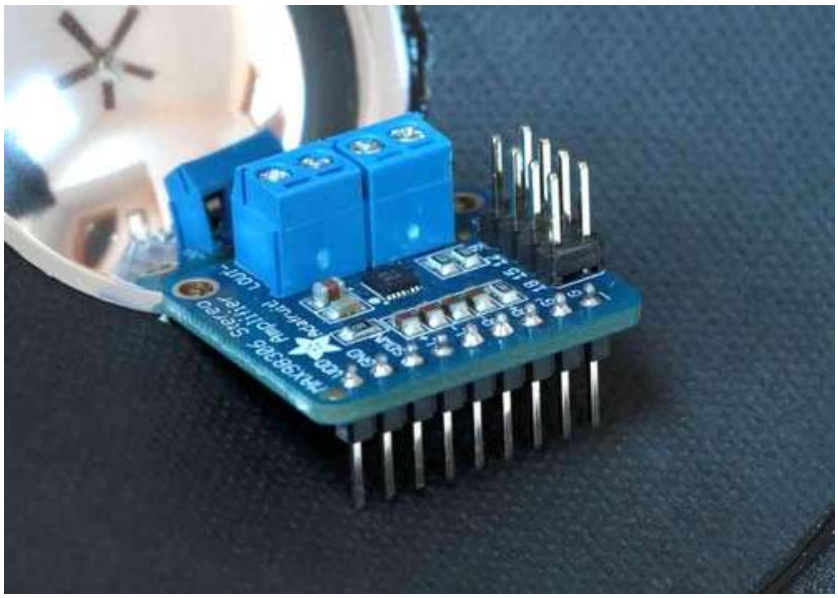
Stereo 3.7W Class D Audio Amplifier

Created by Bill Earl



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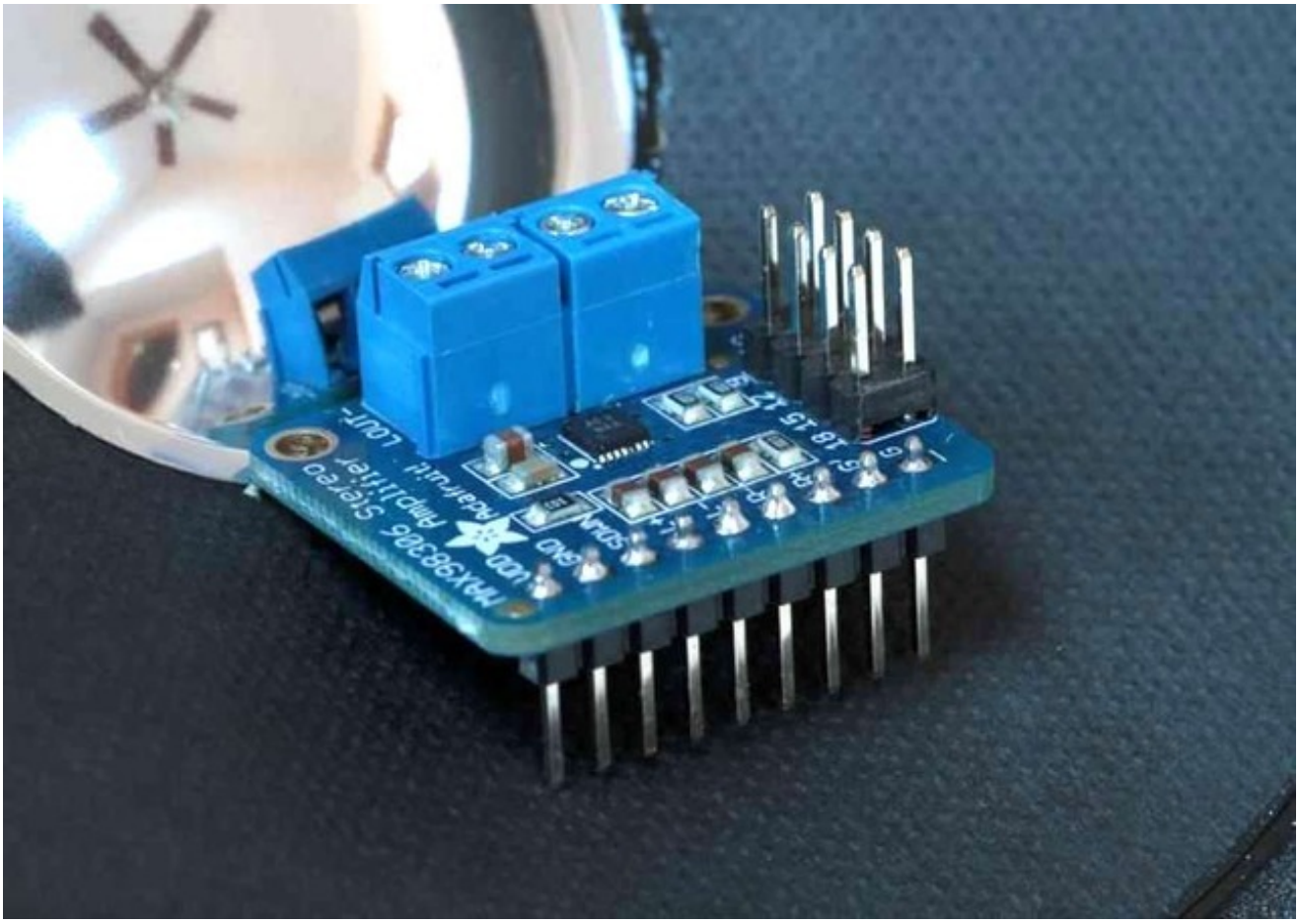
Overview



This incredibly small stereo amplifier is surprisingly powerful - able to deliver 2 x 3.7W channels into 3 ohm impedance speakers. Inside the miniature chip is a class D controller, able to run from 2.7V-5.5VDC. Since the amp is a class D, its incredibly efficient (over 90% efficient when driving an 8Ω speaker at over a Watt).

This amplifier is perfect for portable and battery-powered projects. It has built in thermal and over-current protection, but you really have to drive it hard before it even gets warm! This board is a welcome upgrade to basic "LM386" amps!

Specifications:

- Output Power: 3.7W at 3Ω, 10% THD, 1.7W at 8Ω, 10% THD, with 5V Supply
- Passes EMI limit unfiltered with up to 12 inches (30 cm) of speaker cable
- High 83dB PSRR at 217Hz

- Spread-Spectrum Modulation and Active Emissions Limiting
- Differential Inputs
- Five pin-selectable gains: 6dB, 9dB, 12dB, 15dB and 18dB. Select with a jumper or by setting the G and G' breakout pins (see schematic for breakout board showing gain pin settings (http://adafru.it/aWT) for details)
- Excellent click-and-pop suppression
- Thermal and short-circuit/over-current protection
- Low current draw: 2mA quiescent and 10uA in shutdown mode

What is a Class D Amplifier?

A Class D Amplifier uses PWM to generate high-frequency square waves with a duty-cycle proportional to the voltage level of the input audio signal. By minimizing the transition time between fully on and fully off, the MOSFET drivers are able to operate at a very high efficiency. Class D amplifiers such as this one typically operate at over 90% efficiency, compared to efficiencies of 50% or less for typical class AB amplifiers.

The high frequency square-wave component of the output signal is filtered by the inductance of the speaker voice coil, leaving only the amplified audio signal.

Other Audio amps available at Adafruit

We have a few choices of audio amplifiers, here's how you can compare them

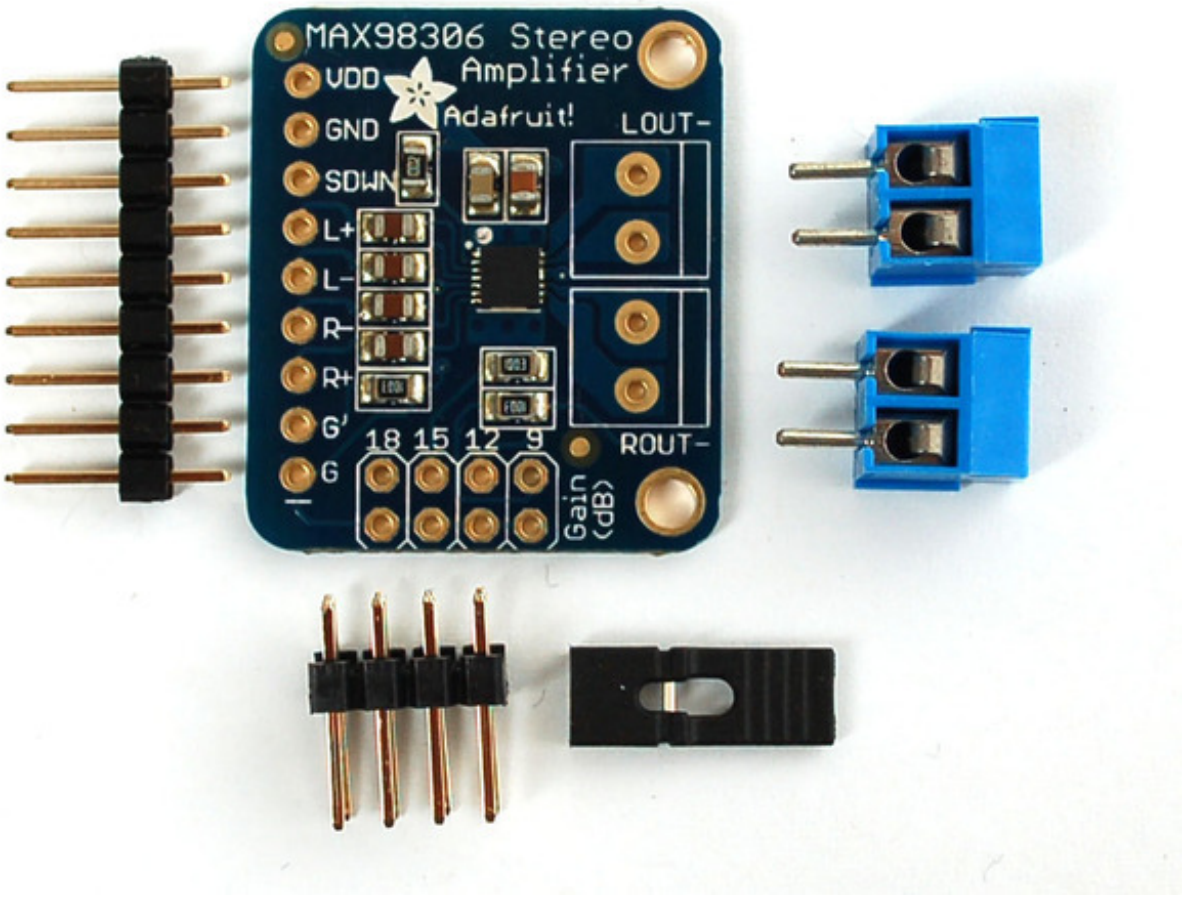
- MAX98306 (http://adafru.it/987) - This class D audio amplifier has selectable gains of 6dB, 9dB, 12dB, 15dB and 18dB that you can choose with a jumper. It can do up to 3.7W into 3Ω, 2.8W into 4Ω and 1.7W into 8Ω. However, you cannot shut down each speaker separately. Its a good choice where you don't mind setting the gain with a jumper and if you do not need to ever turn off only one audio channel and you do not need more than 18dB. Its an excellent amplifier that can driver down to 3Ω speakers Like the TS2012, it has differential inputs, bridge tied outputs, and can run from 2.7V to 5.5V

- TS2012 (http://adafru.it/1552) - This class D audio amplifier has selectable gains of 6dB, 12dB, 18dB and **24dB** that you can choose with a jumper (the MAX98306 goes up to 18dB only). It can do up to 2.8W into 4Ω and 1.7W into 8Ω. It cannot drive 3Ω.

You can shut down each channel separately. Setting the gain is easy on the onboard DIP switches. Its a good choice where you don't need to drive 3Ω speakers or if you ever want to turn off only one audio channel. If you need 24dB gain this amp can do it. Like the MAX98306, it has differential inputs, bridge tied outputs, and can run from 2.7V to 5.5V

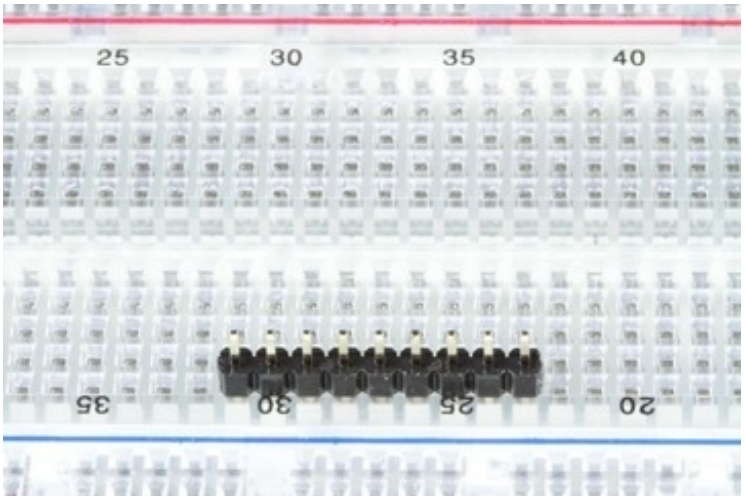
Available from Adafruit! (http://adafru.it/987)

Assembly



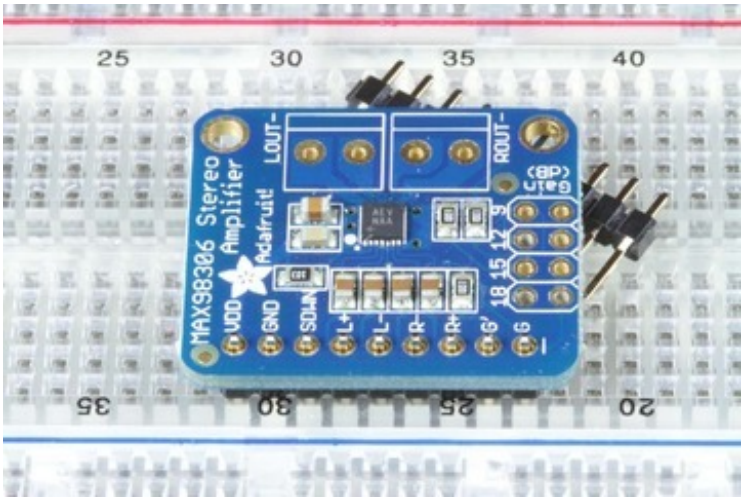
The amplifier breakout board is fully assembled and tested. To easily integrate the amplifier into your project, we include the following:

- A 9-pin header for use with breadboard or connectors
- 3.5mm screw-terminal blocks for your speakers
- A 2x4 header + jumper for setting the gain



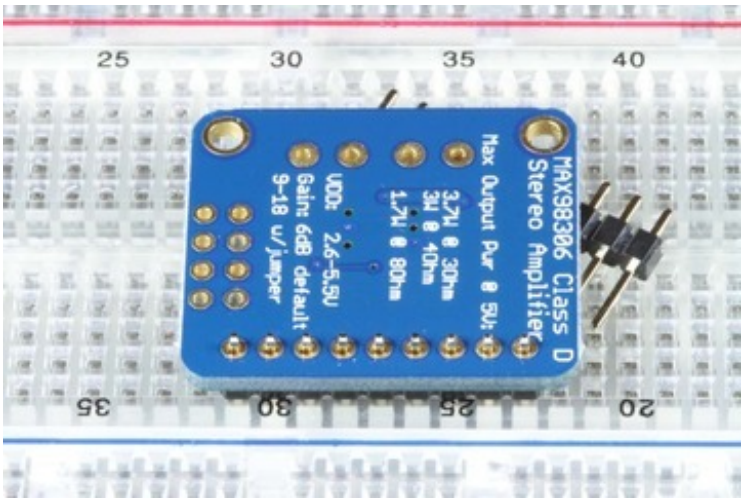
Solder the header:

Cut the header to size (9 pins) and insert it into a breadboard (long pins down!) to hold it steady.



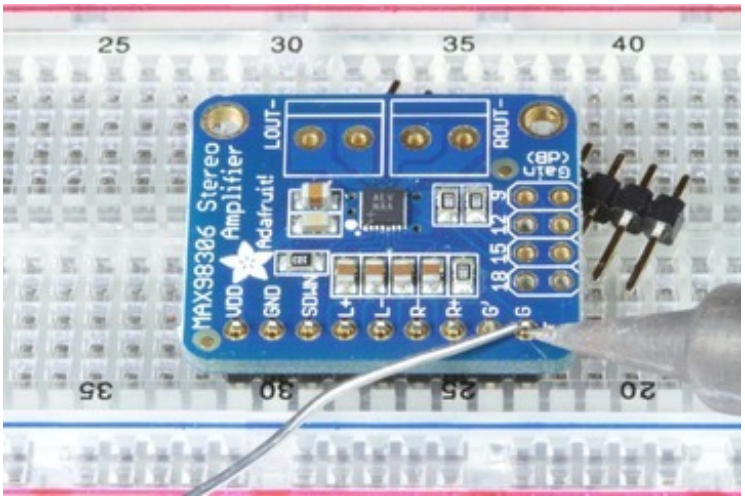
For breadboard use:

Place the amplifier module face-up over the headers. Prop the back-edge up with the leftover header strip to align it.



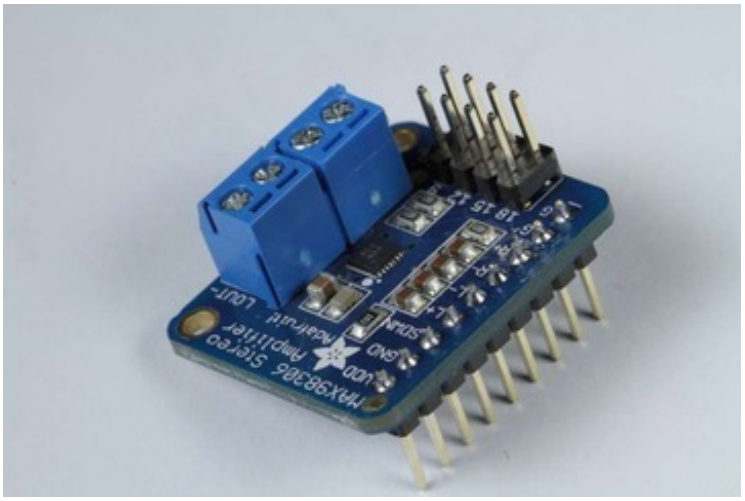
For use with connectors:

If you are going to build this into a project and want to connect from the front side, place the amplifier module face down for soldering.

- 

And Solder!

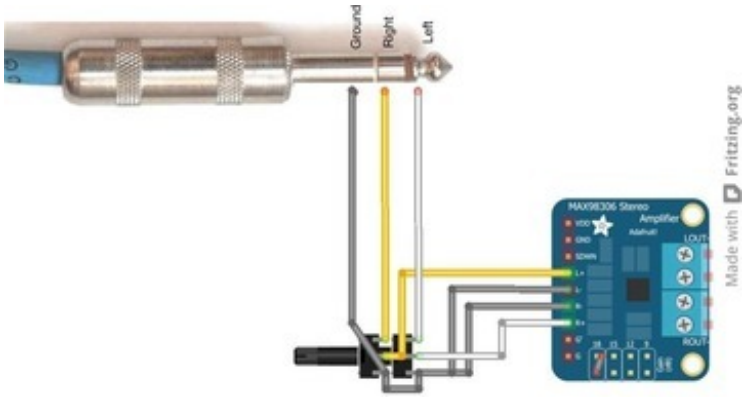
For tips on soldering, see our [Adafruit Guide to Excellent Soldering.](http://adafru.it/aTk) (http://adafru.it/aTk)

- 

Add Gain Selection and Speaker Terminals

Solder the 2x4 pin header for gain selection to the top of the board as shown. Also solder in the 3.5mm screw terminals for the speakers.

Connections and Settings

- 

Inputs:

The amplifier inputs are coupled via 1.0uF capacitors so they can handle single ended or differential signals.

For Single Ended signals (shown on left), connect:

- R+ to R+
- GND to R-
- L+ to L+
- GND to L-

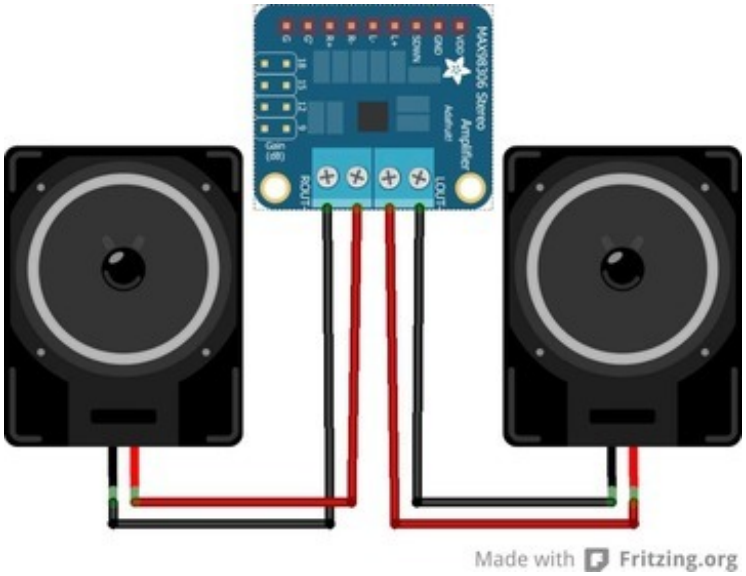
For differential signals, connect:

- R+ to R+
- R- to R-
- L+ to L+
- L- to L-

For volume control, a dual 50K audio taper pot can be wired in series with the inputs as shown.

Outputs:

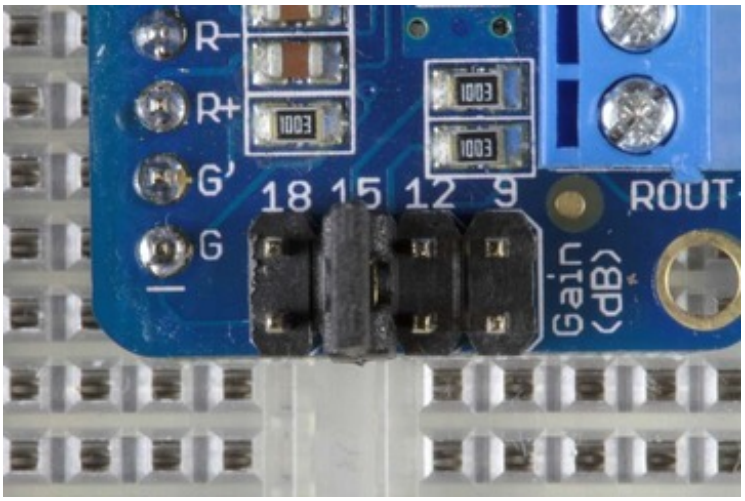
This amplifier is designed to drive moving coil loudpeakers only. Speaker impedence must be 3ohms or more. The output signal is a 360KHz PWM square wave with a duty cycle proportional to the audio signal. The inductance of the speaker



coil serves as a low-pass filter to average out the high-frequency components. Do not try to use this as a pre-amplifier.

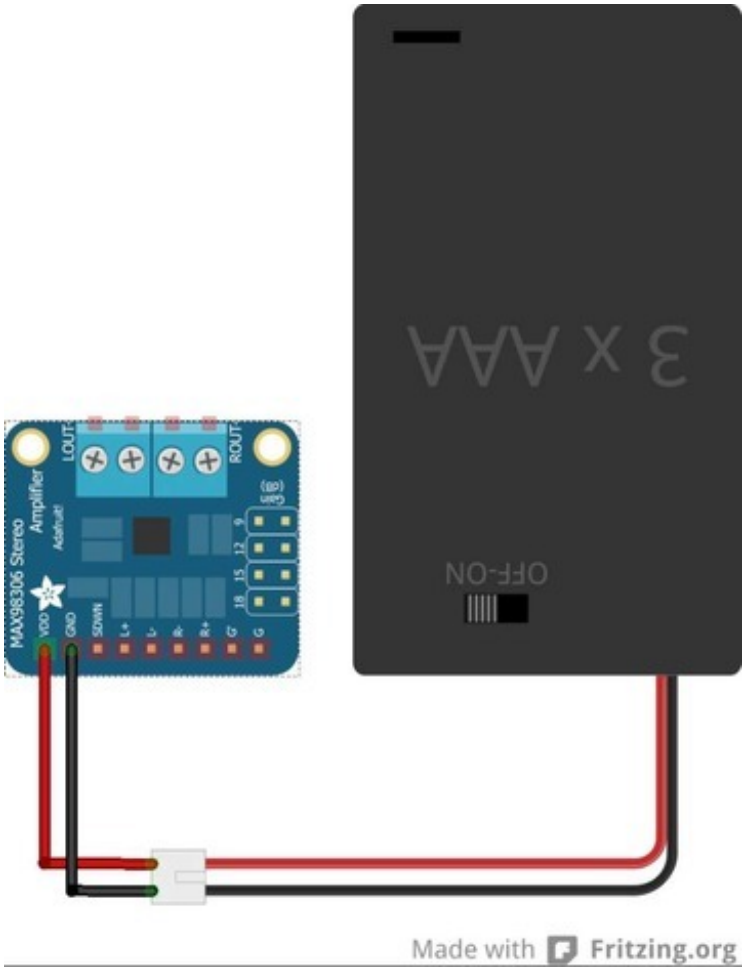
The outputs of *each channel* are "Bridge-Tied" with no connection to ground. This means that for each of the two channels, the + and - alternate polarity to create a single channel amplifier with twice the available power. However, that means **you cannot bridge R and L together**, so don't try to connect ROUT to LOUT, it will damage the amp! If you only need one speaker, just connect to either ROUT *or* LOUT and leave the other output set alone

Connect your speakers using the 3.5mm screw-terminal blocks.



Gain:

Gain is configurable for 9, 12, 15 or 18 dB. For higher level outputs such as from a WaveShield, you will want to select a lower gain. For low-level outputs such as from an iPod or MP3 player, a higher gain setting works best. To set the gain, install the jumper in one of the 4 marked positions on the 4x2 header.



Power:

The amplifier can be powered by 2.7 to 5.5v DC. Good power sources are:

- 5v 2A power supply (http://adafru.it/276)
- 3xAA (4.5v) battery holder (http://adafru.it/771)

Connect the negative wire to GND and the positive wire to VDD.

Build a Portable Sound System

Materials:

To build a portable sound system, you will need:

- 1 Adafruit Stereo Class-D Amplifier (http://adafru.it/987)
- 2 speakers (3 ohm minimum. 3" to 4" is a good size)
- 1 3xAA Battery Pack (http://adafru.it/771)
- 1 Power Switch (http://adafru.it/482)
- 1 Phono Jack (We used a 1/4" here)
- 1 50kOhm Stereo Audio-taper pot
- 1 knob
- Jumper wires (http://adafru.it/266)

- 1 Box (We used the case from a power tool. But any lunch-box sized enclosure will work as well)
- 2 Speaker Grilles (We used some 4" fan grilles here)
- Screws & nuts to mount the speakers.
- Polyester batting or pillow stuffing

Mount The Speakers

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Cut holes in the box to fit your speakers and mount them in the box with screws. Here we used 4" speakers with 4" fan grilles and mounted them with 3/4" 6-32 machine screws and nuts.

- 

Mount the Controls

Drill holes to fit your power switch, volume pot and phono jack in a convenient location and mount the controls.

Here we used a 1/4" phono jack. Smaller plugs can be accomodated via adapters. Our volume pot has a Spinal-Tap compliant volume scale that "goes to eleven".

Wire it up!

Make all connections as shown on the diagram to the left. We used these pre-terminated jumper wires (http://adafru.it/266) to simplify connections to the amplifier.

Mount the Amplifier

- Some double-sided foam tape will hold it securely inside the box.

Add some stuffing

- Loosely stuff the back of the box with some polyester batting or pillow stuffing for a less 'hollow' sound.

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Plug And Play!

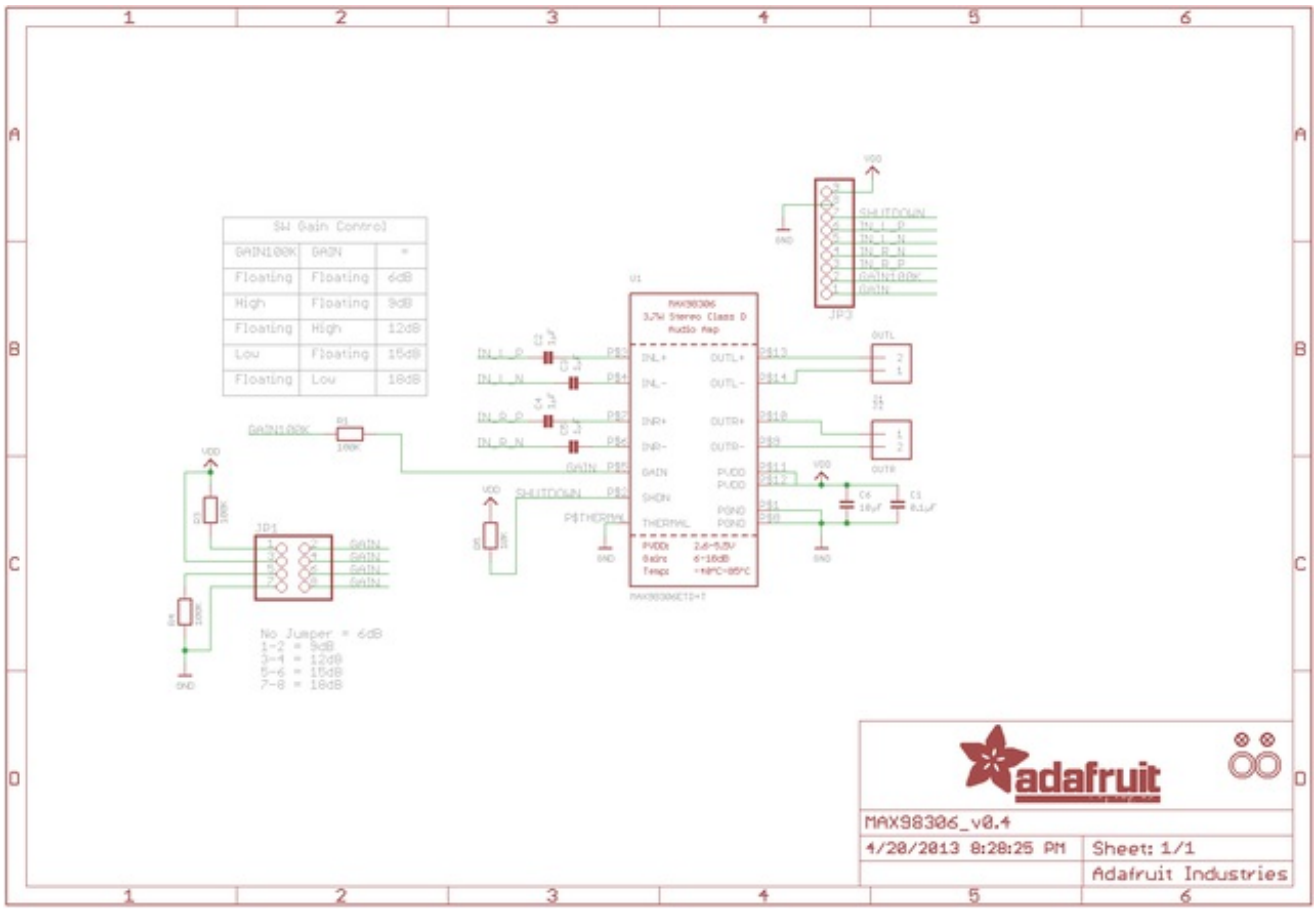
For an iPod or similar player, you will want to use the highest gain setting.

Downloads

Files

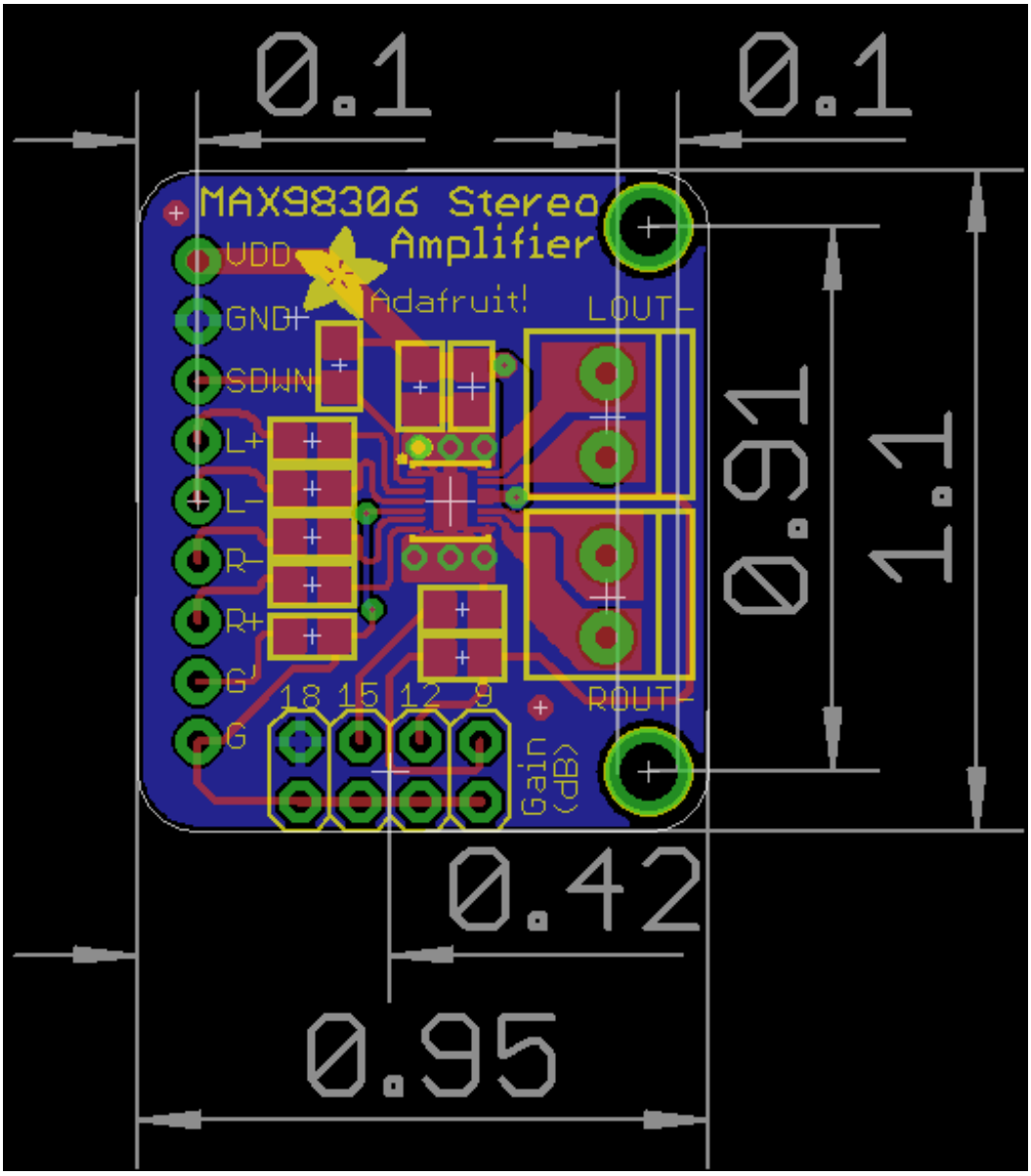
- MAX98306 Datasheet (http://adafru.it/e7o)
- Fritzing object in Adafruit Fritzing library (http://adafru.it/aP3)
- EagleCAD PCB files on GitHub (http://adafru.it/rJc)

Schematic



PCB Fabrication Print

Dimensions in inches


0.1
0.1
MAX98306 Stereo
Amplifier
Adafruit!
VDD
GND
SDWN
L+
L-
R-
R+
G
G
LOUT-
ROUT-
18 15 12 9
Gain (dB)
0.91
1.1
0.42
0.95