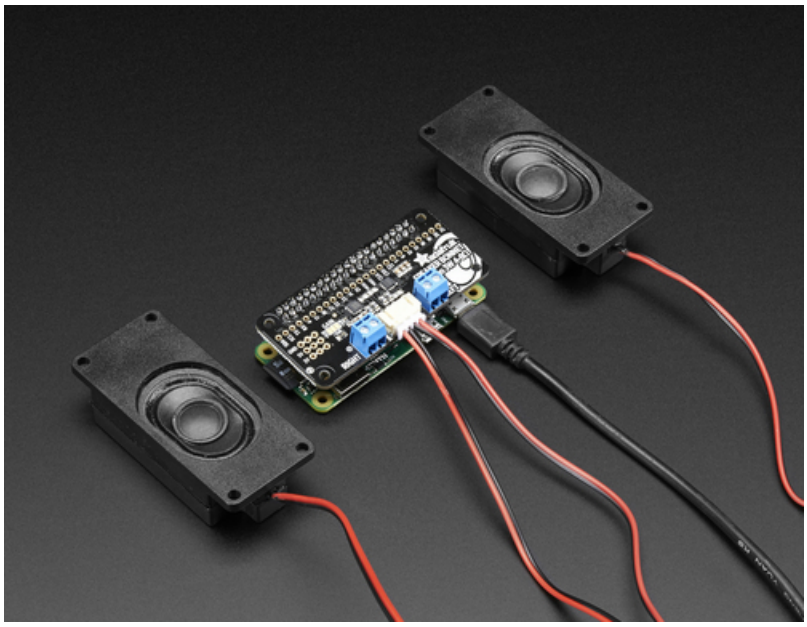
adafruit learning system

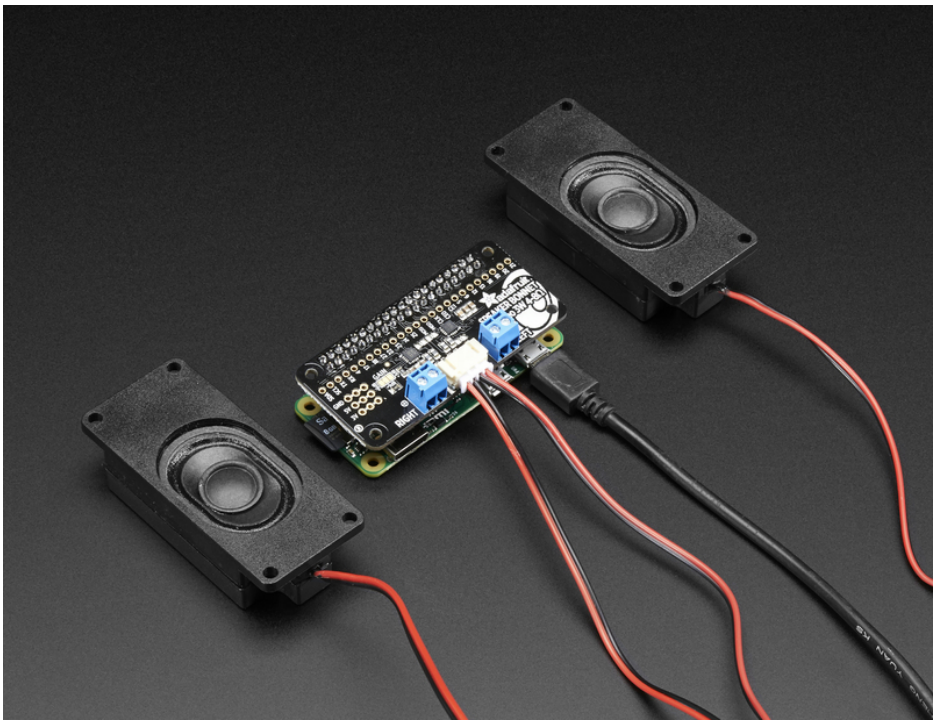
Adafruit Speaker Bonnet for Raspberry Pi

Created by lady ada

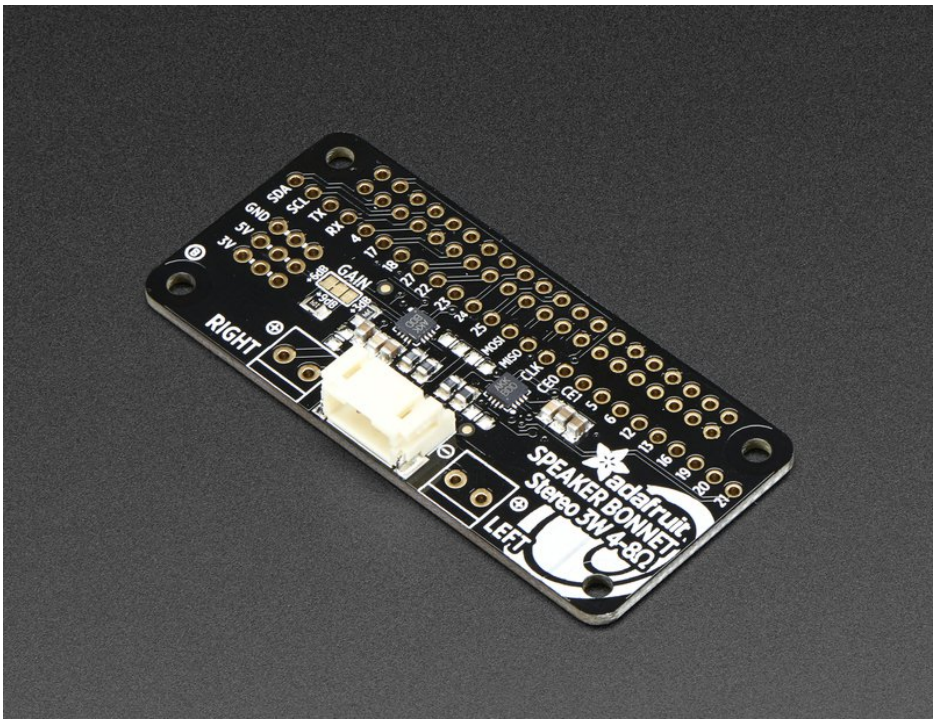


Last updated on 2019-03-12 05:04:11 PM UTC

Overview

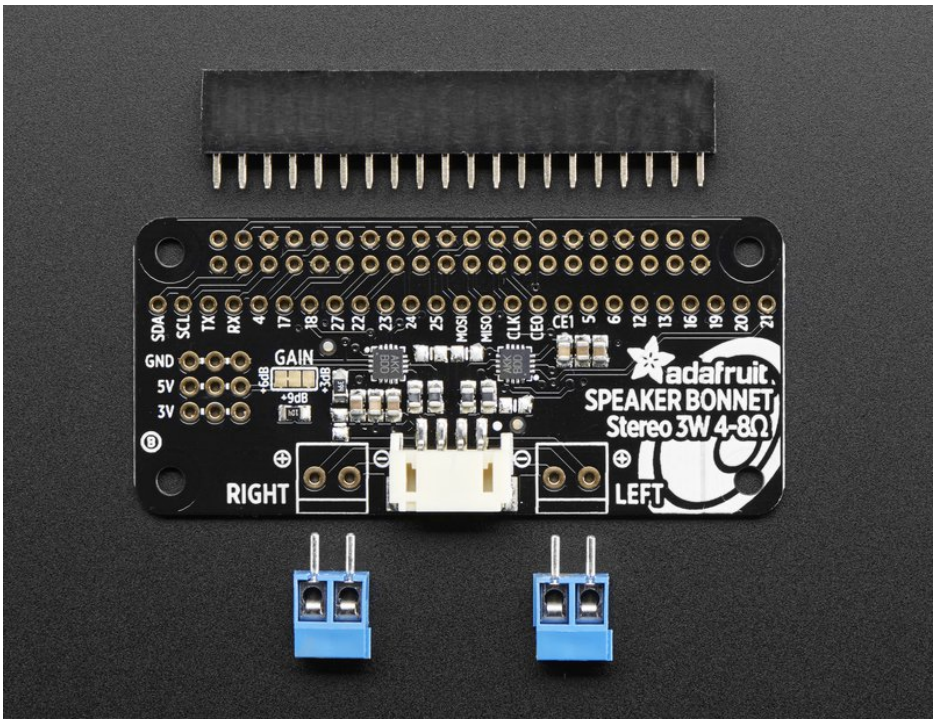


Hey Mr. DJ! Turn up that Raspberry Pi mix to the *max* with this cute 3W Stereo Amplifier Bonnet for Raspberry Pi. (It's not big enough to be an official HAT, so we called it a bonnet, you see?) It's the exact same size as a Raspberry Pi Zero but works with any and all Raspberry Pi computers with a 2x20 connector - A+, B+, Zero, Pi 2, Pi 3, etc. We've tested it out with Raspbian (the offical operating system) and Retropie.



This Bonnet uses I2S a digital sound standard, so you get really crisp audio. The digital data goes right into the

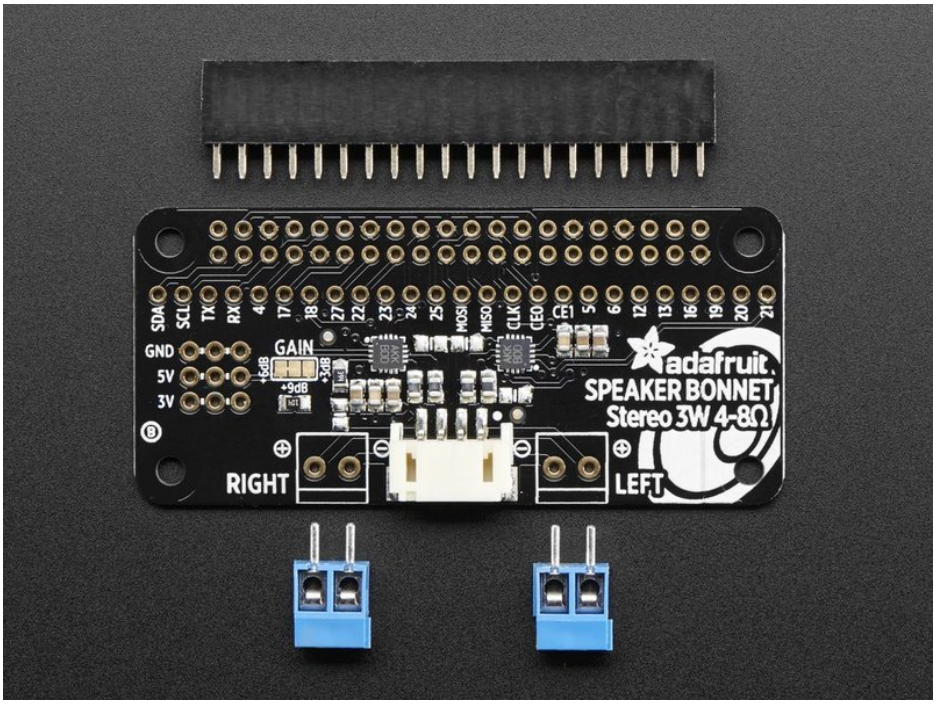
amplifier so there's no static like you hear from the headphone jack. And it's super easy to get started. Just plug in any 4 to 8 ohm speakers, up to 3 Watts, run our installer script on any Raspberry Pi, reboot and you're ready to jam!

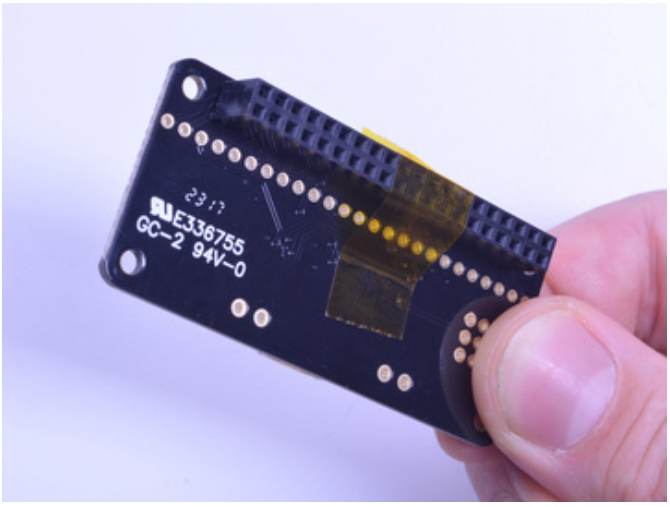


Each order comes as a fully assembled PCB with a 2x20 header and 2x terminal blocks. Some light soldering is required to attach the header onto PCB so you can plug it into your Raspberry Pi. Once that's done either plug one of our enclosed speaker sets (http://adafru.it/1669) right into the JST jack in the middle *or* you can solder the terminal blocks in and then connect any speaker you like.

Don't forget to make sure you have a good strong 5V power supply - especially if you're using the 3W 4 ohm speakers! Our 2.4A power plug is recommended (http://adafru.it/1995)

Assembly





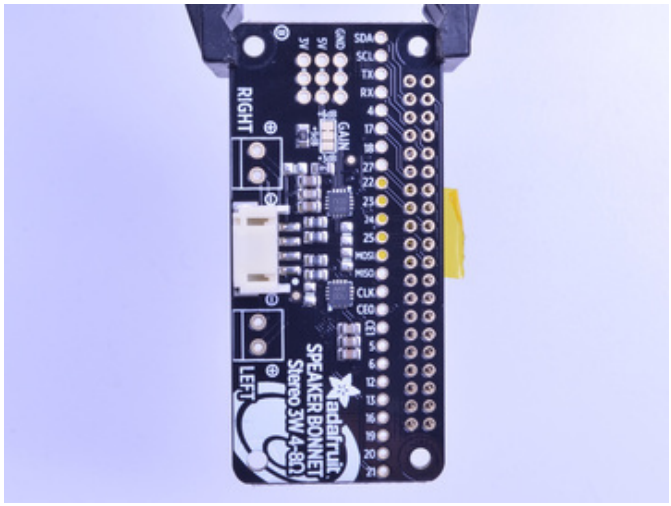
Place the 2x20 female header in so the connector is on the **bottom**. To make it easier to keep it in place, you can use some tape. Tacky clay also works, whatever you've got handy!

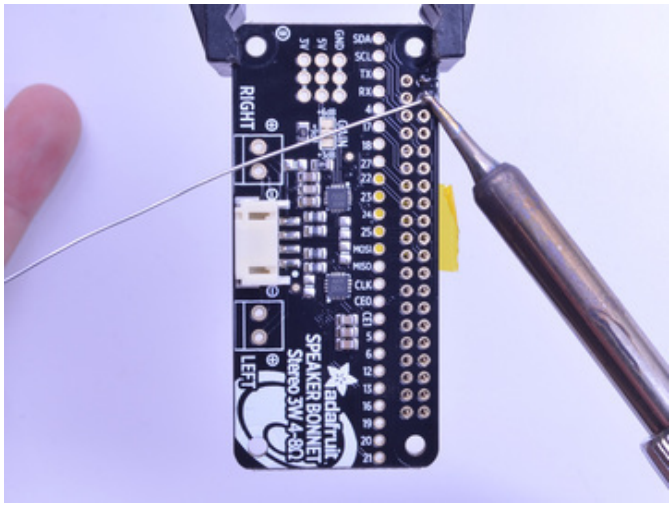
And Solder!

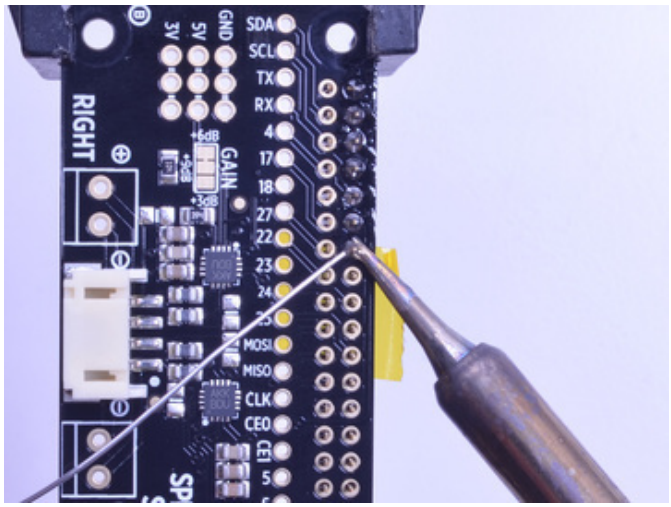
Be sure to solder all pins for reliable electrical contact.

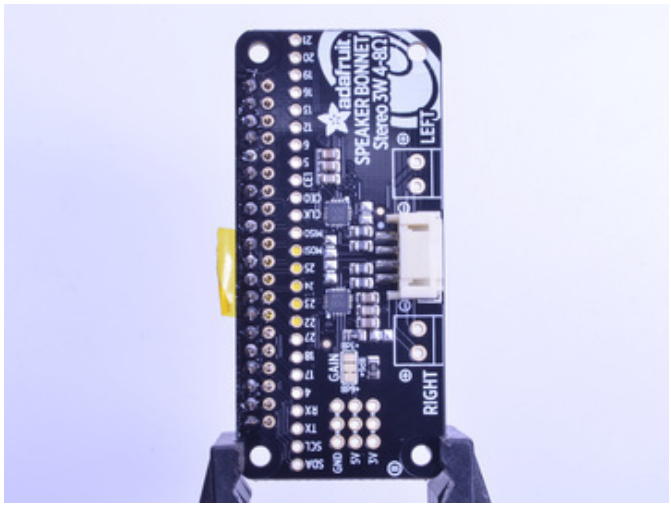
(For tips on soldering, be sure to check out our Guide to Excellent Soldering (https://adafru.it/aTk).

Start by soldering the first row of header

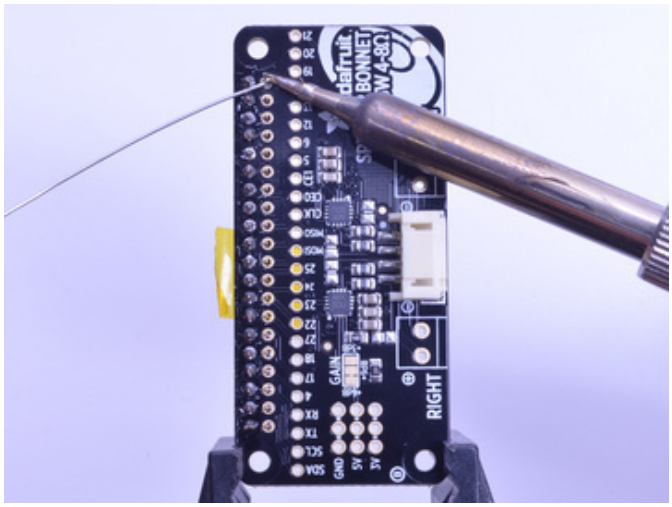

RIGHT
LEFT
SPEAKER BONNET
Stereo 3W 4-8Ω
adafruit

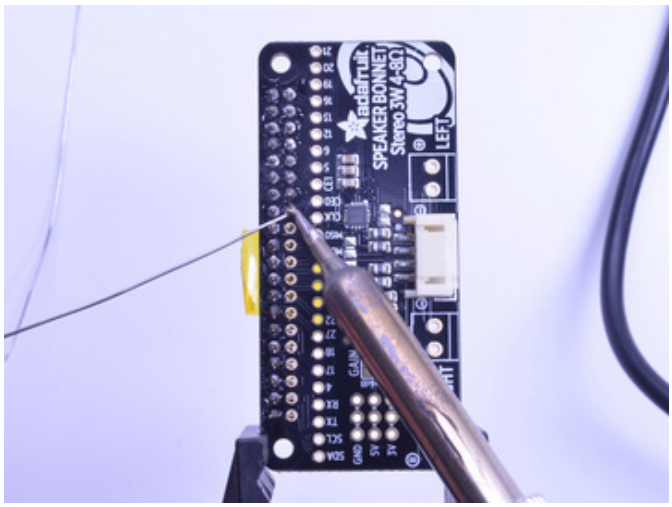

RIGHT
LEFT
SPEAKER BONNET
Stereo 3W 4-8Ω
adafruit

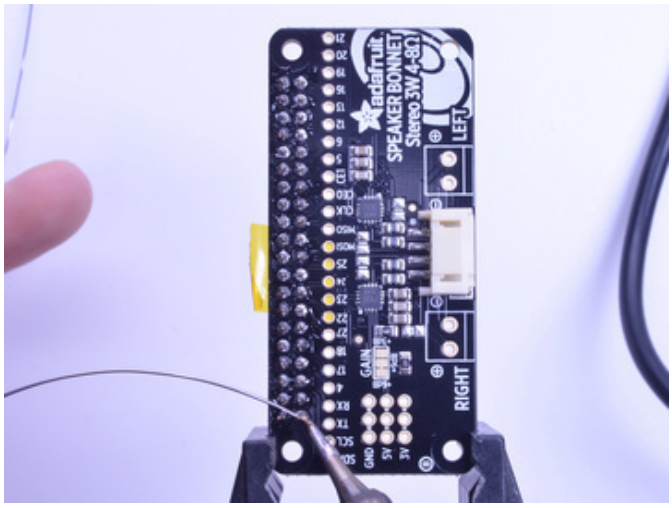

RIGHT
SDA
SCL
TX
RX
GAIN
MOSI
MISO
CLK
CE0
CE1

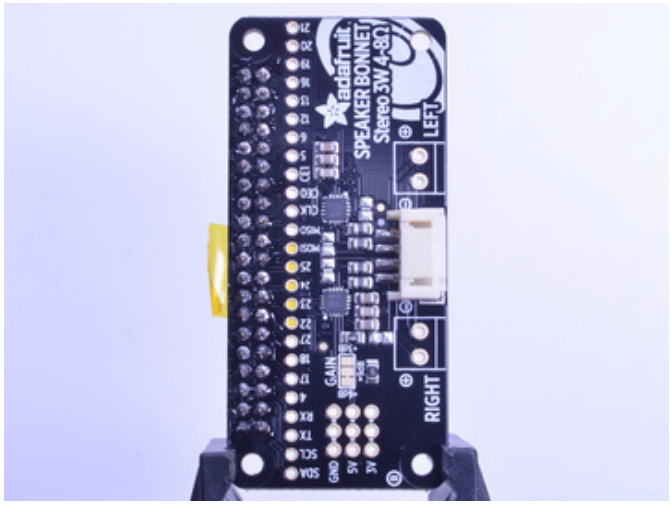


Now flip around and solder the other row completely



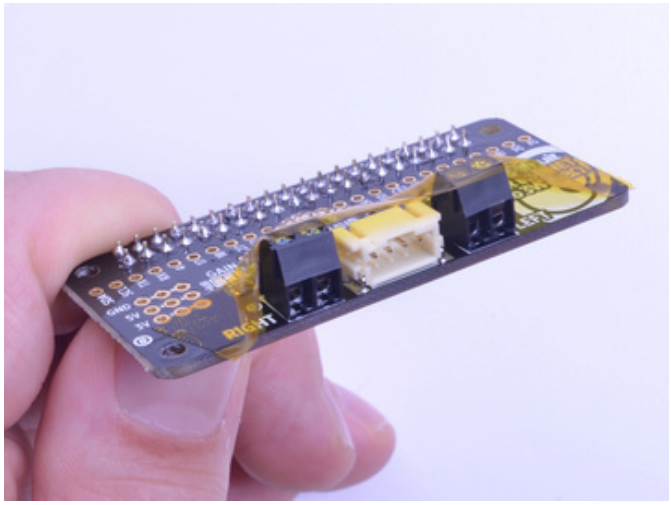






You're done with the header strips.

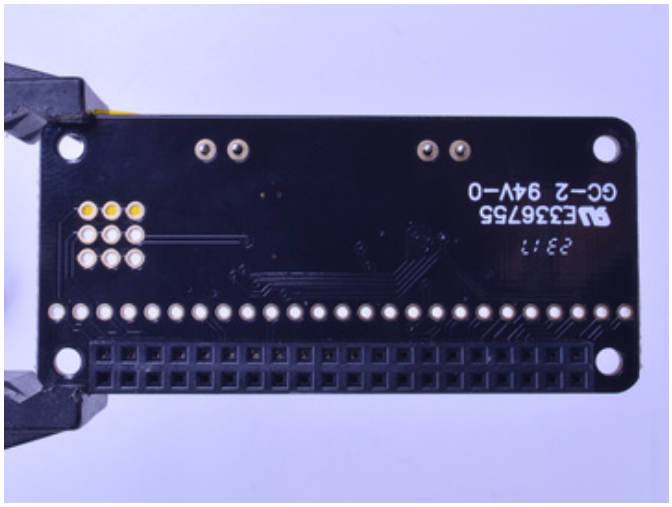
Check your solder joints visually and continue onto the next steps



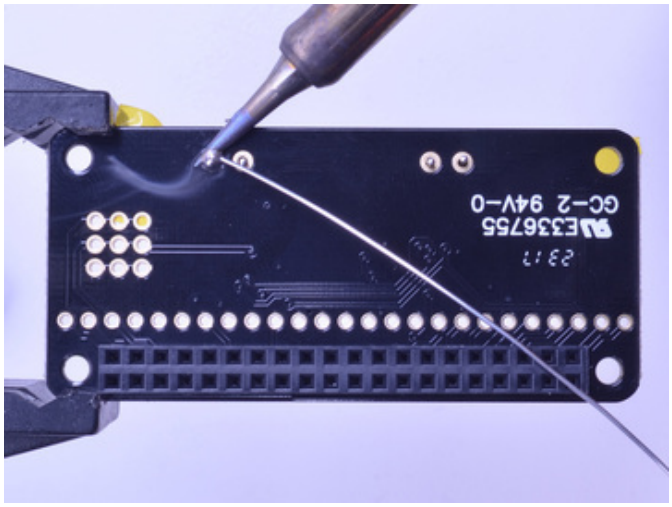
Next we will solder in the 2 3.5mm terminal blocks used to connect *speakers* to the *Speaker* Bonnet.

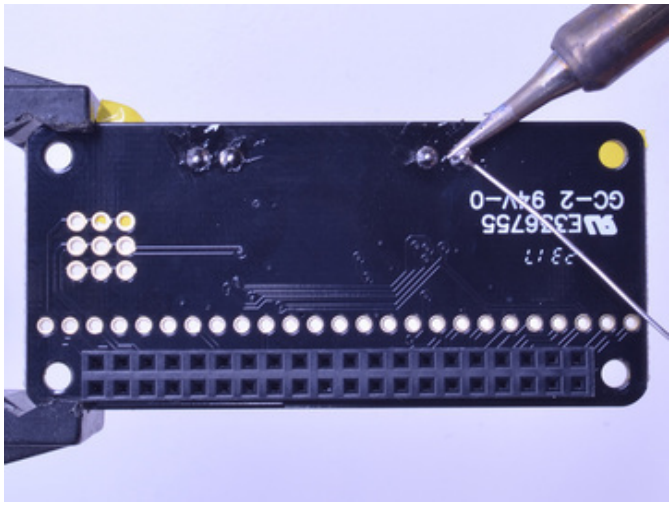
Make sure the open parts of the terminals face outwards so you can easily connect wires.

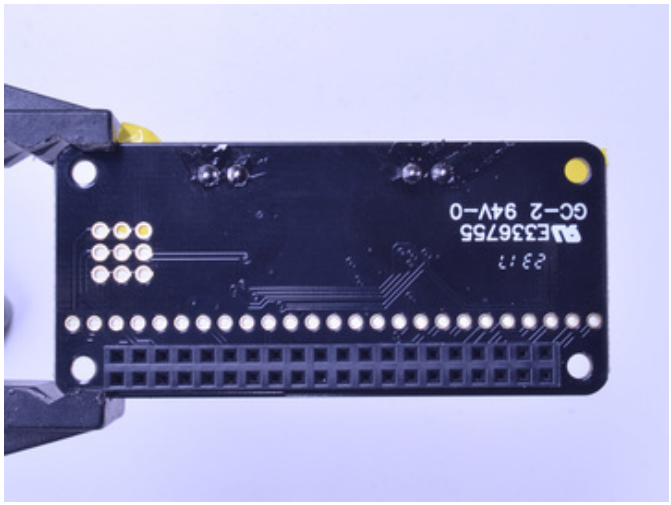
To make it easier to keep these in place, you can use some tape to hold down the two header pieces. Tacky clay also works, whatever you've got handy!



Solder in each block, make sure you get to each of the 4 pins





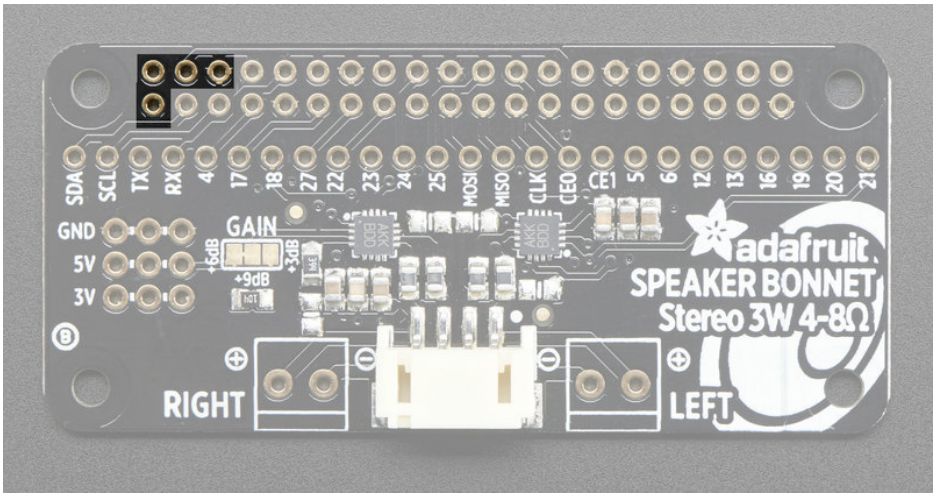


Now that you're done with the terminal blocks, check your work make sure that each solder joint is done and looks shiny

OK you're done!

Pinouts

Power Supply



The two amplifier chips use the 3V + 5V + GND power pin at the 'top' of the 2x20 header. If using 3W speakers, you can draw a significant amount of current, over 1.5 Amps! Make sure you power your Pi with a good wall adapter like our 2.4A microUSB power plug.

5V 2.5A Switching Power Supply with 20AWG MicroUSB Cable

$7.50
IN STOCK

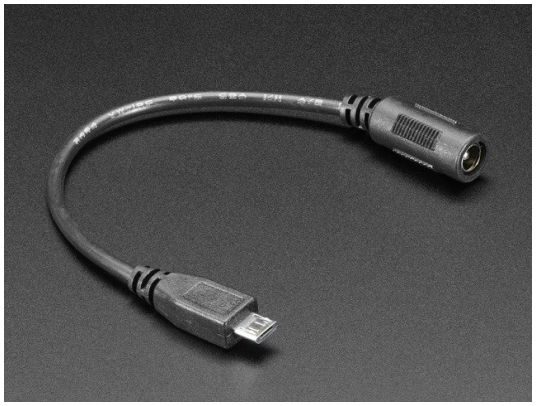
ADD TO CART

Alternatively, if you *really* need a lot of power, use a 5V 4A power adapter and then a DC to micro USB adapter

5V 4A (4000mA) switching power supply - UL Listed

$14.95
IN STOCK

ADD TO CART

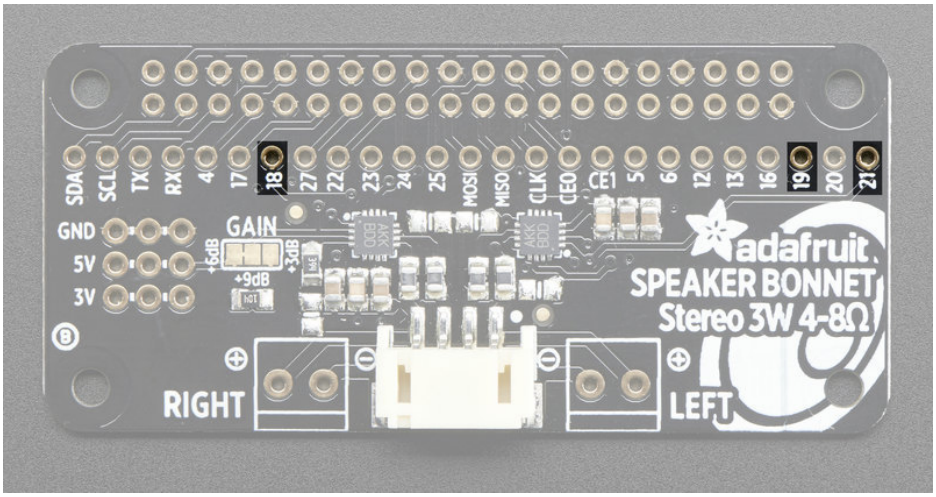


MicroUSB Plug to 5.5/2.1mm DC Barrel Jack Adapter

$1.95
IN STOCK

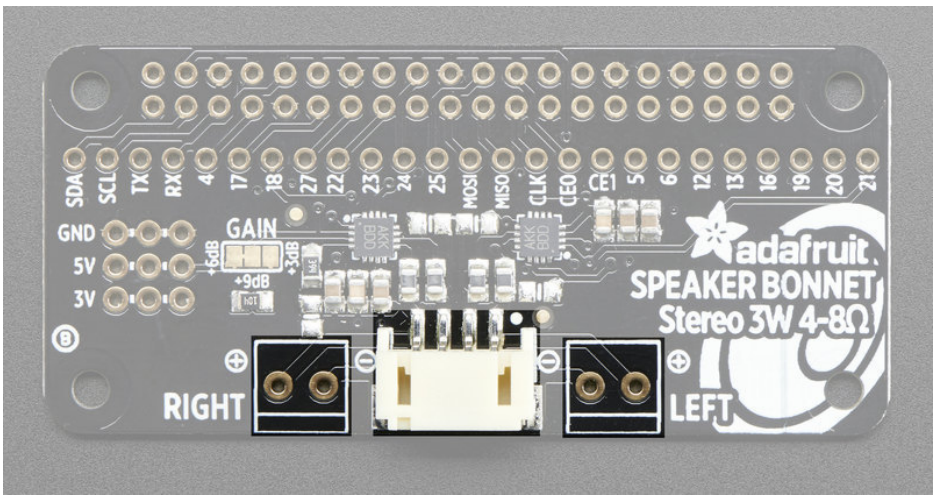
ADD TO CART

I2S Audio Data Pins



The Bonnet uses 3 data pins **and they cannot be changed!** Pins #18, #19 and #21 are used. All other pins are available

Speaker Outputs



This is the fun part, you get stereo output - one left and one right channel. Each one is Bridge-Tied-Load so **do not connect both outputs together** to get more volume!

You can use the JST 4-pin plug in the center if you're going to just plug in one of our enclosed speaker kits:

Stereo Enclosed Speaker Set - 3W 4 Ohm

$7.50
IN STOCK

ADD TO CART

OR

You can use the terminal block spots on the left & right to connect regular speaker cones. You'll need to solder wires on and such but this way you can use whatever speaker you like! We suggest 8 ohm 1W or 4 ohm 3W. For louder audio, but more power usage, use the 4 ohm speakers. For quieter audio, but less power usage, use the 8 ohm speakers

Speaker - 3" Diameter - 4 Ohm 3 Watt

$1.95
IN STOCK

ADD TO CART

Speaker - 3" Diameter - 8 Ohm 1 Watt

$1.95
IN STOCK

ADD TO CART

You can also use other 'audio' devices like sonic transducers! These are devices you can put down onto a surface like a table, to make it into a speaker.

Medium Surface Transducer with Wires - 4 Ohm 3 Watt

$14.95
IN STOCK

ADD TO CART

Raspberry Pi Setup

At this time, Raspbery Pi linux kernel does not support mono audio out of the I2S interface, you can only play stereo, so any mono audio files may need conversion to stereo!

2017-11-2 Raspbian PIXEL ('full') has broken something in volume control. I2S works, but there's no software volume setup, if you need this, try Raspbian Lite - will try to fix as soon as we figure out why :)

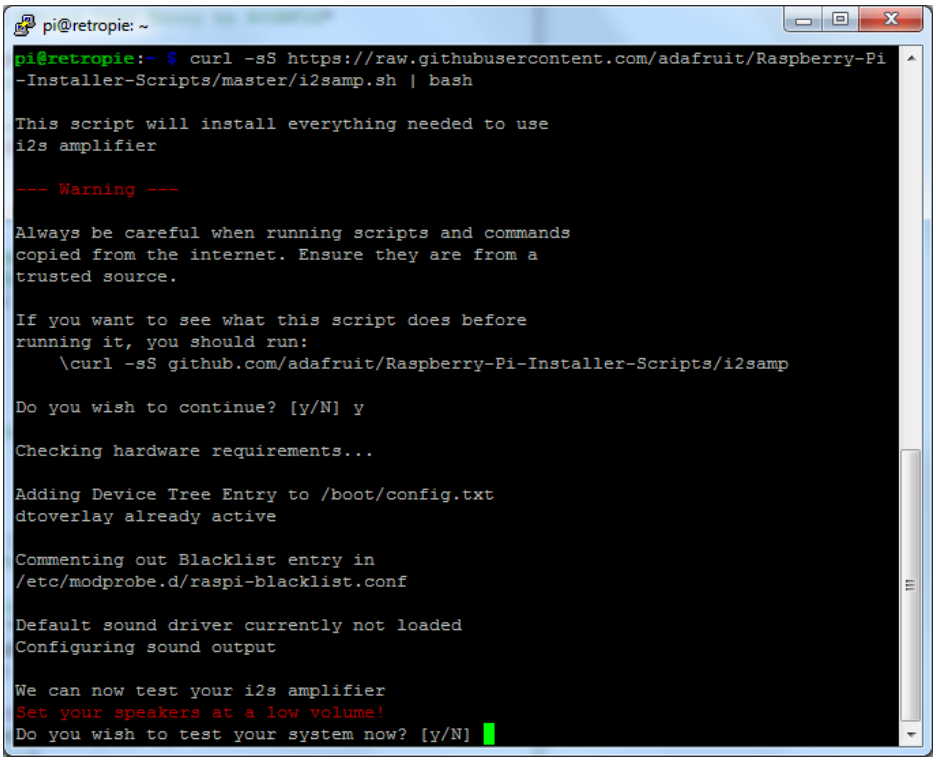
Fast Install

Luckily its quite easy to install support for I2S DACs on Raspbian.

These instructions are totally cribbed from the PhatDAC instructions at the lovely folks at Pimoroni! (https://adafru.it/nFy)

Run the following from your Raspberry Pi with Internet connectivity:

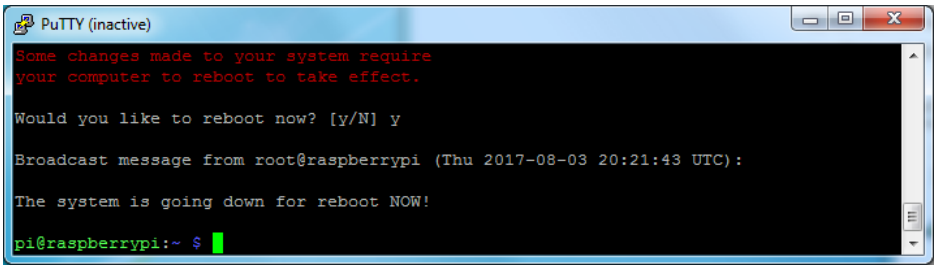
```
curl -sS https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-Scripts/master/i2samp.sh | bash
```



We've added an extra helper systemd script that will play quiet audio when the I2S peripheral isn't in use. This removes popping when playback starts or stops. It uses a tiny amount of CPU time (on a Pi Zero, 5%, on a Pi 2 or 3 its negligible). You don't need this on RetroPie because it never releases the I2S device, but it's great for Raspbian.

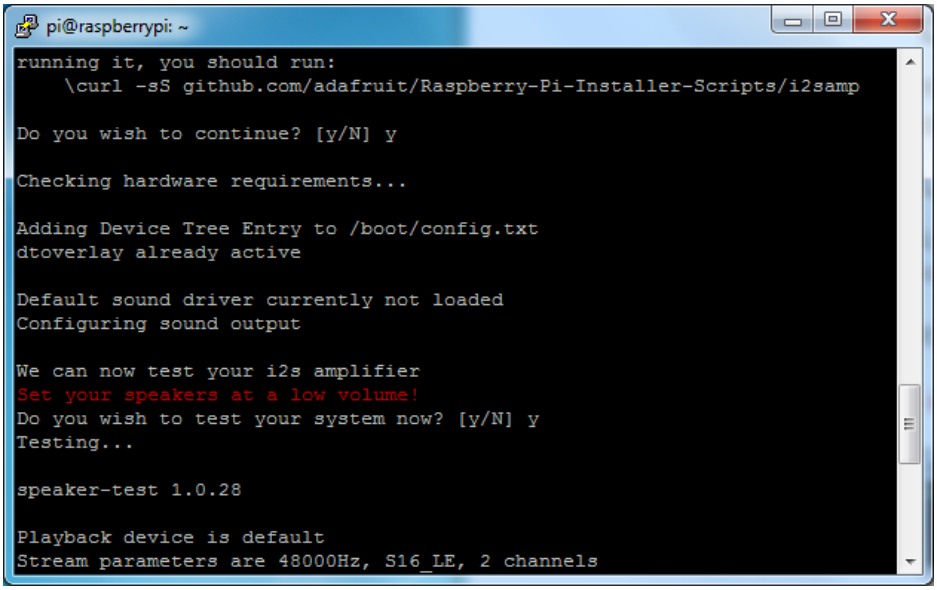
```
Installing aplay systemd unit
Removed /etc/systemd/system/multi-user.target.wants/aplay.service.

You can optionally activate '/dev/zero' playback in
the background at boot. This will remove all
popping/clicking but does use some processor time.

Activate '/dev/zero' playback in background? [RECOMMENDED] [y/N] y
```

You will need to reboot once installed.



You must reboot to enable the speaker hardware!

After rebooting, log back in and re-run the script again...It will ask you if you want to test the speaker. Say **y**es and listen for audio to come out of your speakers...



If it sounds really distorted, it could be the volume is too high. However, in order to have volume control appear in Raspbian desktop or Retropie you must reboot a second time after doing the speaker test, with **sudo reboot**

You must reboot *twice* to enable alsamixer volume (really!)

Once rebooted, try running **alsamixer** and use arrow keys to lower the volume, 50% is a good place to start.

If you're still having audio problems, try re-running the script and saying **N** (disable) the `/dev/zero playback service`.

You can then go to the next page on testing and optimizing your setup. Skip the rest of this page on **Detailed Installation** if the script worked for you!

Detailed Install

If, for some reason, you can't just run the script and you want to go through the install by hand - here's all the steps!

Update /etc/modprobe.d (if it exists)

Log into your Pi and get into a serial console (either via a console cable, the TV console, RXVT, or what have you)

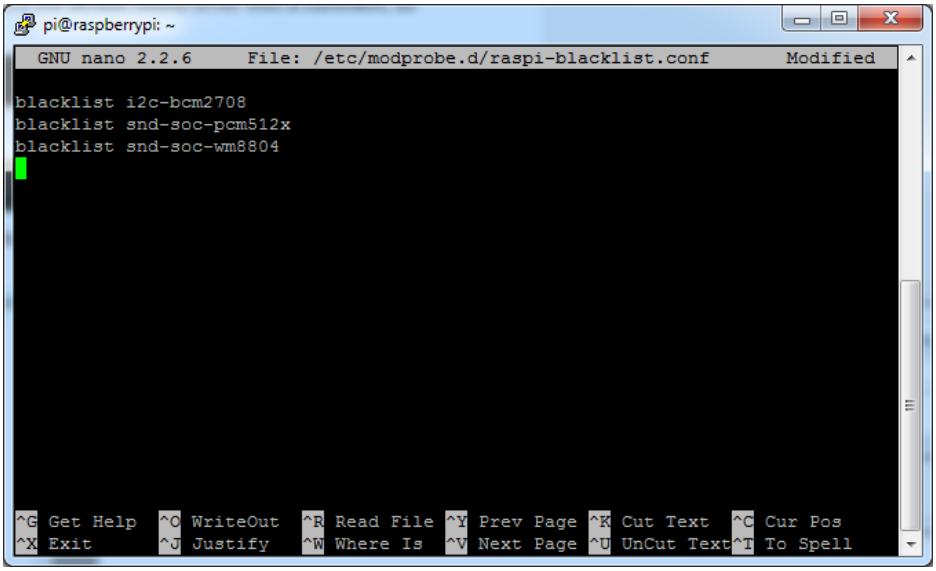
Edit the raspi blacklist with

```
sudo nano /etc/modprobe.d/raspi-blacklist.conf
```

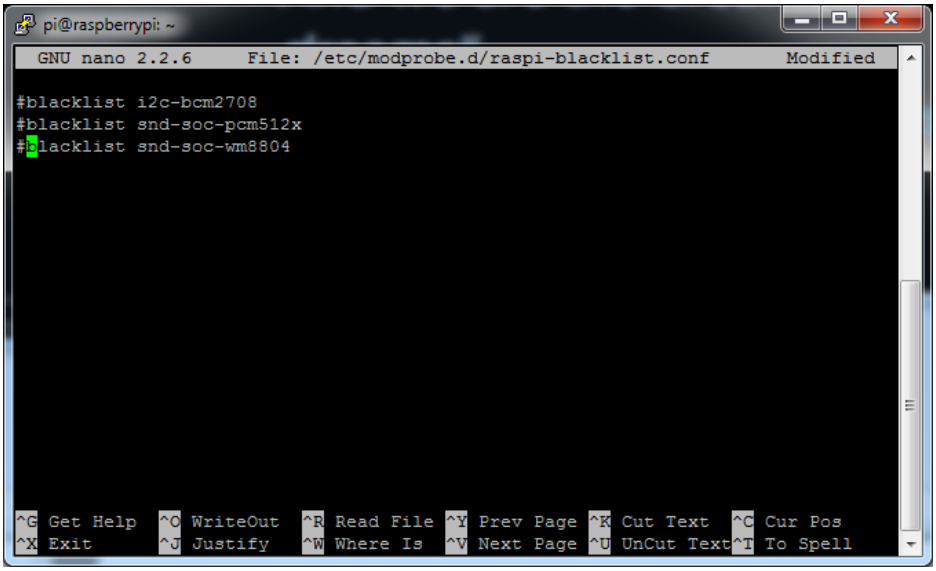
If the file is empty, just skip this step

However, if you see the following lines:

```
blacklist i2c-bcm2708
blacklist snd-soc-pcm512x
blacklist snd-soc-wm8804
```



Update the lines by putting a # before each line



Save by typing **Control-X Y <return>**

Disable headphone audio (if it's set)

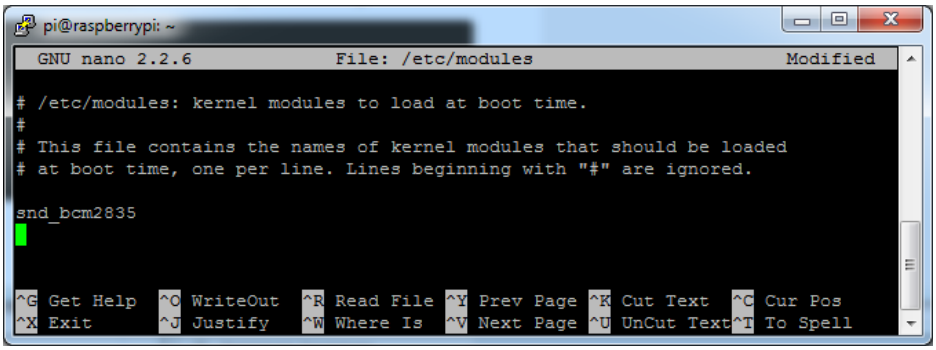
Edit the raspi modules list with

```
sudo nano /etc/modules
```

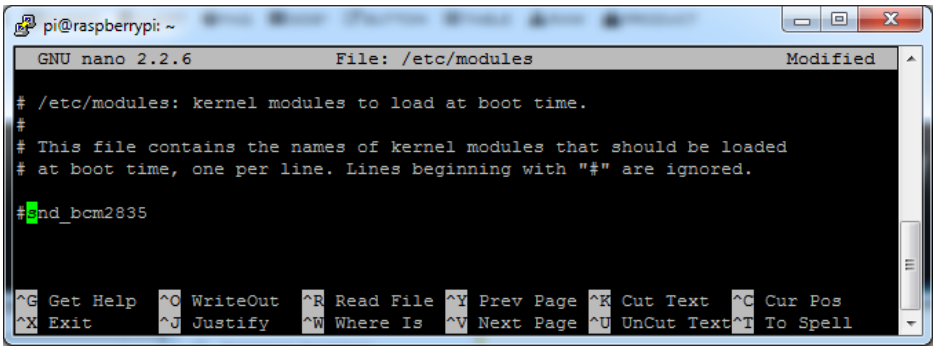
If the file is empty, just skip this step

However, if you see the following line:

```
snd_bcm2835
```



Put a # in front of it



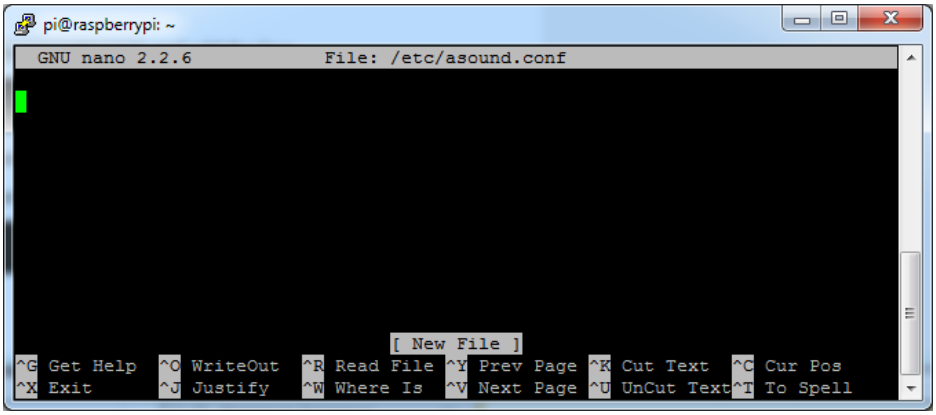
and save with **Control-X Y <return>**

Create asound.conf file

Edit the raspi modules list with

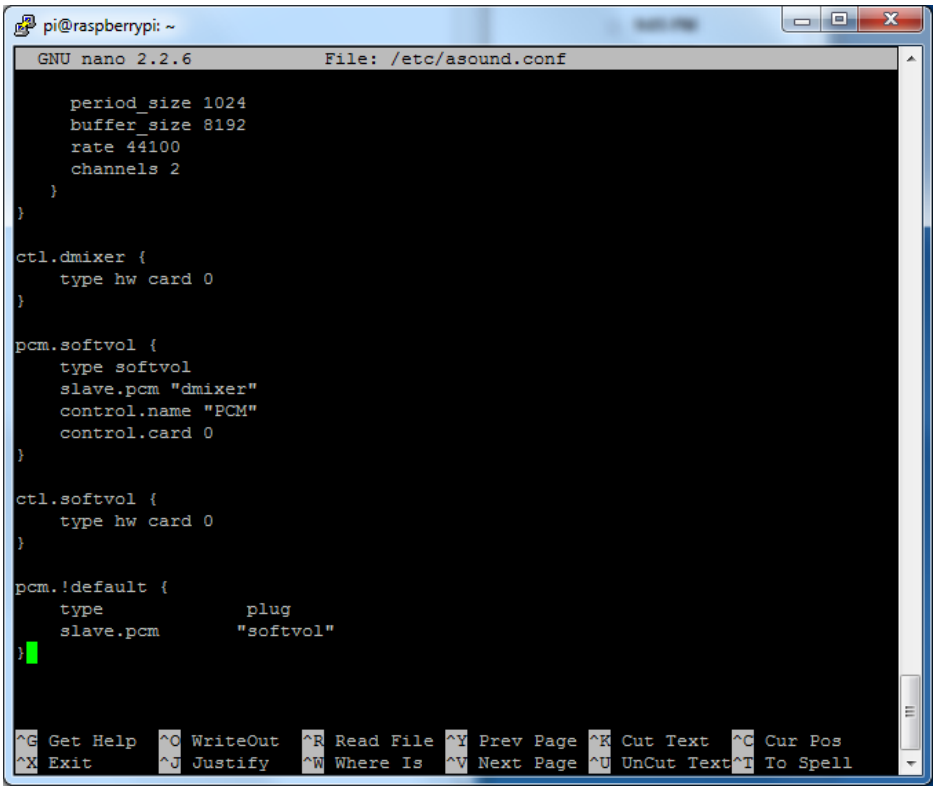
```
sudo nano /etc/asound.conf
```

This file ought to be blank!



Copy and paste the following text into the file

```
pcm.speakerbonnet {
   type hw card 0
}

pcm.dmixer {
   type dmix
   ipc_key 1024
   ipc_perm 0666
   slave {
     pcm "speakerbonnet"
     period_time 0
     period_size 1024
     buffer_size 8192
     rate 44100
     channels 2
   }
}

ctl.dmixer {
    type hw card 0
}

pcm.softvol {
    type softvol
    slave.pcm "dmixer"
    control.name "PCM"
    control.card 0
}

ctl.softvol {
    type hw card 0
}

pcm.!default {
    type             plug
    slave.pcm       "softvol"
}
```



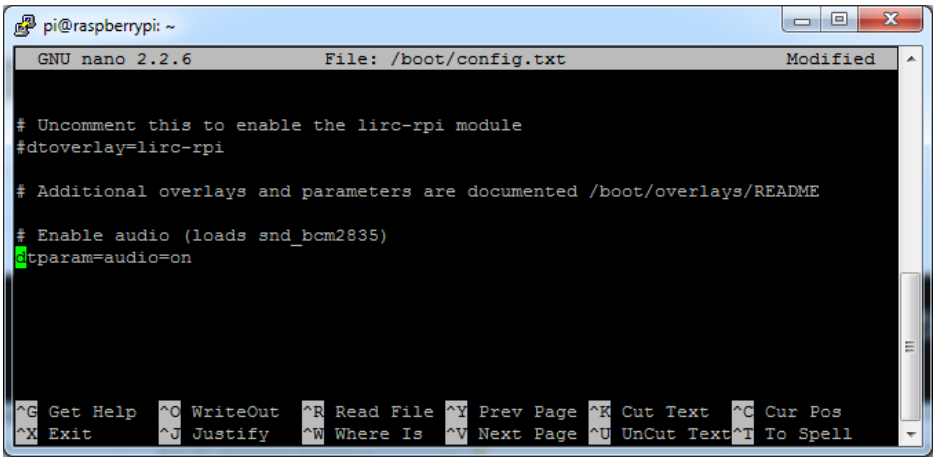
Save the file as usual

Add Device Tree Overlay

Edit your Pi configuration file with

```
sudo nano /boot/config.txt
```

And scroll down to the bottom. If you see a line that says: `dtparam=audio=on`

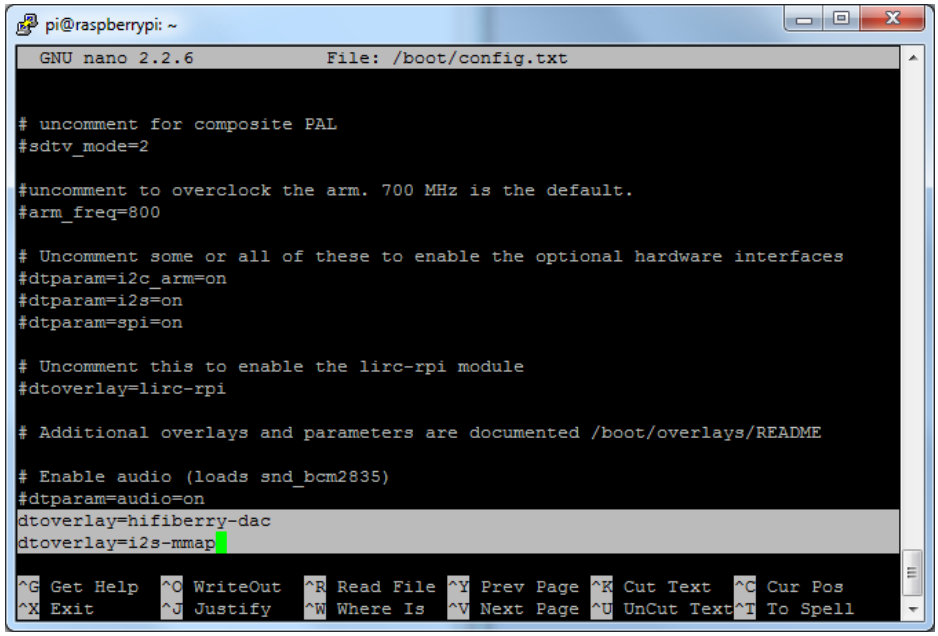


Disable it by putting a # in front.

Then add:

```
dtoverlay=hifiberry-dac
dtoverlay=i2s-mmap
```

on the next line. Save the file.



Reboot your Pi with **sudo reboot**

Raspberry Pi Test

Speaker Tests!

OK you can use whatever software you like to play audio but if you'd like to test the speaker output, here's some quick commands that will let you verify your amp and speaker are working as they should!

Simple white noise speaker test

Run `speaker-test -c2` to generate white noise out of the speaker, alternating left and right.

If you have a mono output amplifier, the I2S amp merges left and right channels, so you'll hear continuous white noise

Simple WAV speaker test

Once you've got something coming out, try to play an audio file with **speaker-test** (for WAV files, not MP3)

```
speaker-test -c2 --test=wav -w /usr/share/sounds/alsa/Front_Center.wav
```

You'll hear audio coming from left and right alternating speakers

Simple MP3 speaker test

If you want to play a stream of music, you can try

```
sudo apt-get install -y mpg123
mpg123 http://ice1.somafm.com/u80s-128-mp3
```

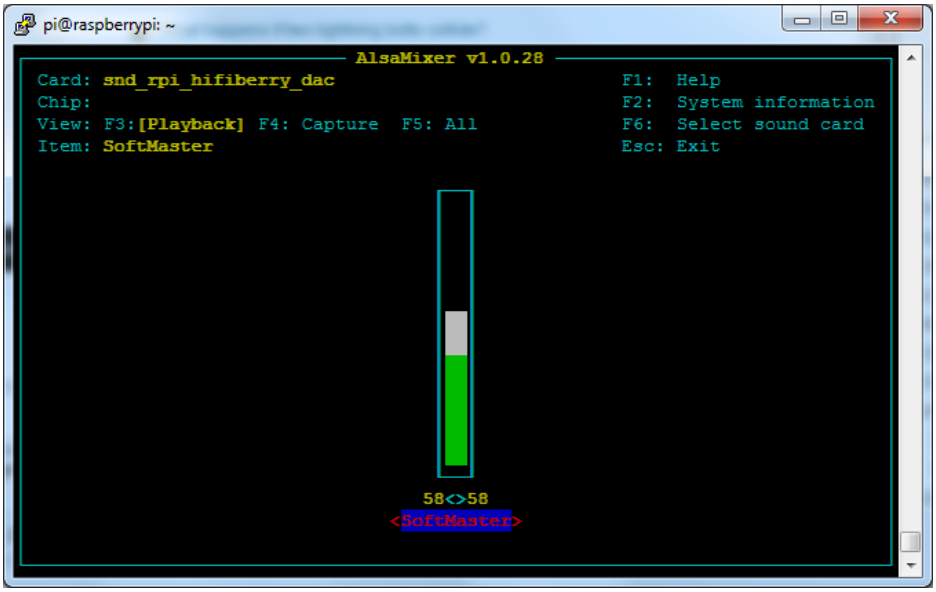
If you want to play MP3's on command, check out this tutorial which covers how to set that up (https://adafru.it/aTD)

At this time, Jessie Raspbery Pi kernel **does not support mono audio** out of the I2S interface, **you can only play stereo**, so any mono audio files may need conversion to stereo!

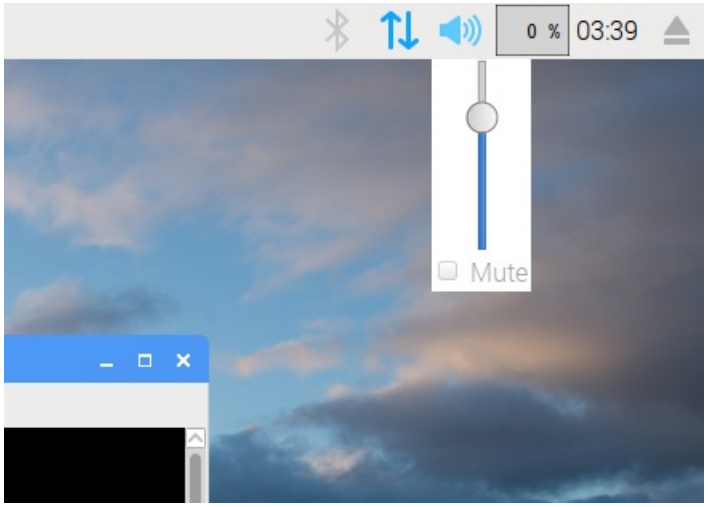
omxplayer does not seem use the I2S interface for audio - only HDMI - so you won't be able to use it

Volume adjustment

Many programs like PyGame and Sonic Pi have volume control within the application. For other programs you can set the volume using the command line tool called **alsamixer**. Just type alsamixer in and then use the up/down arrows to set the volume. Press Escape once its set



In Raspbian PIXEL you can set the volume using the menu item control. If it has an X through it, try restarting the Pi (you have to restart twice after install to get PIXEL to recognize the volume control



Pi I2S Tweaks

This page is deprecated, our installer already performs these steps for you, but we'll keep them here for archival use!

Reducing popping

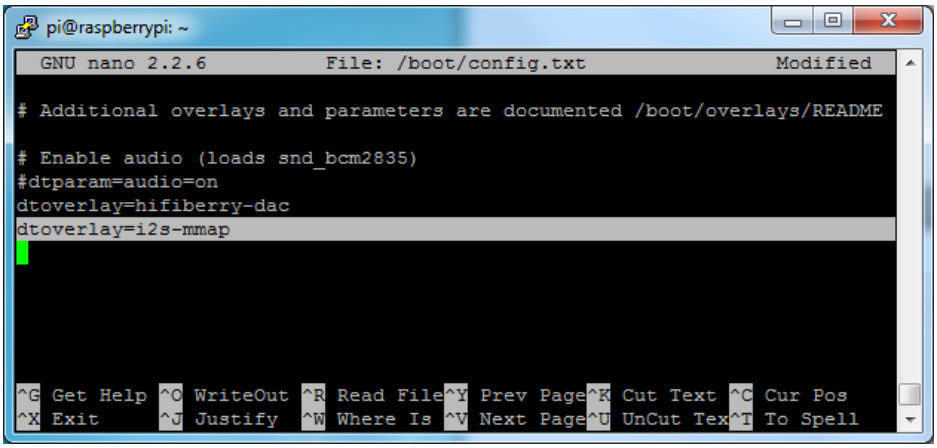
For people who followed our original installation instructions with the simple alsa config, they may find that the I2S audio pops when playing new audio.

The workaround is to use a software mixer to output a fixed sample rate to the I2S device so the bit clock does not change. I use ALSA so I configured **dmixer** and I no longer have any pops or clicks. Note that the RaspPi I2S driver does not support **dmixer** by default and you must follow these instructions provided (https://adafru.it/sHF) to add it. Continue on for step-by-step on how to enable it!

Step 1

Start by modify **/boot/config.txt** to add `dtoverlay=i2s-mmap`

Run **sudo nano /boot/config.txt** and add the text to the bottom like so:



Save and exit.

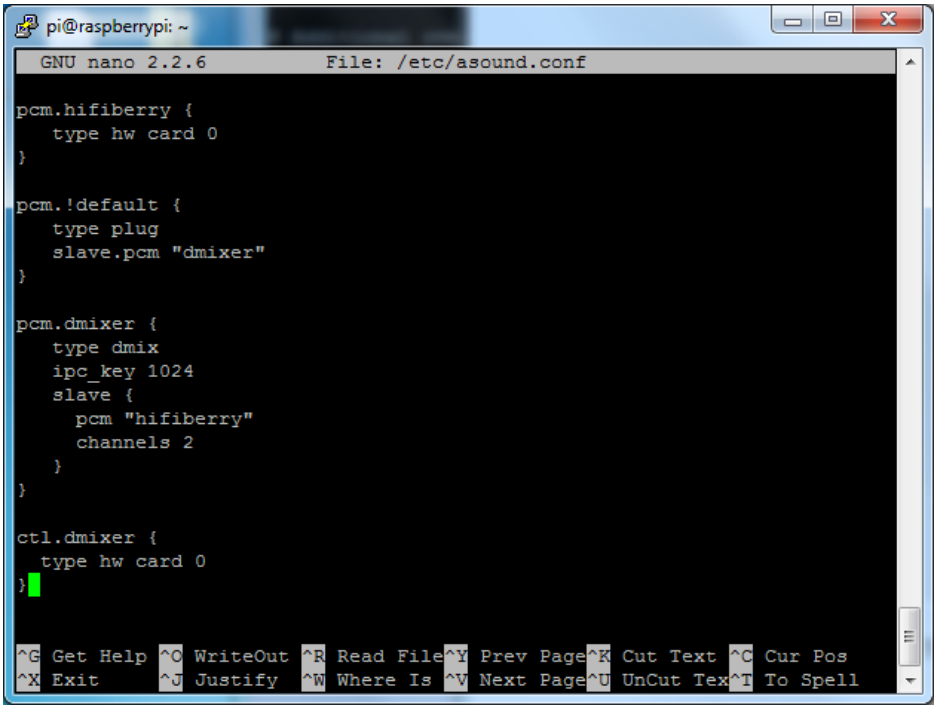
Then change **/etc/asound.conf** to:

```
pcm.speakerbonnet {
   type hw card 0
}

pcm.!default {
   type plug
   slave.pcm "dmixer"
}

pcm.dmixer {
   type dmix
   ipc_key 1024
   ipc_perm 0666
   slave {
     pcm "speakerbonnet"
     period_time 0
     period_size 1024
     buffer_size 8192
     rate 44100
     channels 2
   }
}

ctl.dmixer {
  type hw card 0
}
```

By running `sudo nano /etc/asound.conf`

This creates a PCM device called speakerbonnet which is connected to the hardware I2S device. Then we make a new 'dmix' device (`type dmix`) called `pcm.dmixer` . We give it a unique Inter Process Communication key (`ipc_key 1024`) and permissions that are world-read-writeable `(ipc_perm 0666`) The mixer will control the hardware pcm device speakerbonnet (pcm "speakerbonnet") and has a buffer set up so its nice and fast. The communication buffer is set up so there's no delays (`period_time 0` , `period_size 1024` and `buffer_size 8192` work well). The default mixed rate is 44.1khz stereo (`rate 44100 channels 2`)

Finally we set up a control interface but it ended up working best to just put in the hardware device here - `ctl.dmixer { type hw card 0 }`



Save and exit. Then reboot the Pi to enable the mixer. Also, while it will *greatly* reduce popping, you still may get one once in a while - especially when first playing audio!

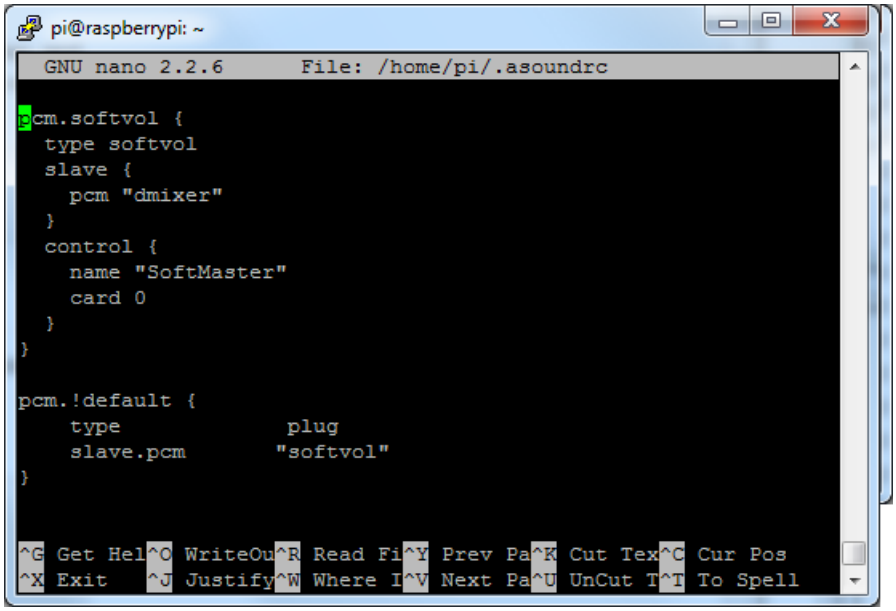
Add software volume control

The basic I2S chipset used here does not have software control built in. So we have to 'trick' the Pi into creating a software volume control. Luckily, its not hard once you know how to do it (https://adafru.it/ydQ).

Create a new audio config file in **~/.asoundrc** with `nano ~/.asoundrc` and inside put the following text:

```
pcm.speakerbonnet {
   type hw card 0
}

pcm.dmixer {
   type dmix
   ipc_key 1024
   ipc_perm 0666
   slave {
     pcm "speakerbonnet"
     period_time 0
     period_size 1024
     buffer_size 8192
     rate 44100
     channels 2
   }
}

ctl.dmixer {
    type hw card 0
}

pcm.softvol {
    type softvol
    slave.pcm "dmixer"
    control.name "PCM"
    control.card 0
}

ctl.softvol {
    type hw card 0
}

pcm.!default {
    type             plug
    slave.pcm       "softvol"
}
```

This assumes you set up the dmixer for no-popping above!

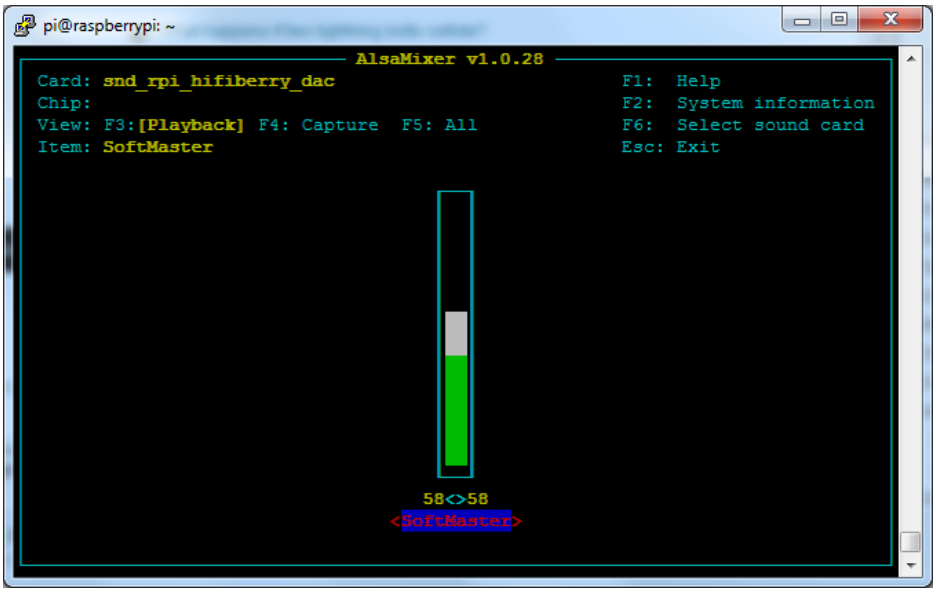


Save and exit

Now, here's the trick, you have to reboot, then play some audio through alsa, then reboot to get the alsamixer to sync up right:

```
speaker-test -c2 --test=wav -w /usr/share/sounds/alsa/Front_Center.wav
```

Then you can type **alsamixer** to control the volume with the 'classic' alsa mixing interface



Just press the up and down arrows to set the volume, and ESC to quit

I2S Audio FAQ

- Hey in Raspbian Pixel desktop, the speaker icon is X'd out!

- Even with dmixer enabled, I get a staticy-pop when the Pi first boots or when it first starts playing audio
  -

- The audio on my DAC sounds really bad/distorted

Does this work with my favorite software?

Play Audio with PyGame

You can use **mpg123** for basic testing but it's a little clumsy for use where you want to dynamically change the volume or have an interactive program. For more powerful audio playback we suggest using PyGame to playback a variety of audio formats (MP3 included!)

Install PyGame

Start by installing pygame support, you'll need to open up a console on your Pi with network access and run:

```
sudo apt-get install python-pygame
```

Next, download this pygame example zip to your Pi

https://adafru.it/wbp

https://adafru.it/wbp

On the command line, run

wget https://cdn-learn.adafruit.com/assets/assets/000/041/506/original/pygame_example.zip (https://adafru.it/wbq)

unzip pygame_example.zip (https://adafru.it/wbq)

Run Demo

Inside the zip is an example called **pygameMP3.py**

This example will playback all MP3's within the script's folder. To demonstrate that you can also adjust the volume within pygame, the second argument is the volume for playback. Specify a volume to playback with a command line argument between 0.0 and 1.0

For example here is how to play at 75% volume:

```
python pygameMP3.py 0.75
```

Here's the code if you have your own mp3s!

```
''' pg_midi_sound101.py
play midi music files (also mp3 files) using pygame
tested with Python273/331 and pygame192 by vegaseat
'''
#code modified by James DeVito from here: https://www.daniweb.com/programming/software-development/code/4


#!/usr/bin/python

import sys
import pygame as pg
import os
import time
```

```
def play_music(music_file):
    '''
    stream music with mixer.music module in blocking manner
    this will stream the sound from disk while playing
    '''
    clock = pg.time.Clock()
    try:
        pg.mixer.music.load(music_file)
        print("Music file {} loaded!".format(music_file))
    except pygame.error:
        print("File {} not found! {}".format(music_file, pg.get_error()))
        return

    pg.mixer.music.play()

    # If you want to fade in the audio...
    # for x in range(0,100):
    #     pg.mixer.music.set_volume(float(x)/100.0)
    #     time.sleep(.0075)
    # # check if playback has finished
    while pg.mixer.music.get_busy():
        clock.tick(30)


freq = 44100    # audio CD quality
bitsize = -16   # unsigned 16 bit
channels = 2    # 1 is mono, 2 is stereo
buffer = 2048   # number of samples (experiment to get right sound)
pg.mixer.init(freq, bitsize, channels, buffer)


if len(sys.argv) > 1:

    try:
        user_volume = float(sys.argv[1])
    except ValueError:
        print "Volume argument invalid. Please use a float (0.0 - 1.0)"
        pg.mixer.music.fadeout(1000)
        pg.mixer.music.stop()
        raise SystemExit

    print("Playing at volume: " + str(user_volume)+ "\n")
    pg.mixer.music.set_volume(user_volume)
    mp3s = []
    for file in os.listdir("."):
        if file.endswith(".mp3"):
            mp3s.append(file)

    print mp3s

    for x in mp3s:
        try:
            play_music(x)
            time.sleep(.25)
        except KeyboardInterrupt:
            # if user hits Ctrl/C then exit
            # (works only in console mode)
            pg.mixer.music.fadeout(1000)
```

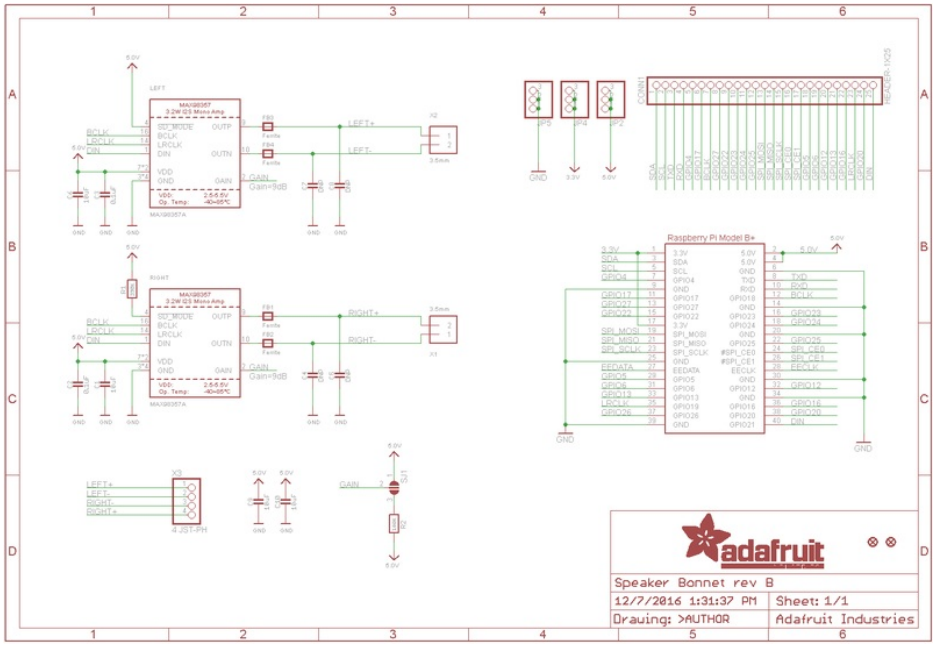
```
            pg.mixer.music.stop()
            raise SystemExit
else:
    print("Please specify volume as a float! (0.0 - 1.0)")
```

Downloads

Datasheets & Files

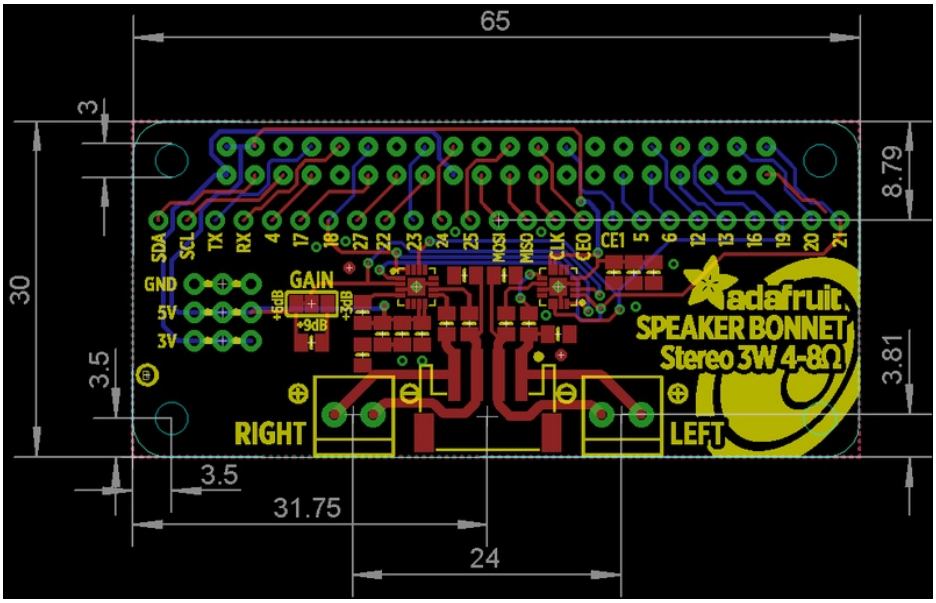
- MAX98357 Datasheet (https://adafru.it/nFz)
- EagleCAD PCB files (https://adafru.it/t1d)
- Fritzing object in Adafruit Fritzing library (https://adafru.it/c7M)

Schematic



Fabrication Print

Dims in mm



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