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DIY Construction of a First-Order Ambisonic Microphone

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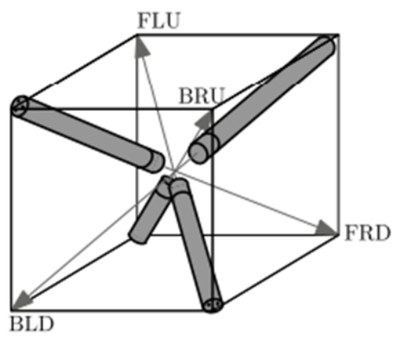
This project presents the design and construction of a DIY first-order ambisonic microphone intended for spatial audio recording in immersive applications such as virtual reality, 3D sound installations, and experimental music production. The microphone is based on four high-sensitivity TSB-2555 electret capsules arranged in a regular tetrahedral configuration to capture the full-sphere sound field in Ambisonic A format.

To ensure low noise and consistent gain across channels, each capsule is connected to a dedicated preamplifier built using the OPA1642 operational amplifier, known for its low distortion, high dynamic range, and low input-referred noise. The amplifier topology is based on the "Alice" design, a proven circuit used in the ambisonics DIY community for its simplicity and performance.

The enclosure was custom-designed and 3D printed to ensure acoustic transparency, physical symmetry, and mechanical stability. The housing provides precise positioning of the capsules and includes basic shielding from electromagnetic interference.

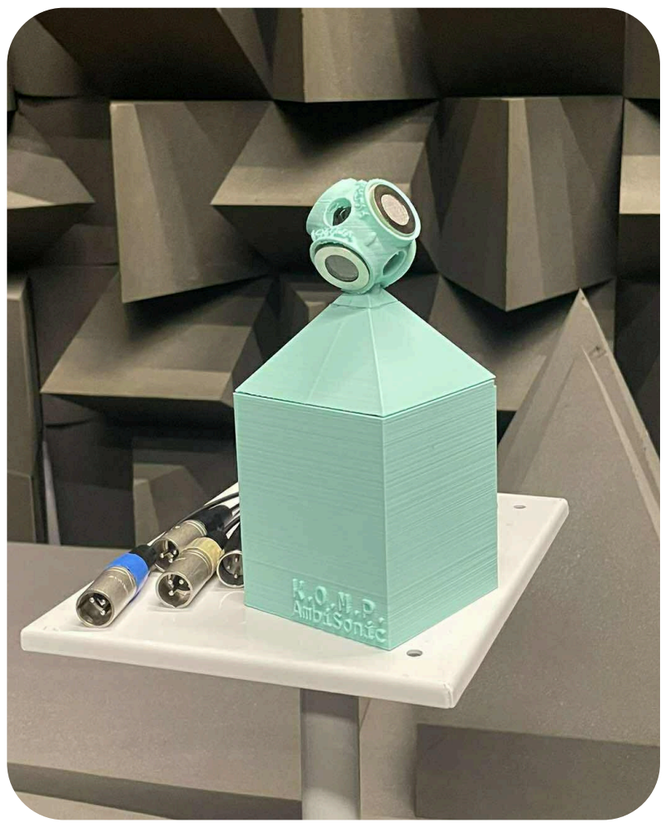


Tetrahedral Configuration & Capsules

The microphone uses four VAMISOUND TSB-2555 electret capsules, known for their cardioid pattern, high sensitivity (−42 dB), and low self-noise.
Capsules are arranged on the faces of a regular tetrahedron to capture a 3D sound field and derive the Ambisonic W, X, Y, and Z signals.
Accurate physical placement ensures spatial coherence and minimizes phase mismatch between channels. This arrangement follows the principles of first-order ambisonics, where sound from three directions is combined with an omnidirectional signal.

Electronics & Amplifier Design

Early tests with off-the-shelf electret preamps revealed high noise and poor signal quality due to incompatibility with JFET-less capsules.
A custom amplifier based on the “Alice” topology was adopted, featuring OPA1642 low-noise op-amps, phantom power support (48V), and differential outputs.
The final preamp modules were selected for their clean gain structure and compact size, suitable for integration into the 3D-printed enclosure.



Enclosure Design

The mechanical enclosure plays a crucial role in precise capsule placement, electromagnetic shielding, and practical field use. Our first prototype was modeled in Autodesk Fusion 360 and 3D printed in PLA. Key design features include:

- tetrahedral capsule mounts for accurate spatial arrangement
- internal routing channels for shielded audio wiring
- dedicated space for four individual preamplifier modules and XLR connectors

This custom enclosure ensures physical symmetry and mechanical stability, supporting reliable multichannel spatial audio capture.

Key development stages included component selection, choosing a suitable designed PCB for the amplifier modules, gain matching, and noise optimization. Troubleshooting focused on minimizing self-noise, ensuring balanced channel response, and avoiding ground loop issues. Simulations and measurement tests are planned for the next phase of development.

Assembly of the microphone has already been completed. Calibration and initial test recordings are scheduled for late May 2025. These tests will focus on verifying channel alignment, frequency response consistency, and spatial accuracy of the recorded sound field. Further evaluation will involve Ambisonic decoding and playback using standard software tools such as Reaper and AmbiX.
If you want to find out more about the project, scan the QR code to access the full manuscript.

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