

Paper, Ink & Electronics



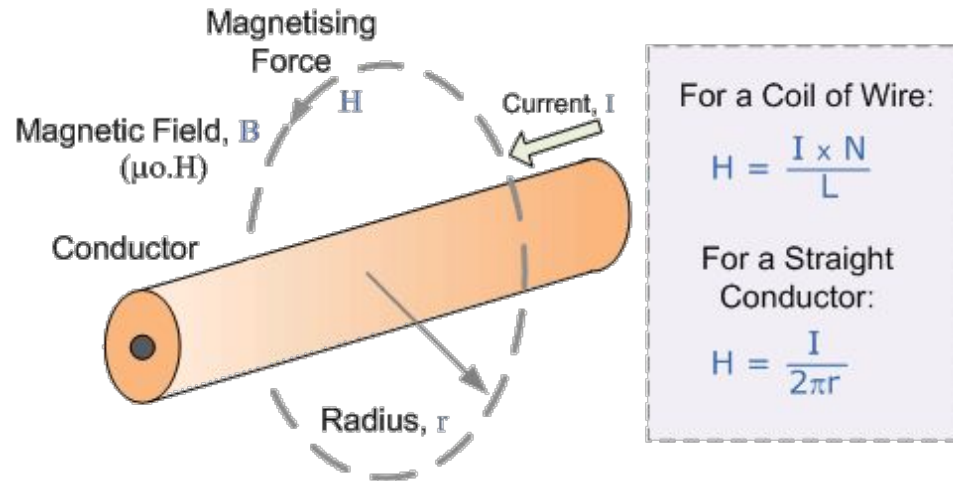
3. Printing Speakers & Microphones

Clemens Wegener

November, 29th 2021

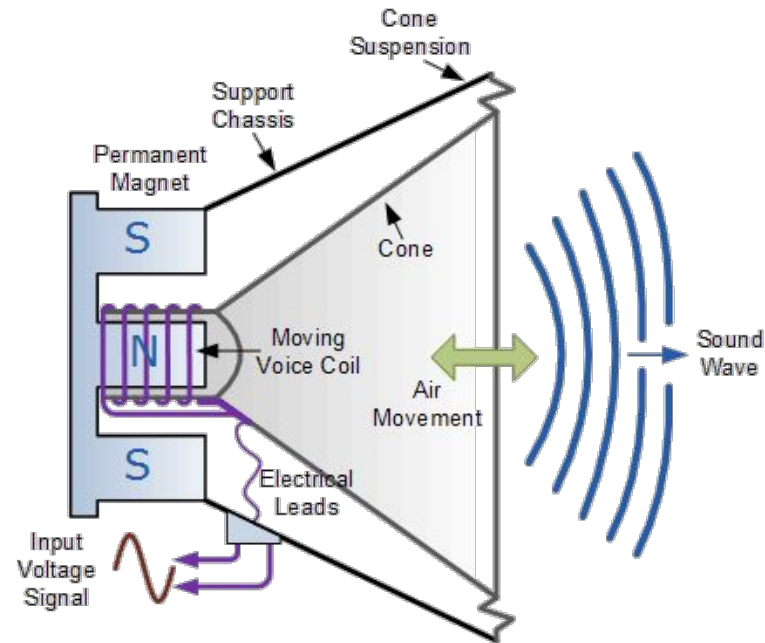
Bauhaus-Universität Weimar

Electromagnetic Force



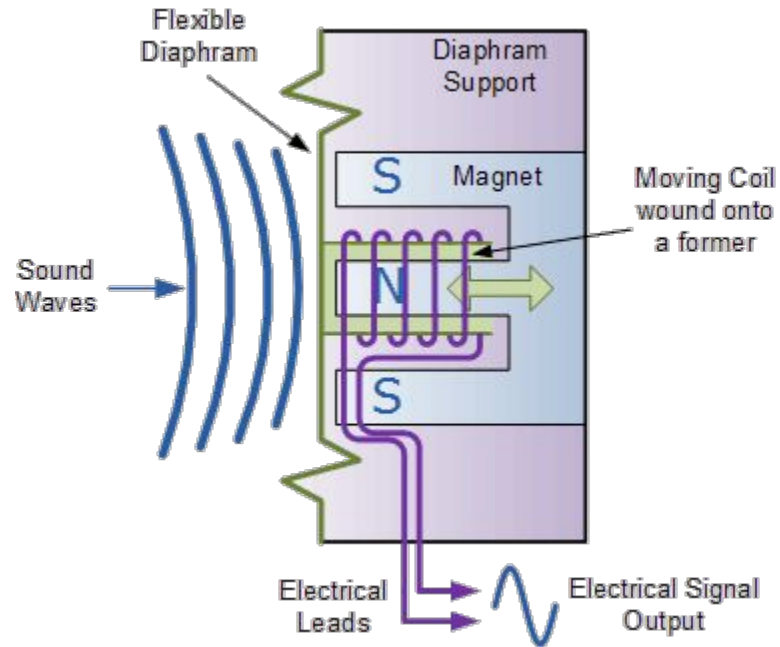
H ... Magnetic force. Source [1].

How does a speaker work?



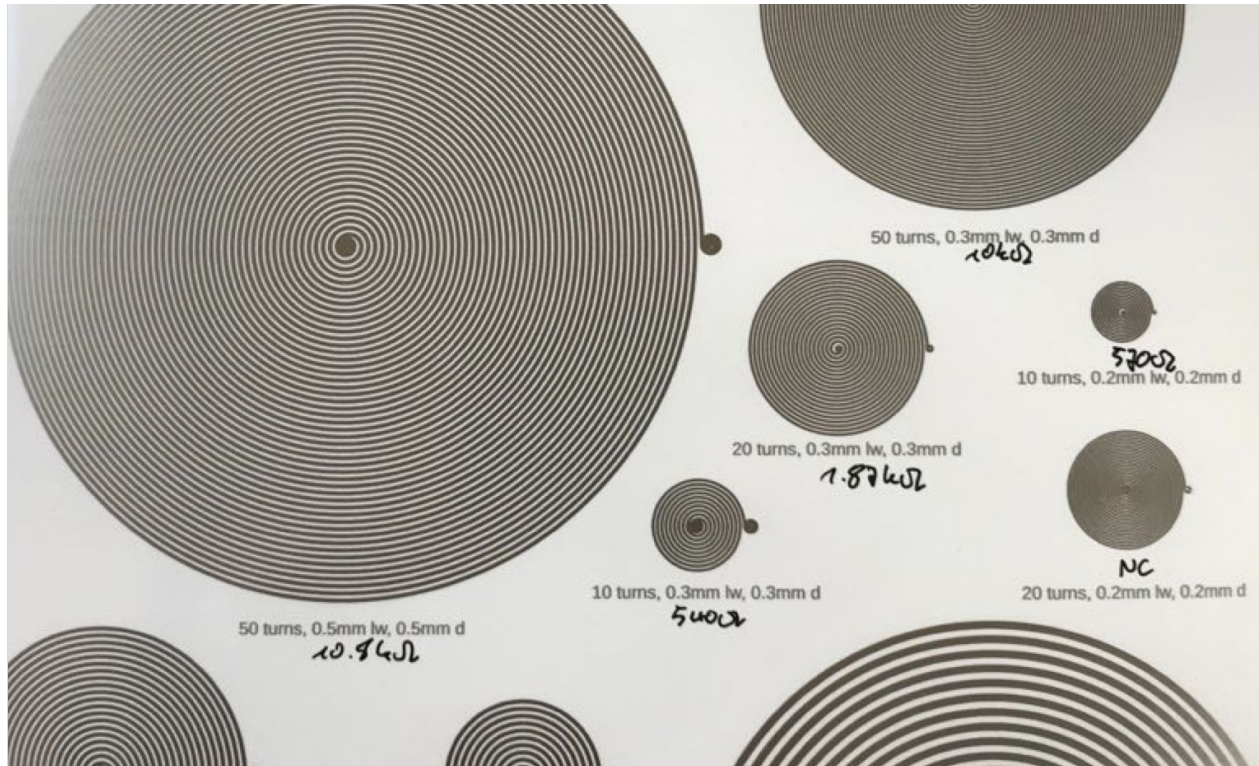
Electromagnetic speaker. Source [1].

How does a microphone work?



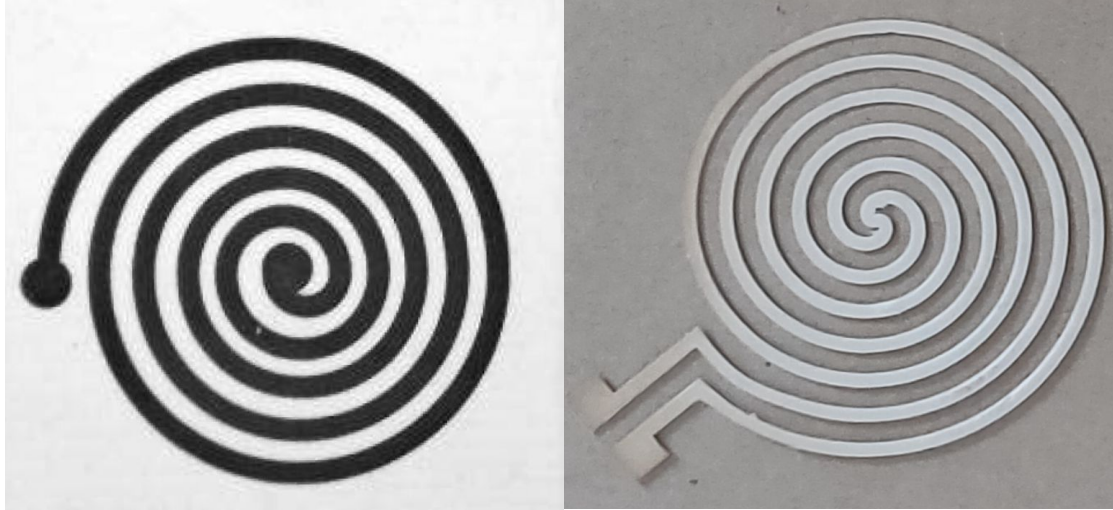
Electromagnetic microphone. Source [1].

Printing Coils



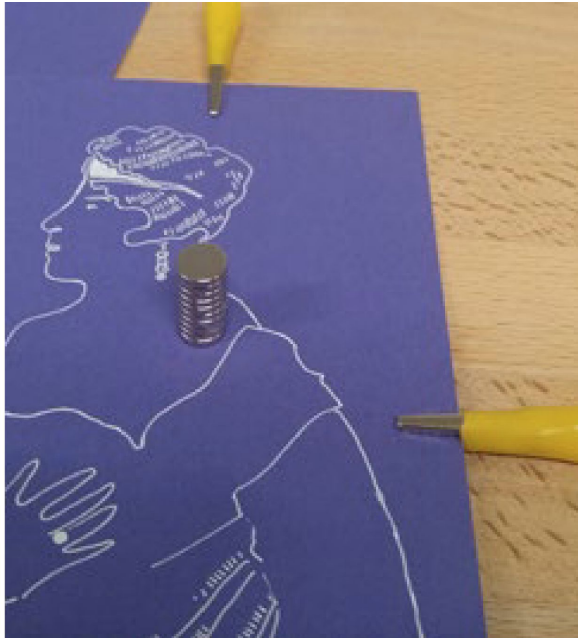
Inkjet printed coils.

Printed Coils



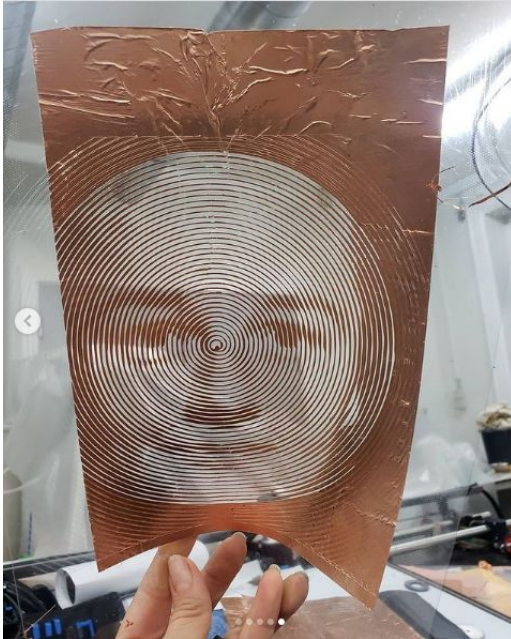
Single- and two-arm spiral. Source [2].

Printed Speaker Postcards



Elham Massoumi - Printed Speaker Postcards. Source [3].

Printed Speaker Postcards



- Copper foil cut into a custom half toning pattern with a vinyl cutter
- May also be printed
- Custom Halftone Tutorial:
<https://www.youtube.com/watch?v=CRIq4ykaJmA>

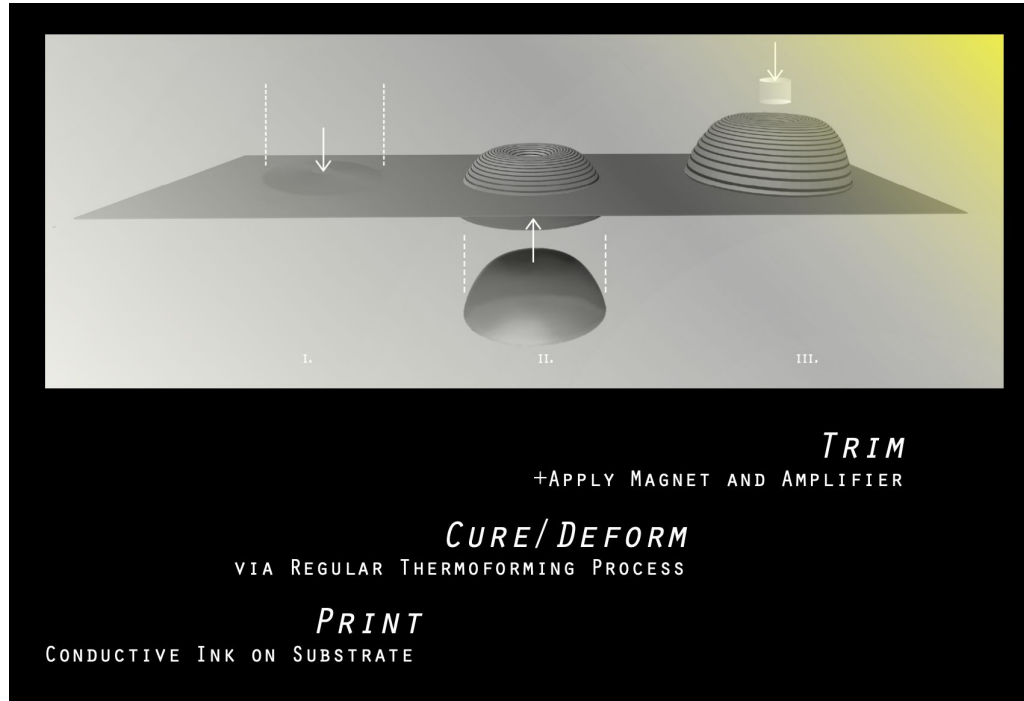
Victoria Shen. Copper foil speaker. Source [5].
<https://youtu.be/KtuaAbQYhNk>

Thermoformed printed speakers



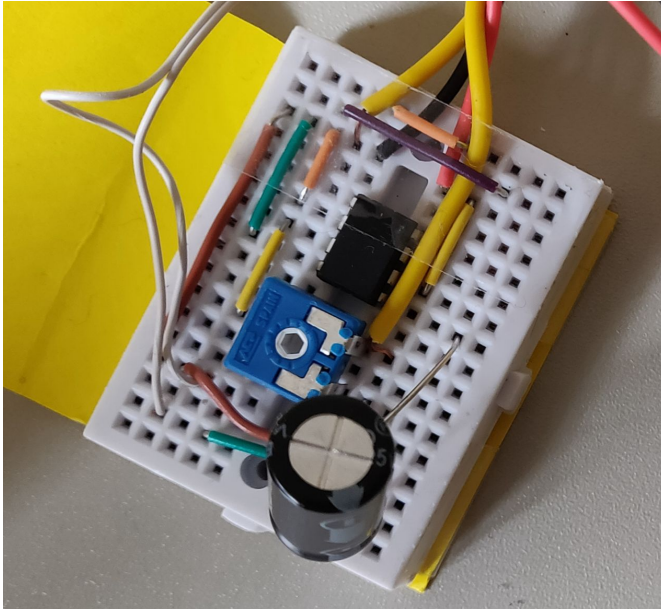
Linda Dertinger - Thermuzak speaker. Source [2].

Thermoforming process

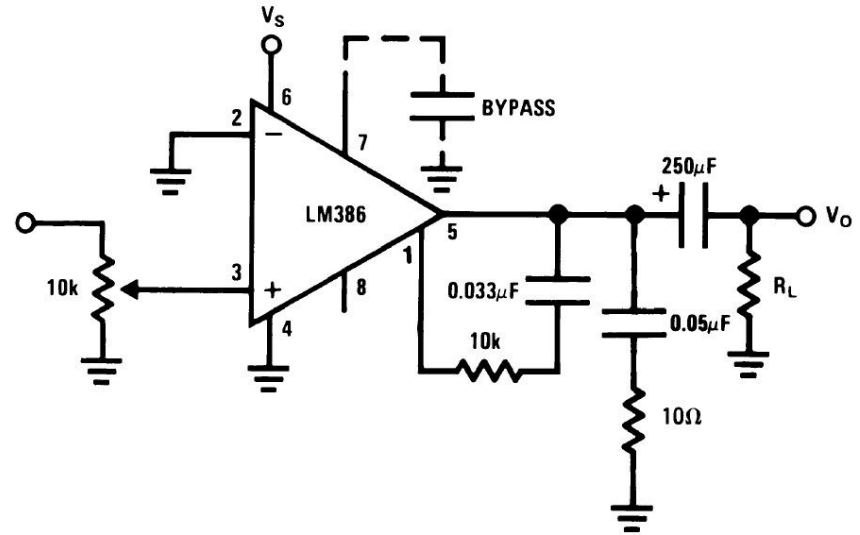


Linda Dertinger - Thermuzak speaker. Source [2].

Amplifier Circuit

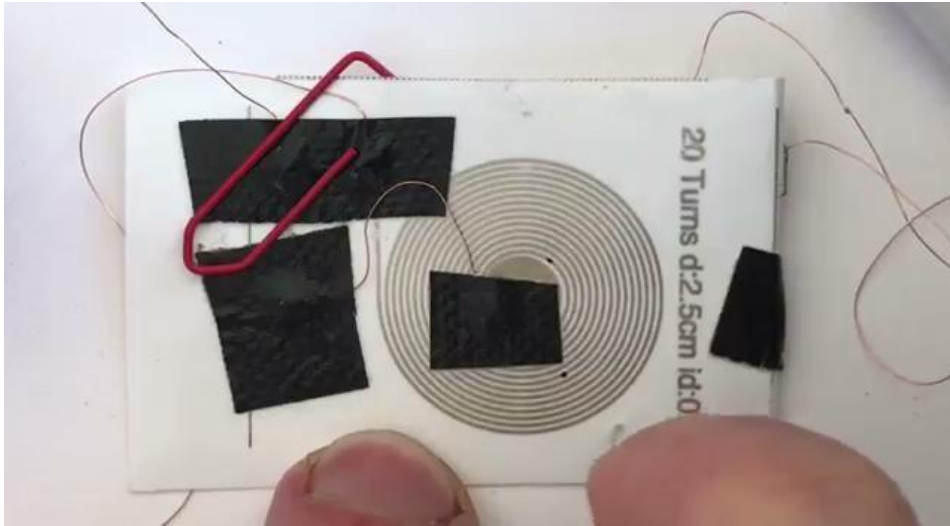


LM386 Amplifier on breadboard. Source [2].



Amplifier schematic from LM386 Datasheet.

Printed vibration sensor

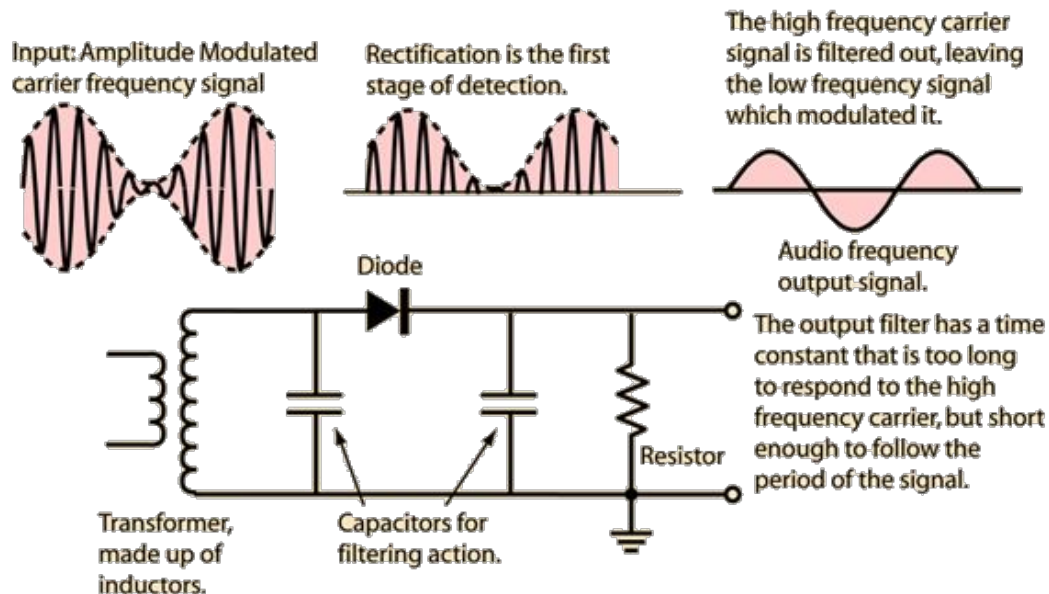


Printed transceiver type vibration sensor.

<https://youtu.be/qPUO5P3iKTs>

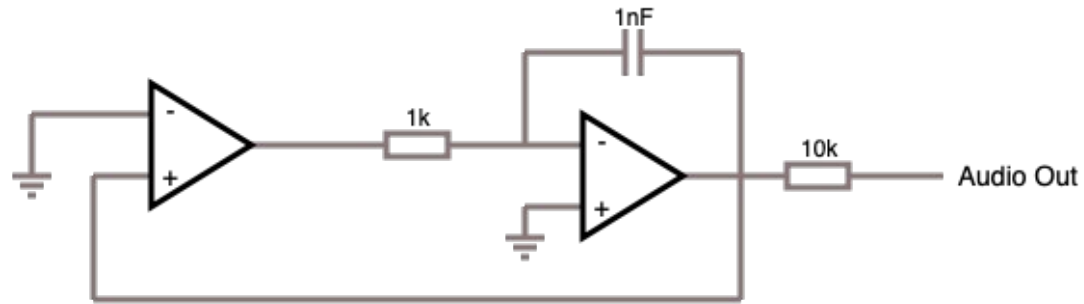
- Two silver nano ink printed coils are folded on top of each other.
- A high frequency sine wave is transmitted on the sending- and detected on the receiving coil.

Printed vibration sensor



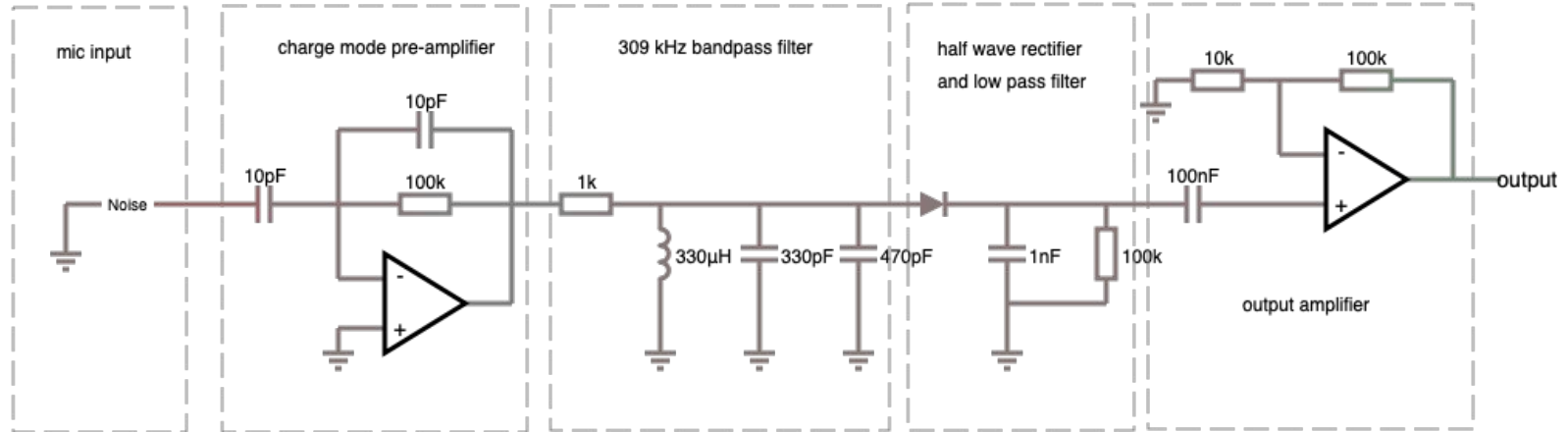
Amplitude modulation detector. Source [4].

Printed vibration sensor



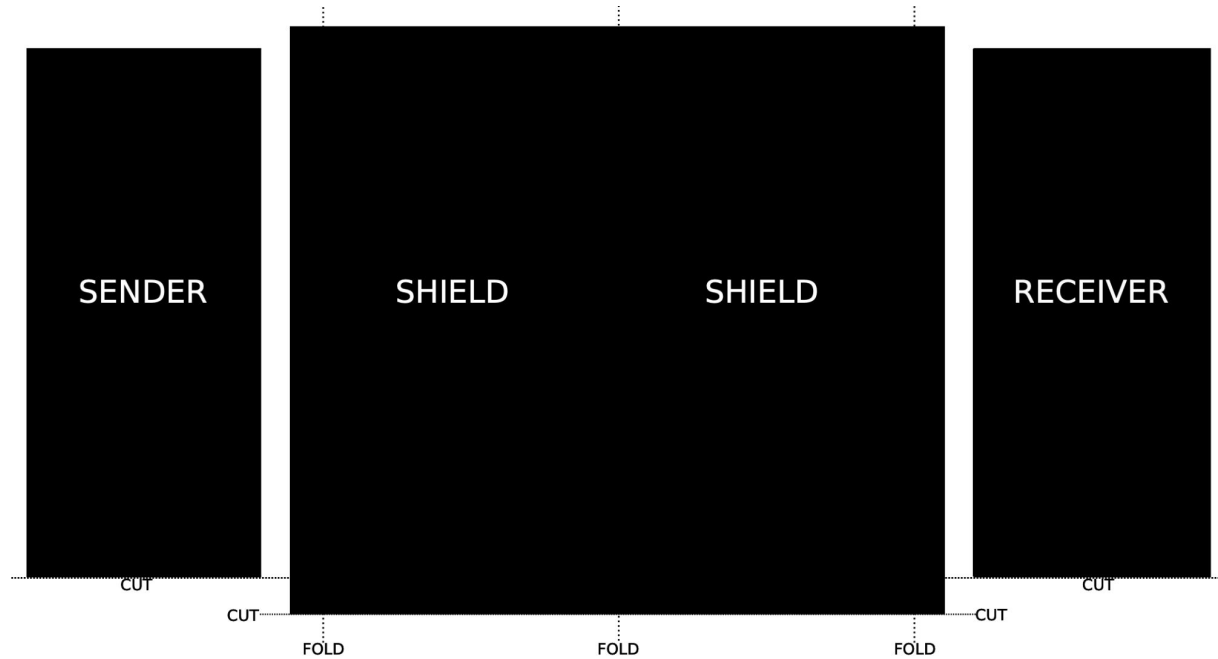
Sending Circuit (trianlge wave).

Printed vibration sensor



Receiving circuit: amplitude detector.

Printed vibration sensor



Print layout for the sensor.

Printed vibration sensor

Documentation, Breadboarding instructions and circuit simulations [here](#).

https://www.uni-weimar.de/kunst-und-gestaltung/wiki/IFD:Printing_Acoustic_Interfaces/acoustic_sensing_circuits

Syllabus (updated 27th Oct.)

- Mo, 18.10.2021 (online)
 - Meet & greet,
 - Short intro
 - Needed material
 - Mo, 25.10.2021 (online)
 - Introduction to electronics
 - Inkjet & screen printing
 - Manual circuits & Connections
 - Mo, 1.11.2021 (M7 002)
 - Workshop 1: manual circuits
 - Mo, 8.11.2021 (M7 002)
 - Workshop 2: inkjet printing
 - Mo, 15.11.2021 (M7 002)
 - Workshop 3: screen printing
 - Mo, 22.11.2021 (online)
 - Arduino programming & libraries
 - Mo, 29.11.2021 (online)
 - circuits for speakers and microphones
 - Mo, 6.12.2021 (online)
 - Project proposals & inspiration sessions
 - **Mo, 13.12.2021 (M7 002)**
 - **Presentation of project ideas**
- Christmas Break! --
- 3.1.2022 - 7.2.2022 Workshop Sessions
 - **Mo, 14.2.2022 Final Presentations**
 - **Mo, 28.3.2022 Hand in documentation**

Sources

[1] https://www.electronics-tutorials.ws/io/io_8.html access Nov. 28, 2021.

[2] Dertinger, Linda (2019). *Speaker Thermuzak*. Projekt Report: Interface Design Master Class 2018/2019, Bauhaus-Universität Weimar.

[3] Wittig, Florian (2018). *Printed Electronics at Bauhaus-Universität Weimar*. Course Report: Interface Design 2016/2017.

[4] <http://hyperphysics.phy-astr.gsu.edu/hbase/Electronic/amfmdet.html>, access Nov. 28, 2021.

[5] Victoria Shen, <https://www.instagram.com/p/B5h6LMaFAnB/>, access 2021-10-17.