Graphone

Electrical/Computer Engineer
Harrell Tollentino
Sheriff Adewumi
Rodney Edge

Mechanical Engineer
Ayush Giri
Fikunwa Kolawole

Advisor
Hyung Bae

Background

The condenser microphone is a device that converts sound waves into electrical signal. The way this is achieved is using capacitance between a backplate and a diaphragm when the diaphragm oscillates due to sound waves. However, the signal that is created is very miniscule, hence requiring the help of a preamplifier to convert it to a usable form. To power the preamplifier, an external voltage source is needed. It is noted that a condenser microphone generally offers a better sound quality than a dynamic microphone due to its lower mass diaphragm. In addition, condenser microphones have a wider range of frequency, a lower noise ratio, and a higher sensitivity.

The “graphone” is an alternative design of a condenser microphone that uses graphene for its diaphragm. Due to its nature, graphene offers a more flexible component which can withstand more intense sound waves without tearing. As such, “graphone” can offer a smaller microphone but with the same sensitivity. A custom PCB is required to establish the foundation of the device and connect it to a preamplifier and other connections.

Problem Statement

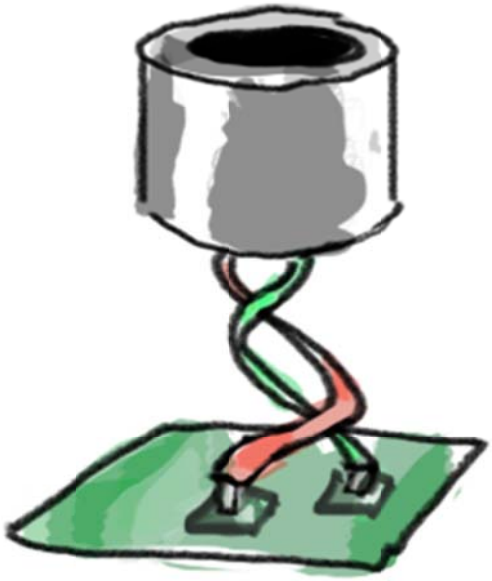
Today's microphones are limited in their material designs. Graphone provides a robust design that can tolerate sound waves more than its standard microphone counterpart. Graphene bolstered by polymer provides a flexible component that provides more elasticity as a diaphragm. In addition, the graphone is generally much smaller but still provides the same sensitivity. However, in trying to achieve this, there are requirements that we must consider:

- Need a customized PCB to calculate the capacitance resolution
- The PCB must fit the customized model provided by the specifications
- Must be able to interface with software to perform calculation of voltage and capacitance

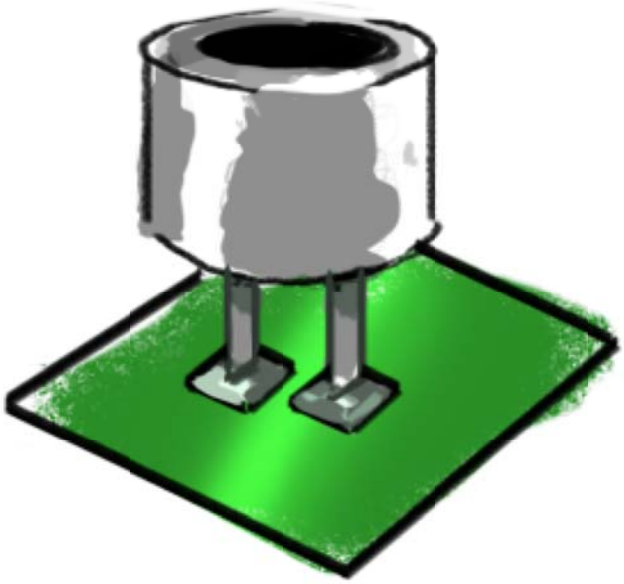
There are also constraints we must consider, with the largest one being that graphene is more expensive to harvest and produce than it's standard counterparts in other microphones.

Top 3 Designs (Top 2 highlighted in BLUE)

Design 1

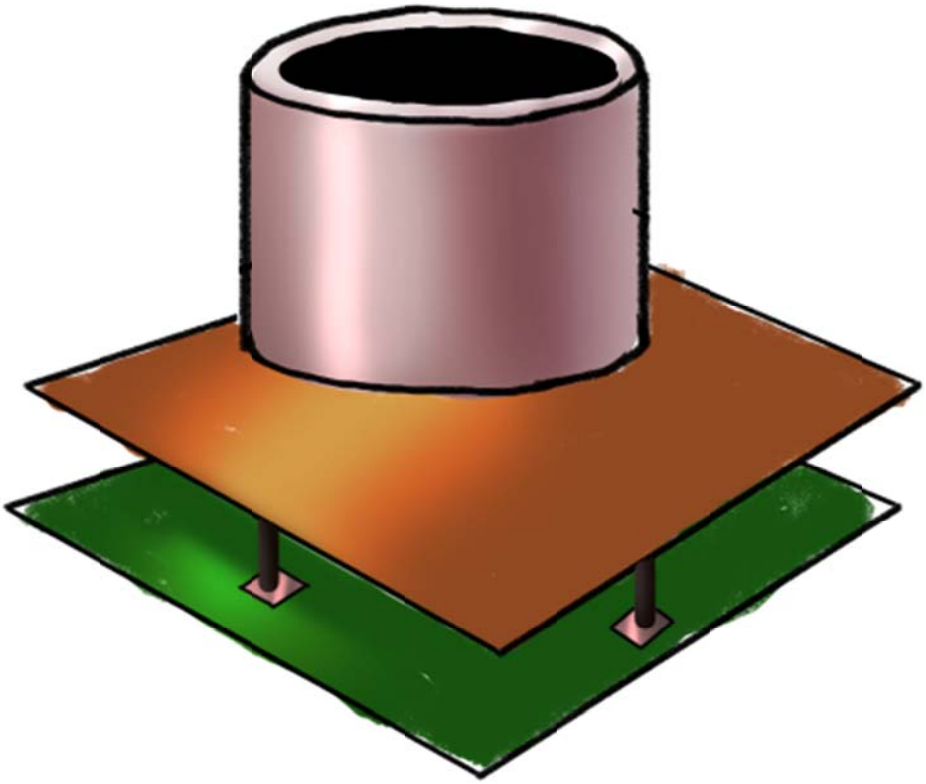


Design 2



Design 3

Final Design



Top 2 Design Pros and Cons

Design 2

Pros	Cons
2 prong connector to PCB gives more reliable connection	Increased distance from PCB introduces signal distortion
PCB backplate can be a different material from PCB board	Less space on PCB due to custom prong connectors
Requires a lighter diaphragm which reduces weight of microphone	Elevated diaphragm requires a strong mount, diaphragm could be susceptible to physical stimuli

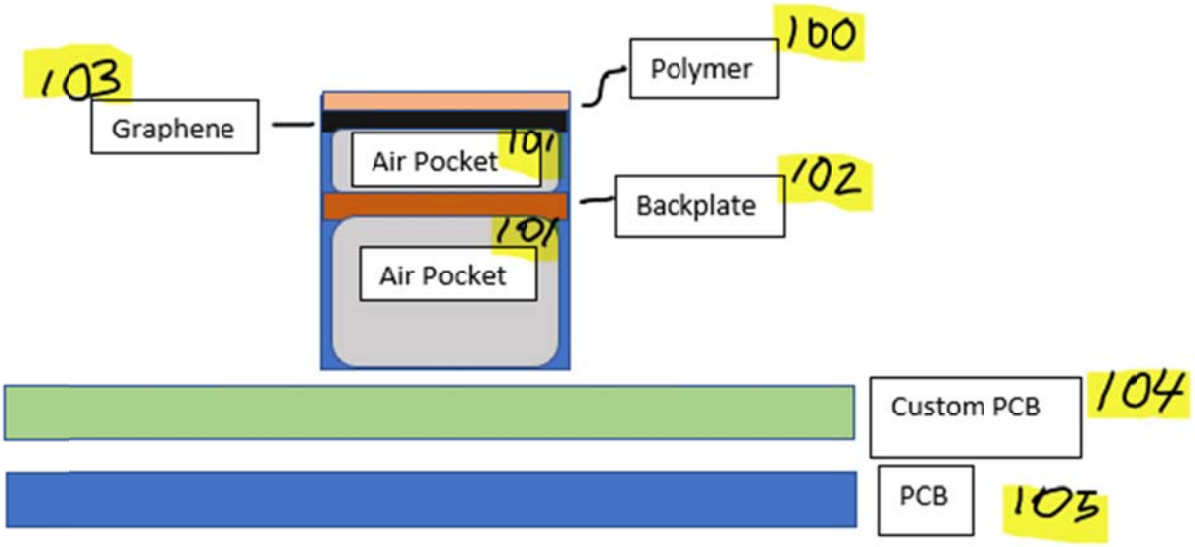
Design 3

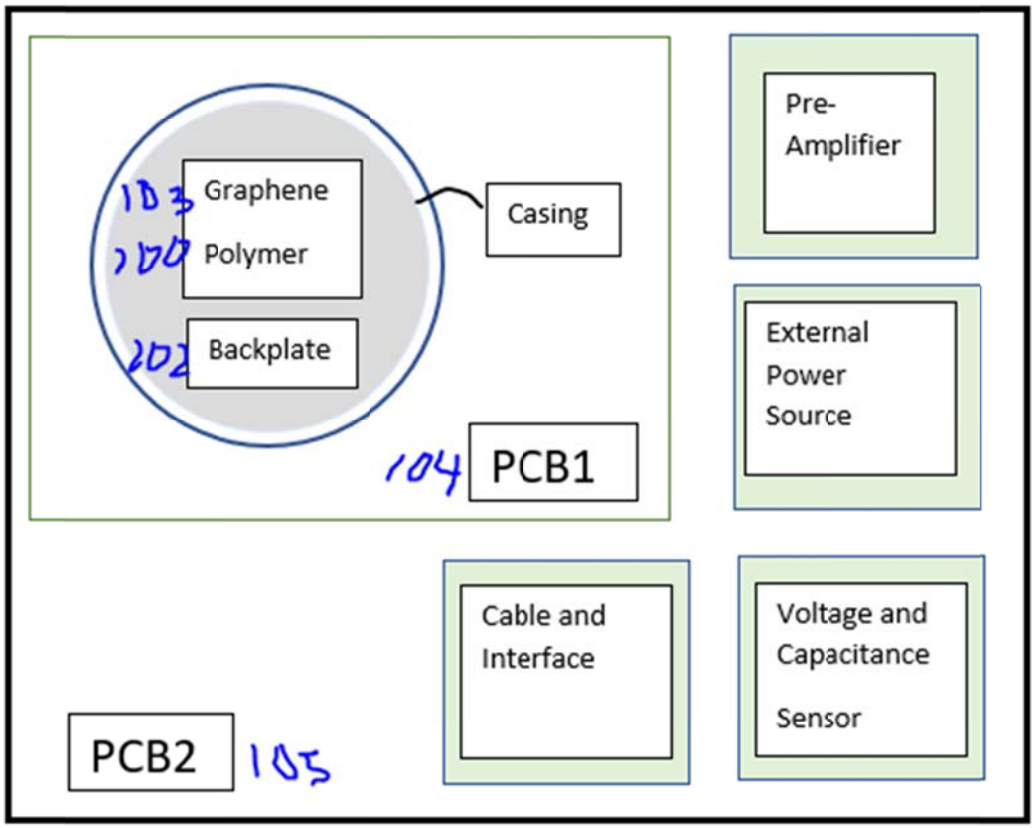
Pros	Cons
Built in diaphragm increases available space on PCB	Limited mobility of design
More resistance to physical stimuli along with less weight	More expensive to implement
Less distortion of signal from diaphragm to PCB	Requires diaphragm backplate to be the same as PCB material

Top 2 Design Matrix

	Weight	Design 1	Score	Agg. Score	Design 2	Score	Agg. Score
Weight	3	Approx. 0.15g	4	12	Approx. 0.04g	5	15
Stability	5	Diaphragm supported by two prongs	3	15	Diaphragm built in to PCB	5	25
Connectivity	4	Prongs deliver reliable connection	5	20	No dedicated connector channels	2	8
Signal Quality	5	More signal distortion	3	15	Less signal distortion	5	25
Cost	4	Less expensive to produce	2	8	More expensive to produce	0	0
TOTAL				**70**			**73**

Schematic





Solution Design Description

The diaphragm is consisted of a one-part polymer sheet **100** and one-part sheet of graphene **103**. The graphene provides a robust diaphragm that is more flexible than a standard diaphragm. The polymer provides further elasticity and durability to the graphene sheet. The backplate **102** is stationed to realize the capacitance. The spacing between the backplate and diaphragm is carefully measured in relation to commercially available condenser microphones. Furthermore, the air pocket **101** provides the final component for solving capacitance with the permittivity of 8.85×10^{12} . The custom PCB **104** is the bridge between the microphone itself and the PCB **105**. The PCB includes both the preamplifier and capacitance/voltage measurements.