Amplifier with a Piezo Contact Pickup
A Do-It-Yourself Guide to Promote STEM Skills and Awareness

Summary
Combine a mono amplifier board kit, a piezo electric disk, and a potentiometer to make a custom amplifier with a contact pickup. Amplify the sound from a homemade musical instrument or listen to faint sounds from any vibrating object.

Authors: Diane Brancazio, MIT Edgerton Center, dianeb@mit.edu

Date: October 24, 2019
Revision Number: 1
Edgerton Center STEM Projects are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. http://creativecommons.org/licenses/by-nc-sa/4.0/

Why We Use Creative Commons Licensing:
Our mission at the Edgerton Center is to uphold the legacy of Harold “Doc” Edgerton by providing the necessary resources, encouragement, and support for students to gain an education in engineering both in the conventional classroom and particularly outside of it. We promote an overarching ethos of building, learning, and sharing.

As a non-profit entity committed to “building, learning, and sharing” resources for students, we want to make our materials available for free whenever possible, and encourage others to share. Publishing our materials under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License allows us to do this by requiring users and contributors to redistribute at no charge, and by helping others to trace our materials back to their original source.

More information: http://creativecommons.org/licenses/by-nc-sa/4.0/

You are free to use, modify, and share our materials under these terms:

**BY:** Give proper Attribution - this requires that when you use or share our materials, you provide the following: the name of the creator (MIT Edgerton Center) and other parties that collaborated or provided funding for the work; a copyright notice; this license notice; a disclaimer notice; a link to the material; and indications of changes that were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

**NC:** You may only use the material for NonCommercial purposes.

**SA:** You may remix, transform, or build upon the material - and if you do, you must ShareAlike - distribute your contributions under the same license as the original. When sharing or adapting, there are to be no additional restrictions — you may not apply legal terms or technological measures that legally restrict others from doing anything the original license permits.

**In your advertising materials:**
*You may* say that your program uses curriculum developed by the MIT Edgerton Center, and where appropriate, provide a link to our home page: http://edgerton.mit.edu/.

*You may not* describe your program as a partnership or collaboration with MIT or the MIT Edgerton Center.

Help others to find us by citing the MIT Edgerton Center website, where a variety of curriculum materials are available for download: http://edgerton.mit.edu/k-12
Amplifier with a Piezo Contact Pickup

**Summary:** Combine a mono amplifier board kit, a piezo electric disk, and a potentiometer to make a custom amplifier with a contact pickup. Amplify the sound from a homemade musical instrument or listen to faint sounds from any vibrating object. When the piezo-electric element is fastened to a vibrating surface it picks up the vibrations and converts them to an electric signal. This signal goes to the amplifier circuit and out to a small speaker. A potentiometer (variable resistor) is used to control the gain on the amplifier and serves as a volume control for the output speaker.

**Estimated time** to complete is 3 hours for a beginner, and 2 hours for someone experienced in electrical wiring, soldering and hand construction.

**Materials Summary** (Parts list at end of tutorial)
- Kitronik Mono Amplifier kit part number 2165 (includes board, electrical components, battery pack, speaker, and 2-conductor cable)
- Piezo-electric disk, 35 mm, with solder connection points
- Potentiometer, rotary action, linear taper, 100 K Ohm with integrated SPST switch
- Knob for potentiometer (optional)
- 2 AA batteries
- Extra wire, 24 AWG, red, black, 1 or 2 other colors as available
- Cardboard or plastic sheet to make a housing

**Tools**
- Wiring tools: wire stripper, needle nose pliers, wire cutters
- Soldering equipment: soldering iron, solder, brass sponge, tip cleaner
- Cutting tools for cardboard/plastic sheet
- Hot Glue gun and glue sticks
- Velcro-type fasteners
Procedure with time estimates:

- **Step 1** - Create the Housing (30 min)
- **Step 2** - Solder components on the board (20 min)
- **Step 3** - Wire the potentiometer, On/Off switch, and battery pack (20 min)
- **Step 4** - Solder the wires to the speaker (10 min)
- **Step 5** - Solder wires onto the piezo pickup (10 min)
- **Step 6** - Connect all the components to the amplifier board (20 min)
- **Step 7** - Test the circuit (10 min)
- **Step 8** - Assemble electronics and housing (10 min)

This project is best built by an individual or a group of up to 4. For a group build, the first 5 steps can be done in parallel as described here. The project could be completed in about 60 minutes.

<table>
<thead>
<tr>
<th>Group member</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prep Tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1 - Create the Housing (30 min)</td>
<td>Step 2 - Solder components on the board (20 min)</td>
<td>Step 3 - Wire the potentiometer, On/Off switch and battery pack (20 min)</td>
<td>Step 4 - Solder the wires to the speaker (10 min)</td>
<td></td>
</tr>
<tr>
<td>Optional – collect instruments and items that that vibrate (10 min)</td>
<td></td>
<td></td>
<td>Step 5 - Solder wires onto the piezo pickup (10 min)</td>
<td></td>
</tr>
<tr>
<td>Assembly Tasks</td>
<td></td>
<td>Step 6 – Connect all components to the amplifier board (20 min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td></td>
<td>Step 7 - Test the circuit (10 min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Assembly</td>
<td></td>
<td></td>
<td>Step 8 – Assemble electronics and housing (10 min)</td>
<td></td>
</tr>
</tbody>
</table>
Step 1 - Create the Housing (30 min)
Use the template or design your own housing. (Template included with this tutorial)
Cut out the housing from cardboard, corrugated plastic, or similar material.
Make the hole with a pen, pencil or drill to fit the potentiometer shaft (~0.25”)

Step 2 - Solder components on the board (20 min)
Install only the following components:

- C1 and C3 (1 uF Capacitor, Electrolytic)
- C2, 100 nF Ceramic Disk Capacitor
- R1 (15K Ohm resistor)

Discard the 100K Ohm resistor – you will replace R2 with a 100K Ohm potentiometer
Step 3 - Wire the potentiometer, On/Off switch, and battery pack (20 min)
Solder wires to the center and 1 side contact on the potentiometer as shown in the image. This will allow you to increase the volume when you turn the pot clockwise.
To use the On/Off switch on the potentiometer, solder the red wire from the battery pack to one of the On/Off tabs. Solder a short piece of red wire (~4”) to the other On/Off tab.

A separate On/Off switch would be wired in a similar fashion, interrupting the power from the battery. Put it in the red wire carrying 3V.

Step 4 - Solder the wires to the speaker (10 min)
Cut 8” of wire from the stereo jack cable provided with the amplifier kit. Solder to the existing tabs on the speaker. It doesn’t matter which wire goes to which contact, as long as they do not touch each other. Strip the other ends of the wire about ¼”.

Step 5 - Solder wires onto the piezo pickup (210 min)
Make connections to the piezo element using the speaker wire that came with the amplifier kit.
Solder carefully to the existing solder connections, making sure not to leave the soldering iron on the tabs for long. If the piezo came with thin wires, they can be cut off.
Step 6 – Connect all the components to the amplifier board (20 min)
Check that you have all the components ready to assemble to the board.

Connections
- Piezo element wires at INPUT (wire order does not matter)
- Switched battery power at POWER (be mindful of Red and Black)
- Speaker wires at SPEAKER (wire order does not matter)
- Potentiometer wires at R2. Not shown in image, insert from the top of the board (wire order does not matter)

To create a “strain relief” and protect the solder joints, run the wires up from the bottom of the board, through the holes as shown. (If this is not done, the circuit will still work, just make sure not to pull hard on the wires).
Step 7 – Test the circuit (10 min)
Install the batteries, plug in the speaker, and test the circuit. *Do this before you assemble the electronics to the housing.*

a) Fasten the piezo with thin tape to a vibrating surface such as a musical instrument, a cellphone, or a simple box.
b) Create a vibration but rubbing, tapping, etc. and check if sound comes from the speaker.
c) Turn the potentiometer to either side to check the volume control. To reverse the functionality of the potentiometer, switch the wire on the outside tab to the other outside tab.
d) Check that the On/Off switch works when the pot is turned fully counter-clockwise.

If the circuit does not work, go back through the steps and check if your wiring is correct.

Step 8 – Assemble electronics and housing (10 min)
Install the potentiometer in the base. Fold up the base and attach velcro fasteners as you like. Assemble the potentiometer using the nut and washer that came with it. There may be a tab to keep it from rotating – create a small cut in the sheet material for the tab. Assemble the speaker on the base using a scrap piece of sheet material. Fasten the board and/or the wires to the housing with hot glue.
To focus the sound, create a cylinder or reflector to direct the sound waves by using a paper cup or rolled paper.
<table>
<thead>
<tr>
<th>Description</th>
<th>Part #</th>
<th>URL</th>
<th>Vendor</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mono Amplifier Kit</td>
<td>2165</td>
<td><a href="https://www.kitronik.co.uk/2165-mono-amplifier-version-30.html">https://www.kitronik.co.uk/2165-mono-amplifier-version-30.html</a></td>
<td>Kitronik.uk</td>
<td>4.00</td>
</tr>
<tr>
<td>Piezo, 35 mm diameter</td>
<td>PE-63</td>
<td><a href="https://www.allelectronics.com/item/pe-63/35mm-piezo-element/1.html">https://www.allelectronics.com/item/pe-63/35mm-piezo-element/1.html</a></td>
<td>AllElectronics.com</td>
<td>0.35</td>
</tr>
<tr>
<td>Stranded hook up wire, 24 AWG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knob for potentiometer, pk of 100</td>
<td>B073BCRXZD</td>
<td><a href="https://www.amazon.com/dp/B073BCRXZD">https://www.amazon.com/dp/B073BCRXZD</a></td>
<td>Amazon.com</td>
<td>8.90</td>
</tr>
</tbody>
</table>
Housing for Amplifier with Piezo Pickup
Diane Brancacio 10/2019

scale 1" = ¼" grid