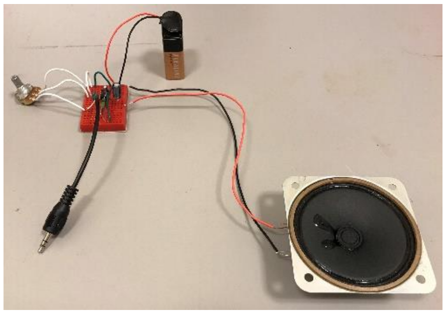
LM386 Audio Amplifier

Workshop



Create your own cost-effective amplifier for your chapter or use this as a workshop template. Empower participants by helping them create an effective, useful, and integral electronic piece.

Number of Participants: 2 - 20

Audience: Highschool and up (14+)

Duration: 20 - 30 mins

Difficulty: Level 3

Materials Required:

- Mini Breadboard (170 Points)
- LM386N-1 op amp
- 0.1 µF capacitor
- 220 µF polarized capacitor
- 10 Ω resistor
- 10 kΩ potentiometer
- 22 gauge wire (solid, not braided)
  - 2 long (9'' to 12")
  - 3 medium (4'' to 6")
  - 4 short (1'' to 3")
- 9 V battery
- 9 V battery connector
- 3.5 mm headphone jack with wire exposed (one end of an aux cord, or headphones with bud cut off works)
- 8 Ω speaker (typically 2 to 3 watts)
- Phone, computer, or 1/8'' audio jack for input
- Wire strippers

Suggested: Mount the assembled circuit in a small box to keep the circuit safe/intact

Setup:

1. Gather all materials.

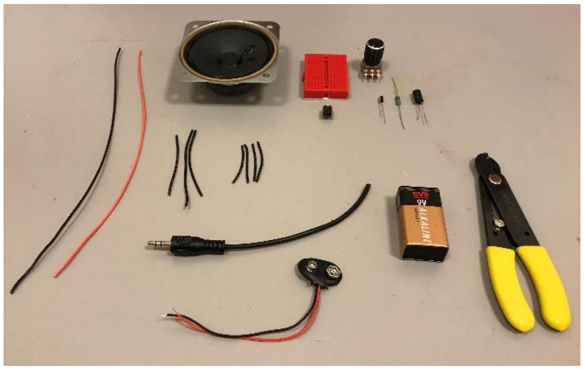


Figure 1 Materials provided needed to create an audio amplifier

2. Take a headphone jack and strip off the insulation for ~2 cm of wire. Inside should be 3 wires: 2 insulated and one bare. For this circuit, you only need 1 of the 2 insulated wires, so strip off the insulation of 1 wire. The headphone jack has two channels (L and R), hence the two insulated wires.
3. *Optional* soldering as in Figure 2:
    a. Lightly solder the ends of the 2 wires on your headphone jack, to make inserting into the breadboard easier.
    b. Solder 3 medium length wires onto potentiometer.
    c. Solder 2 long wires onto the speaker.
    d. Solder the ends of the 9V battery connector cables, to make inserting into the breadboard easier.
    e. If desired, this completed circuit can be soldered on a protoboard for permanent use, rather than put together on the mini breadboard.

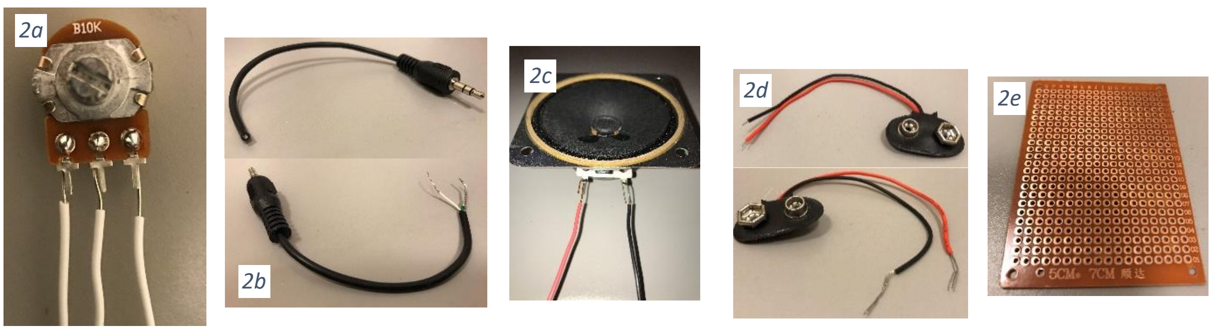


*Figure 2 **a)**The potentiometer wires soldered on **b)** the headphone jack wires before and after wire stripping and soldering **c)** wire speakers soldered **d)** 9V battery connector before and after wire stripping and soldering **e)** a basic protoboard which can be used to solder the circuit together for a more permanent circuit.*

4. Assemble as indicated on circuit diagram. Note V_S is the source voltage, a 9V battery in this case. V_{in} is where the input will go, which will be a headphone jack. The potentiometer will work as the volume control on the speaker.

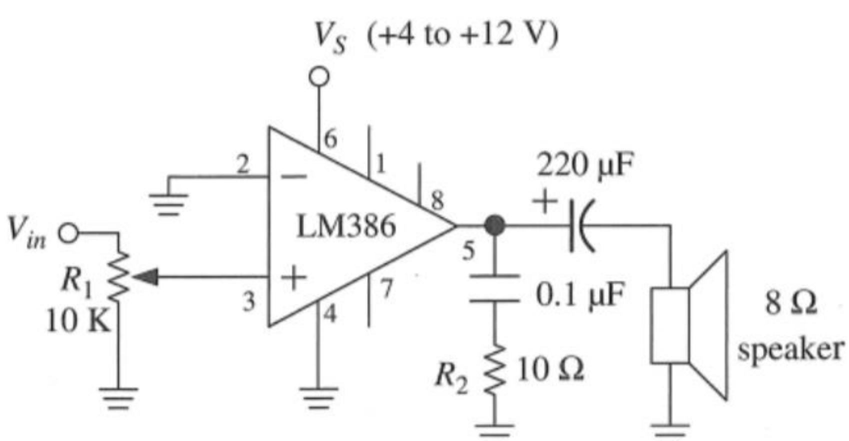


Figure 3 Circuit diagram for the LM386 op amp audio amplifier. Adopted from Scherz & Monk, Practical Electronics for Inventors, Fourth Edition 2016

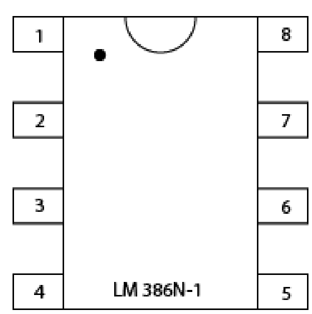


Figure 4 physical pin out of amplifier.

Additional details/assistance:

a. Place LM386 in center of breadboard as in Figure 5.
b. Pin 5, attach the 0.1 µF capacitor and 10 Ω resistor in series, and the 220µF capacitor in parallel with it. Make sure the long end of the capacitor is at the junction (that's the meaning of the positive sign on the capacitor circuit diagram).
c. Ground pins 4 and 2.
d. Attach the red end of the 9 V battery connector to pin 6, and the black end into ground.
e. For the potentiometer, an outer pin should go to ground, the middle to pin 3, and the last outer pin to an open row. On this row is also where one end of the headphone jack cable will go.
f. On the same row as the the 220 µF capacitor, plug in one end of the speaker, and ground the other speaker wire.
g. The last step should always be to connect the power supply. So hook up your phone first, and then plug the 9 V battery into the connector to complete the circuit.

Figure 3 Inserting the LM386 to the breadboard. You want the op amp to be straddled in the middle so each pin is on a separate row.

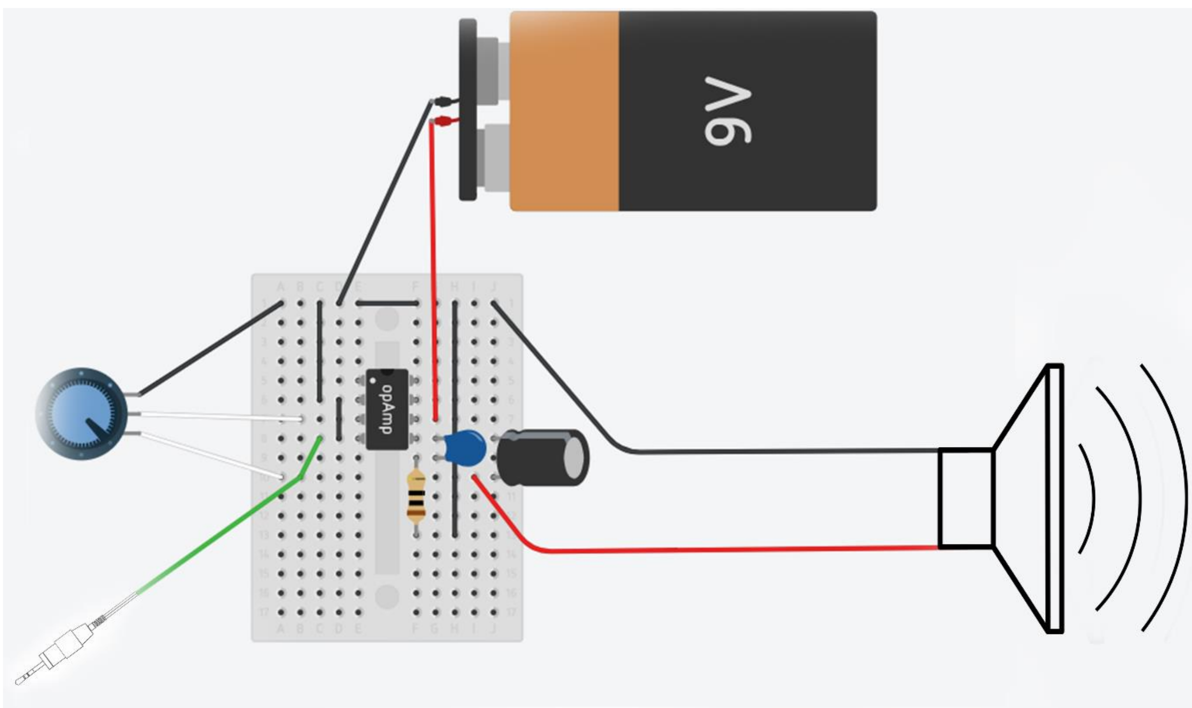


Figure 4 A physical visualization of the circuit. All the black wires indicate they are for grounding, the green wire is the different wires in the speaker. The blue capacitor is the 0.1 uF capacitor, while the big capacitor is the polarized 220 uf capacitor. The longer end of the capacitor should be pinned on the row attached to the op amp.

Vocabulary:

- Gain – the ratio of output to input voltage.
- Op amp – operational amplifier. Here, the op amp is a LM386N-1.
- Potentiometer – 3-terminal variable resistor, that works to adjust the volume of the speaker.

Physics & Explanation:

Highschool and up (ages 14+):

Operational amplifiers (op amps) are incredibly useful integrated devices that are used in a number of different ways. You find them in your car, your phone, in wireless communications and broadcasting, and pretty much in most every day electronics. In general, their main duty is simple: amplify the input signal through the use of negative feedback.

In the giant world of op amps, there is a mini world of audio op amps, which are used for a variety of different purposes. The LM386 was engineered to drive an 8 Ω speaker and is fixed at a gain of 20. There are lots more op amps out there that work with more or less gain, and better for use on different instruments.

Troubleshooting:

- Jiggle each individual component to try and isolate the problem.
- If making a loud squeal, check to make sure no bare wires are accidentally touching.
- Make sure all connections are good, as in figure 7.
- If all else fails, rebuild the circuit from scratch. It may magically help.

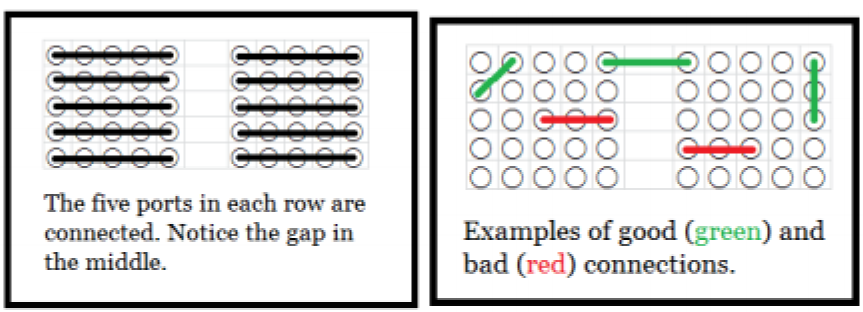


Figure 5 Examples of good and bad connections on a breadboard. Image courtesy of 2013 SPS SOCK.

Additional Resources:

- Scherz & Monk, *Practical Electronics for Inventors*, Fourth Edition 2016
- 2013-14 SOCK