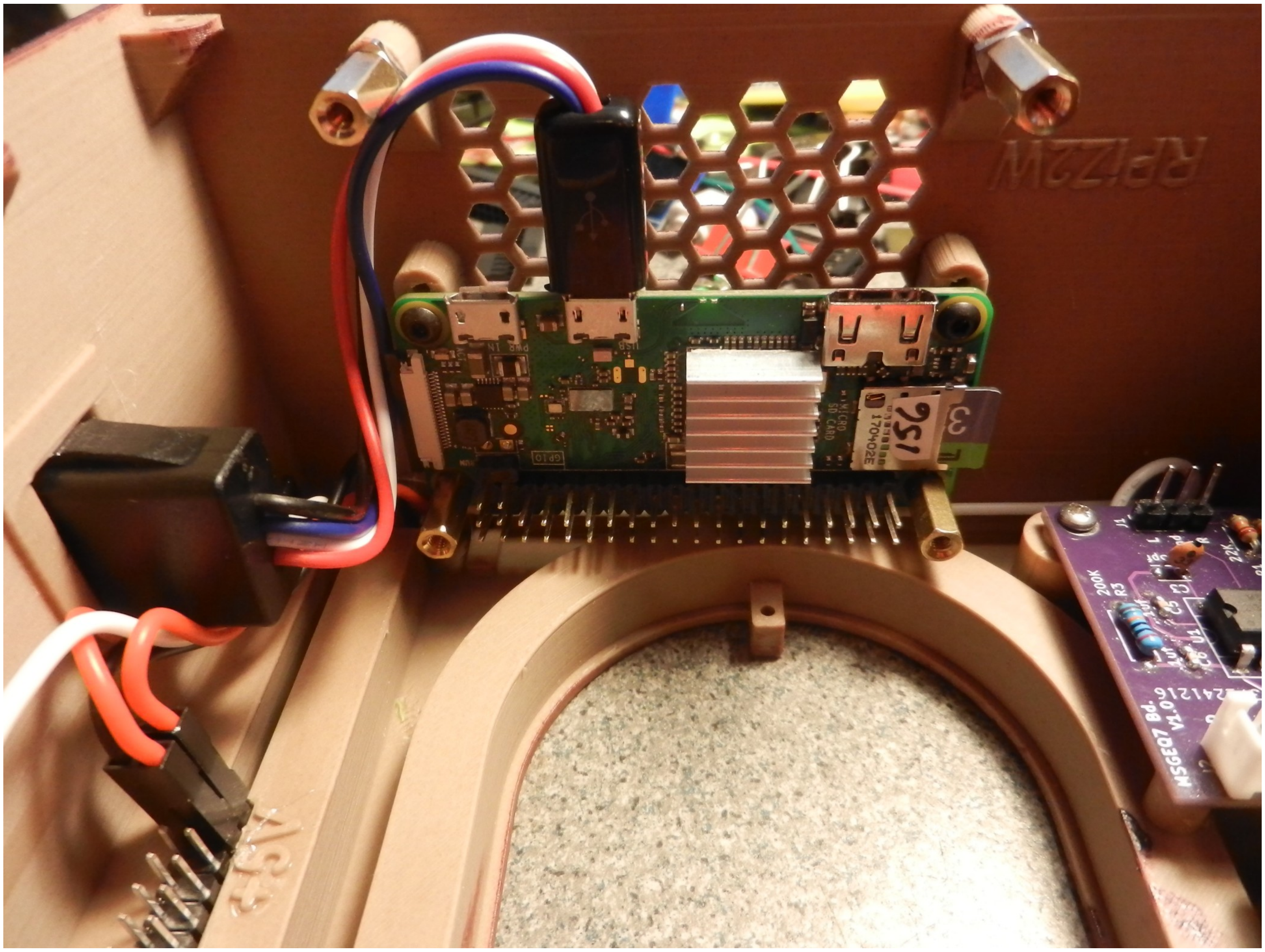


Figure 34, USB-A port cable

25. ***Install Top Chamber Window, Top Chamber and Mirror Holder.***

1. You will need the 3D printed Case, Top Chamber Window with applied one way mirror film, Top Chamber with 13 LED strip, Mirror Holder with applied mirror, three M2 X 5mm self-tapping screws and a screwdriver for the screws.
2. Set the Case in front of you with the front side down.
3. Clean the mirrored surface of the Top Chamber Window.
4. Set the Top Chamber Window into the half-round opening near the top of the Case. The mirrored surface should be inside the Case. The Window has a raised area that exactly fits the opening in the case and a lip to prevent it from passing through the opening.

5. Ensure that the Window is flat against the Case.
6. Place the Top Chamber assembly on top of the Top Chamber Window. The slot and wires should be on your left. The Case has small alignment blocks on either end of the arc. The Top Chamber should be pressed down on to the Window and touching the alignment blocks. The upper rim of the Top Chamber should be level with the three bosses that mount the Mirror Holder.
7. Peel the protective layer off the mirror mounted to the Mirror Holder. Clean the surface of the mirror.
8. Set the Mirror Holder on Top of the Top Chamber with the mirrored side down. Align with the three bosses.
9. Using the three screws, pass each one through the Mirror Holder and screw it into the Case boss below. Do not over-tighten, snug is good.
10. Plug the three wire connector into the mating connector attached to the side emitting LED strip.

*26. **Install DAC board.***

1. You will need the 3D printed Case with the RPi mounted in it, your DAC board, four M2.5 X 5mm screws and an appropriate screwdriver or hex key.
2. Align the DAC board with the RPi's GPIO header.
3. Press the DAC board onto the RPi's GPIO header.
4. The DAC board should rest on the standoffs. If it does not then you need to adjust the length of your standoffs.
5. The GPIO connectors should be fully mated. Adjust standoff's length if needed.
6. Use the four screws to secure the DAC board to the RPi board.

*27. **Install the wiring harness or wire everything together using jumpers.***

1. You will need the wiring harness that you assembled previously, the 3D printed Case with all circuit boards in place.
2. Plug the fourteen pin shell onto the ILI9341 board. Pin one (red wire) is at the top of the circuit board.
3. Plug the dual row shell onto the GPIO header on the DAC board. Pin one (red wire) is the left most pin of the row closest to the front of the Case.
4. If using a Pico
   1. Plug the right ten pin shell onto the top most ten pins on the right side of the Pico. The red wire is pin one. The USB connector on the Pico should be on top.
   2. Plug the left ten pin shell onto the top most ten pins on the left side of the Pico. Make sure to get pin one of the shell on pin one of the Pico. The last two wires on the shell are going to the dual row shell.
5. If using an ADS1115
   1. Plug the ten pin shell onto the ADS1115 board. The orange wire should be on the lowest pin on the board.

    2. Plug any two pin shells with an orange wire onto the +3.3V Power Distribution Block.
6. Plug the five pin shell onto the MSGEQ7 board.
7. Plug the three pin shell onto the three pin header on the MSGEQ7 board.
8. Plug any two pin shells with a red wire onto the +5V Power Distribution Block.
9. At this point your JukeBox should be operational. The remaining steps are mostly cosmetic.

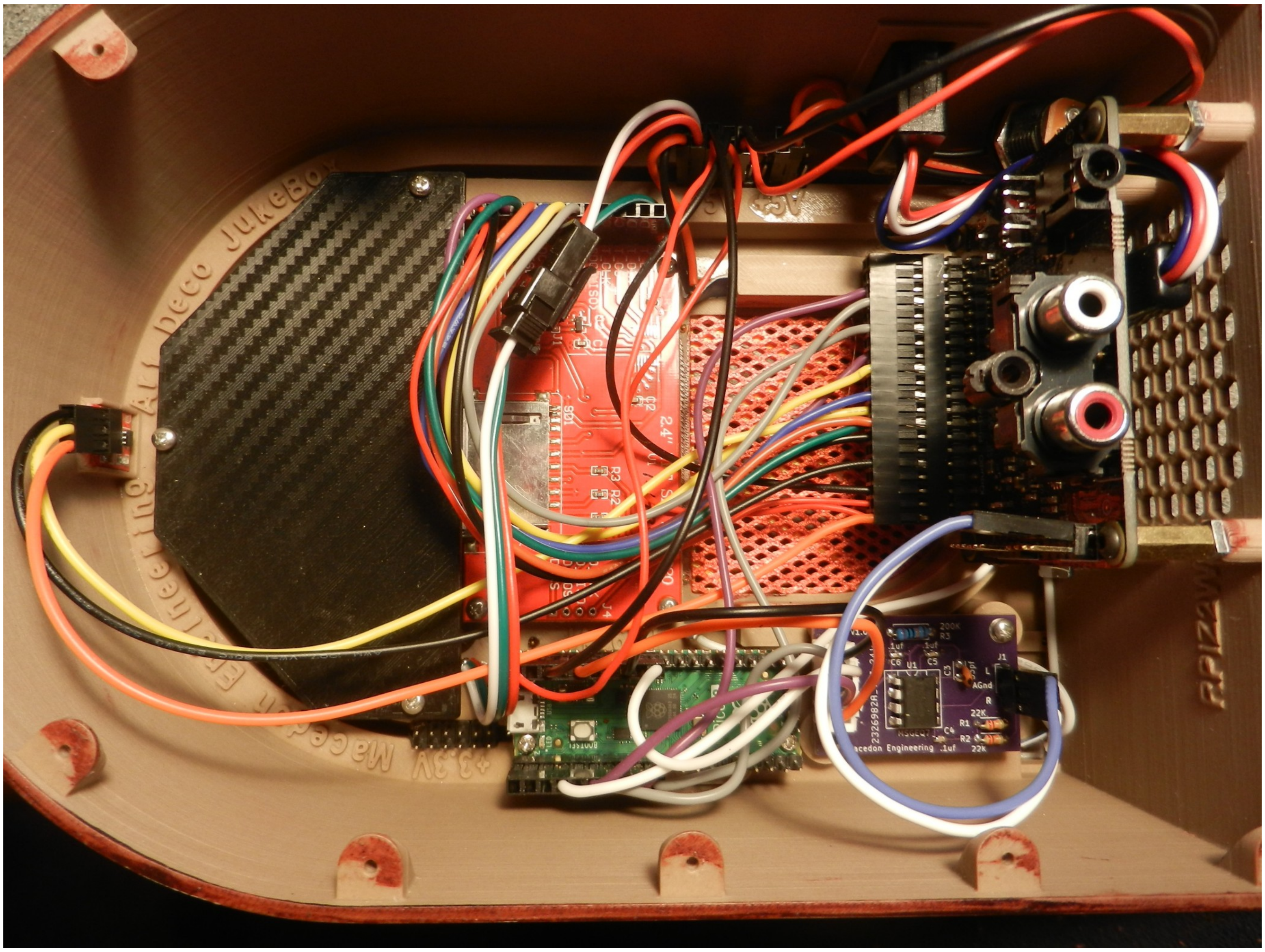


Figure 35, Wiring Harness installed.

10. This is a good time to test your JukeBox.
    1. Do a visual scan of the power distribution blocks.
        1. Are all the red wires on the same side ?
        2. Are all of the two pin shells plugged in ?
            1. Red wires to +5V Power Distribution Block.
            2. Orange wires to +3.3V Power Distribution Block.
    2. Are all the DuPont connector shells oriented correctly ?

        1. Little triangle designates pin one.
    3. If you hand wired using jumpers, check your work.
        1. Pay attention to +5V and GND wires. You do not want to release any magic smoke.

28. ***Install LED Covers, Clamps and Grill Insert.***
    1. You will need the 3D printed Case, Double LED Cover, Double LED Cover Stripe, Single LED Cover, four Double Pipe Clamps, two Top Clamps, one Grill Insert fifteen decorative #2 X ¼ screws and a screwdriver for the decorative screws. Note: M2 X 5mm screws can be substituted for the #2 X ¼ screws.
    2. Place the Case in front of you with the front facing up.
    3. Align the Double LED Cover with the two outer most LED tracks.
    4. Press into place. The LED Covers have ridges on their underside that match the LED tracks in the Case.
    5. When properly aligned and pressed into place, the LED Cover should stay in place.
    6. Place the Double LED Cover Stripe into the gap between the two domes of the Double LED Cover. The broad side should be up. The Stripe was designed to match the curves of the domes and the curve of the Case.
    7. Place one of the Double Pipe Clamps over the Double LED Cover.
        1. Align the Clamp with one of the screw hole on the Case.
        2. Drive a #2 X ¼ decorative screw through the hole in the Clamp and into the Case.
        3. Do not over tighten the screw, just snug it.
        4. Repeat sub-step 2 with the other hole in the Clamp.
    8. Repeat for the three remaining Double Pipe Clamps.
    9. Fasten the two Top Clamps using one screw for each.
    10. Align the Single LED Cover with the remaining LED track.
    11. Press into place. The LED Covers have ridges on their underside that match the LED tracks in the Case.
    12. When properly aligned and pressed into place, the LED Cover should stay in place.
    13. Place the Grill Insert into the grill opening in the Case. The two clamps should go over the Single LED Cover.
    14. The Grill Insert is affixed with five #2 X ¼ decorative screws. Do not over-tighten, just snug.
    15. If you are using an IR receiver then plug it in now.
        1. Plug IR receiver leads into the three pin DuPont shell wired to the dual row DuPont shell or
        2. Plug the three pin DuPont shell attached to the IR receiver onto the three pin header on the DAC board.
        3. Ensure that pin one is correctly oriented.

16. If the ends of the Single LED Cover will not stay in place then
    1. Remove the Grill Insert and LED Cover.
    2. Place a drop of super glue on the inside of the top of the LED track in the Case.
    3. Press the LED Cover into place and hold for ten seconds.
    4. Replace the Grill Insert and screws.

Figure 36, Fully assembled with USB-A port on side.

*29. **Install back panel.***

1. You will need the 3D printed Case, Back Panel, Barrel Jack Power socket sub-assembly, eleven #2 X 1/4 or M2 X 5mm self-tapping screws and an appropriate screw driver.
2. Attach the Barrel Jack power socket to the Back Panel in the hole marked ‘5VDC’.
3. Plug the two pin DuPont shell from the Barrel Jack power socket into a free position on the +5V Power Distribution Block on the inside right of the case.
4. The red wire should be on the same row as the other red wires.
5. Position the Back Panel against the mounting points on the Case.
6. Use the eleven self-tapping screws to screw the Back Panel in place. Do not over-tighten the screws, just snug them up. The audio connectors and any RPi connectors should poke through the cutouts in the Back Panel.
7. Congratulations, this concludes the assembly of your JukeBox.

How to test your JukeBox:

1. If using a Pico, type; ‘***python3 JukeBox.py***’ then press Enter.
2. If using an ADS1115, type; ‘***sudo python3 JukeBox.py***’ then press Enter.
3. At this point your JukeBox should be up and running. If all is working then while holding down the **Ctrl** key, tap the **C** key. This should cause your JukeBox to stop running.
4. If your JukeBox is running without any issues, you can run ‘**autoRun.py**’ to toggle automatic running of the JukeBox script on boot. Type; ‘***python3 autoRun.py***’ then press Enter. Run it again to turn off auto run.
5. If you encountered an error while attempting to run the JukeBox script then read the error message. The most likely cause is a missing library or file.
6. If the problem is a missing library then I suggest that you repeat the steps in ‘**Step 6. Prepare the Raspberry Pi.’.** Pay attention to the messages scrolling on the screen. They will tell you what failed.

Operation of the JukeBox:

1. The audio out connectors should be attached to a set of powered speakers or a stereo amplifier with attached speakers or plug in a set of headphones or ear buds.
1. Select the amplifier’s input source where you attached the JukeBox (Aux, Tape, etc.).
2. Plug a suitable power supply into the JukeBox using either the +5V barrel jack power connector or the USB power connector on the RPi. The power supply should be +5V @ 4 Amps (20W) minimum or an RPi 27W PD power supply.
3. At this point the RPi should boot up and start running the JukeBox script.
4. The JukeBox randomly selects an Artist and then plays all Albums by that Artist that are in your music library. When the last song finishes, a new Artist is selected and the operation repeats.
5. Each time a new song is selected the LED animation changes.
6. The remote control can be used to perform the following tasks;
   1. Raise/lower volume.
   2. Skip to next song.
   3. Re-start current song.
   4. Pause/resume playing.
   5. Mute (same as pause).
   6. Power off/on.
      1. The RPi has a Linux command to power down. However, there is no way to power up the RPi without cycling power. For this reason, the JukeBox never really powers down. Instead it goes into paused mode and blanks the LEDs and the LCD. This gives the appearance of being powered down.
      2. Power on can be achieved by pressing the Power button on the remote or by tapping the touch switch located at the top of the case.

        7. Up Arrow
            1. This button will change the LED animation to the next one.
            2. Same as Touch Switch when powered on.
        8. Right Arrow
            1. This button will toggle the LED animation on/off.
7. Touch Switch.
    1. The Touch switch at the top of the case has two functions.
        1. If the JukeBox is powered off then the Touch button will power up the JukeBox (same as remote power on).
        2. If the JukeBox is powered on then the Touch button will change the LED animation.
8. In order to conserve battery life, all remotes enter a low power state when idle and wake up to transmit a message when a key is pressed. For a Bluetooth remote, the Bluetooth hardware in the RPi will lose the Bluetooth connection some time after the remote goes to sleep. When this happens, the RPi will miss the messages it receives until the connection is re-established. For this reason, you need to press a button on the Bluetooth remote to re-establish the Bluetooth connection, wait about six seconds and then press the button you wanted. IR remotes do not have this issue.

What is a Color Organ ?

A Color Organ is a device that has a red, a green and a blue light source. The intensity (brightness) of each light source is controlled by a set of three bandpass filters. When music is streamed into the device the three light sources react to the part of the music that passes through it's associated filter. The effect is that the hue is constantly changing with the music.

The JukeBox has a MSGEQ7 Audio Spectrum Analyzer that divides the music being played into seven bands. The amplitude of each band is collected and used in various ways by some of the LED animations. In one case the amplitude of the band controls the number of LEDs that are lit (all LEDs of the virtual strip are the same color). In other animations the brightness of the LEDs is controlled by the amplitude. When the red, green & blue LEDs of a virtual strip are each assigned to a three different bands then the result is a virtual LED strip that changes color with the music.

How to Pair Bluetooth Remotes to the RPi.

Bluetooth classic remotes usually require two buttons to be simultaneously pressed and held in order for the remote to enter pairing mode. Consult the documentation for your remote to find out which buttons to use (the remotes that I purchased have a sticker on the back side with directions on how to pair and how to learn IR commands). Once paired the remotes stop sending IR signals and send only Bluetooth signals. Bluetooth BLE remotes do not require any special button combinations to enter Bluetooth pairing mode.

1. Use Putty to SSH into your RPi. Enter any username and password required.
2. Type; ***bluetoothctl***. The RPi will change the prompt to indicate that the mode has changed.
3. Put your Bluetooth remote into pairing mode.
4. Type; ***scan on***. After a few seconds the MAC address of the Bluetooth controller in the RPi will be listed. Wait for the MAC address of the Bluetooth remote to show up.
5. If the remote's MAC address does not show up after a few minutes then;
    1. Make sure the remote is in pairing mode (it may have timed out).
    2. Move the remote closer to the RPi (Bluetooth normally has a range of about 15-30 feet).
    3. Type; ***scan off***.
    4. Repeat from step 3 above.
6. Note the MAC address of the remote.
7. Type; ***trust*** followed by the MAC address of the remote.
8. The RPi should respond with 'device trusted'.
9. Type; ***pair*** followed by the MAC address of the remote.
10. The RPi should respond with 'device paired'.
11. After a short delay the RPi will print out a list of Bluetooth services and characteristics supported by the remote.
12. Type; ***quit*** to exit bluetoothctl. The prompt should return to normal.
13. That's it. You have paired your Bluetooth remote to your RPi. You will need to do this once whenever you boot from a newly minted SD card.

How to determine keycodes from Bluetooth remotes:

1. Every Bluetooth device has a name and a MAC address. Use the name of the Bluetooth device as the name of your '.txt' file. One of my Bluetooth remotes is named '**HID Remote_01**' the other is '**BPR1S**'.
2. Use Putty to SSH into your RPi. Enter any username and password s required.
3. Type; ***evtest.***
4. From the menu enter the number of the input event associated with the Bluetooth receiver.
5. Press keys on your remote. Information about the key pressed will be displayed on the RPi. Part of the information is the hexadecimal value of the keycode associated with the key that was pressed.

6. Copy the file ‘Remote_01.txt’ to another file. Change the name of the file to the name given by your remote. Keep the ‘.txt’ extension.
7. Edit your remote’s ‘.txt’ file to change the keycodes to match your remote.
8. Edit **jukebox.cfg**. Change ‘***Remote_01.txt’*** to the name of the file you just created.

How to determine keycodes from IR remotes:
The following links are all about using an IR remote and key-table. You will need to create a ‘xxxx.toml’ file that is specific to your IR remote.

https://srituhobby.com/how-to-use-an-ir-infrared-receiver-with-a-raspberry-pi-board/

https://blog.gordonturner.com/2020/05/31/raspberry-pi-ir-receiver/#:~:text=Configure%20Raspbian,16384%200%20gpio_ir_tx%2016384%200

https://github.com/gordonturner/ControlKit/blob/master/Raspbian%20Setup%20and%20Configure%20IR.md

1. Open ir-keytable in test mode with all protocols available. Type; ‘***ir-keytable -t -c -p All***’ then press Enter.

In order to build my prototypes, I needed to purchase a roll of one-way mirror film and a package of plastic mirrors. Needless to say, I have a lot of film and mirrors left over. The left over mirrors and film are available. Contact me if you are interested.