



Introduction

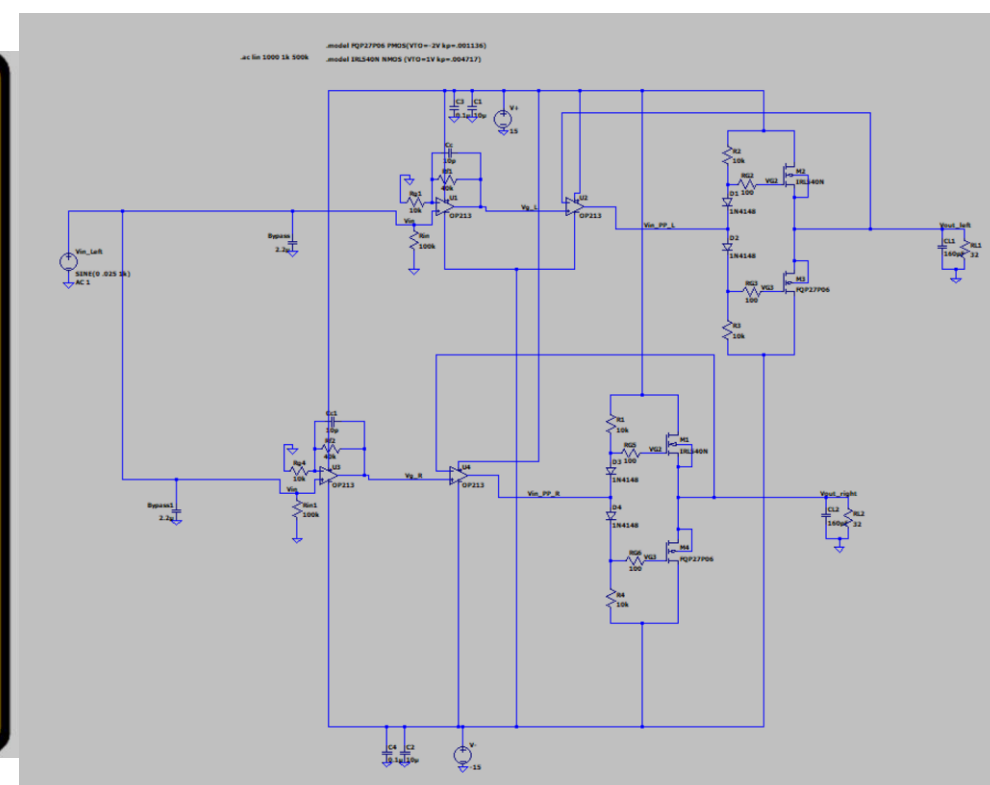
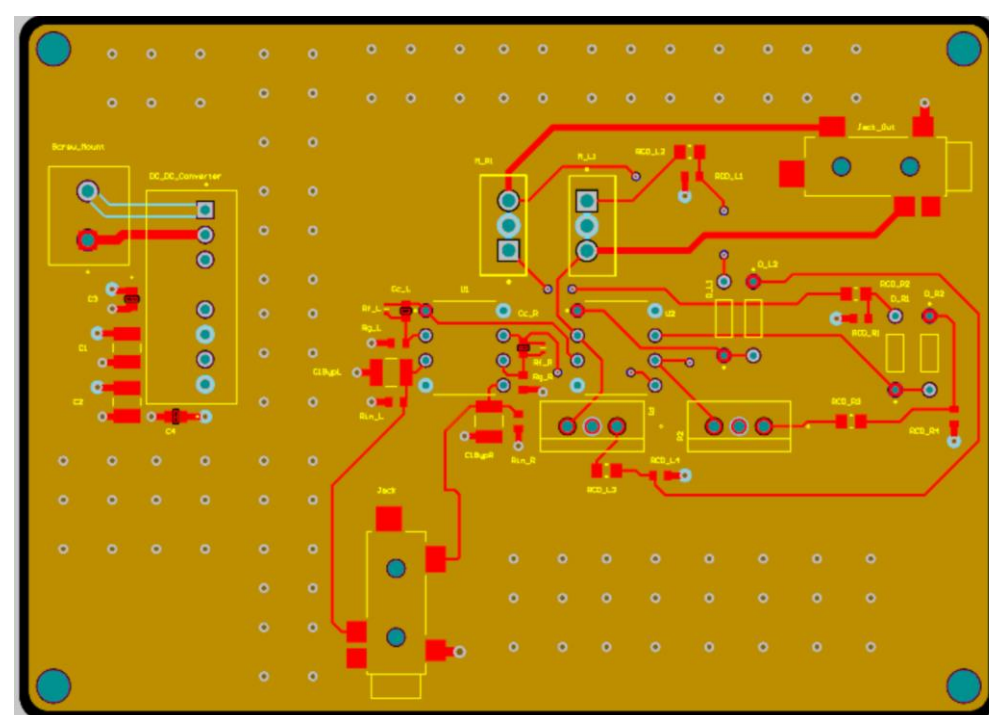
- Background noise is distracting and can reduce audio clarity
- Many existing headphones lack noise cancellation and require amplification
- An external system that provides audio amplification and noise cancelling capabilities is not on the market

Objective

Design and implement a standalone ANC and audio-amplification device compatible with any wired headphones for stationary use.

Analog Audio Amplifier

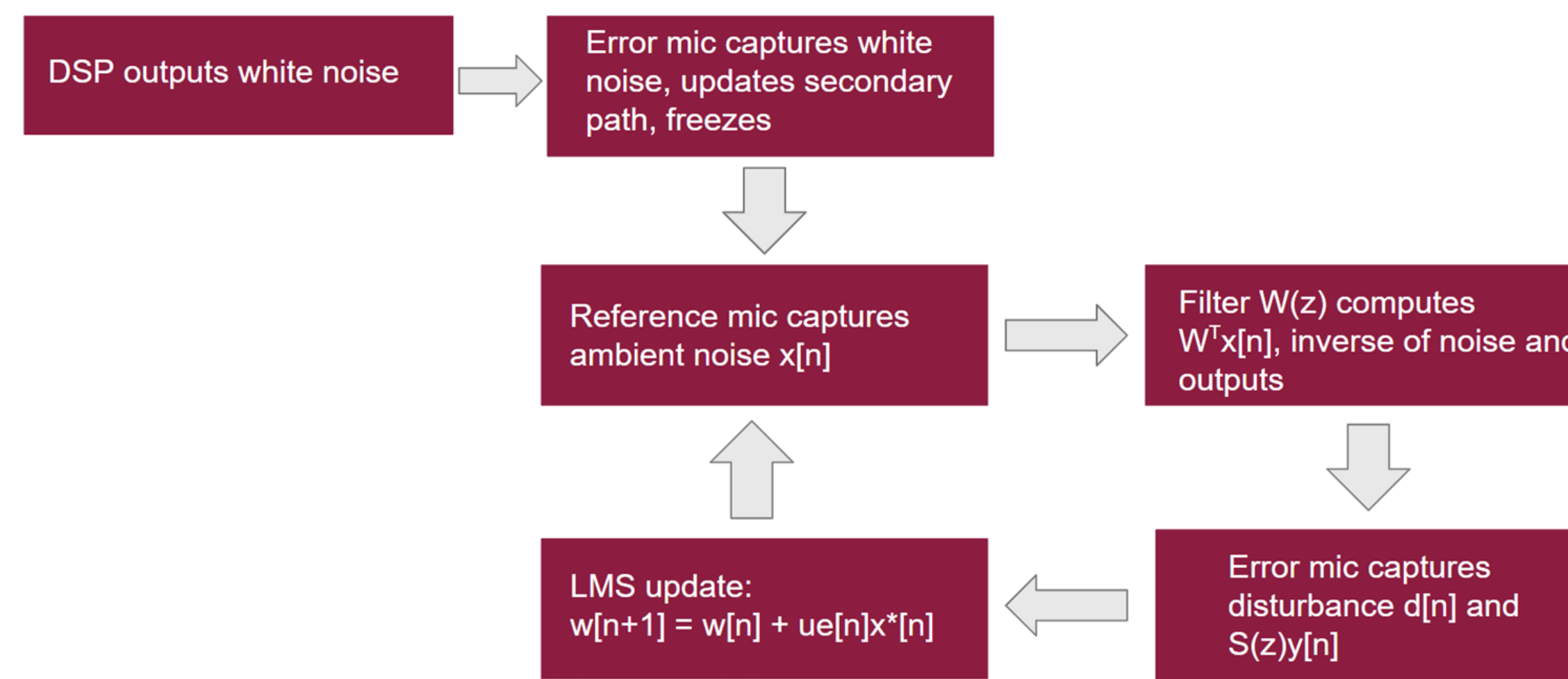
- **Architecture:** Three-stage stereo amplifier (gain stage, buffer stage, Class-AB output stage) driving standard 3.5 mm headphone loads with low distortion from ± 15 V rails.
- **Design targets:** Low-frequency gain ≈ 5 V/V (~ 14 dB), 3 dB bandwidth > 200 kHz, unity-gain frequency > 1 MHz, and phase margin $\approx 60^\circ$ for stable operation.
- **Implementation:** Designed and simulated in LTspice, then implemented as a four-layer PCB in Altium Designer with a dedicated ground plane for reduced noise, short feedback loops to preserve phase margin, and component placement optimized for thermal dissipation and routing.



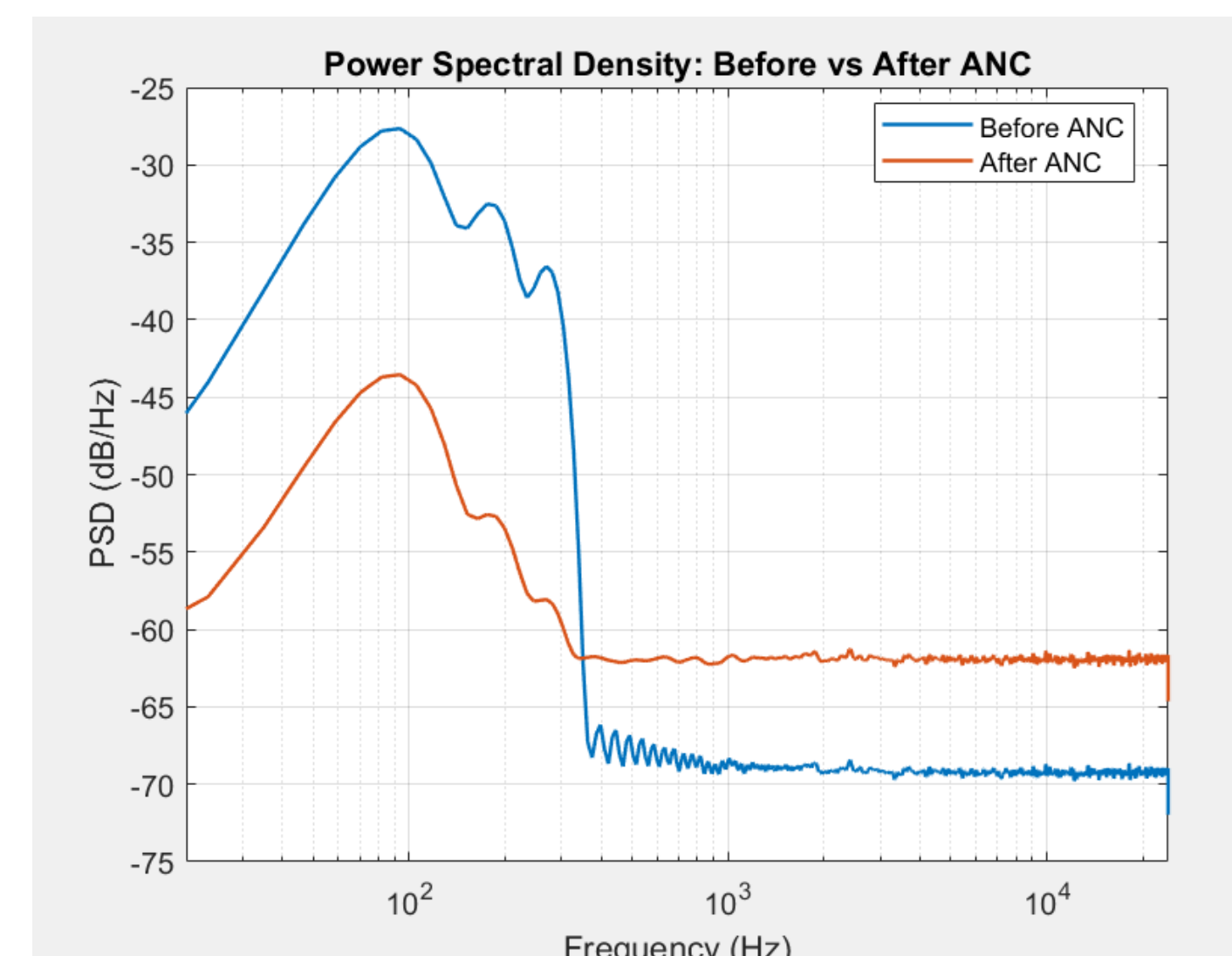
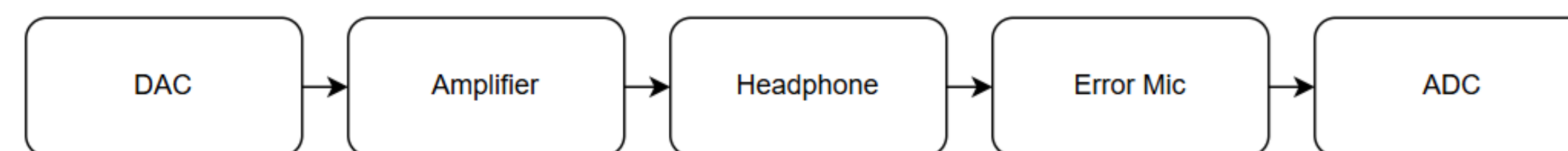
What is Active Noise Cancellation (ANC)?

- Microphones are used to sense noise in the environment and near the listener's ear.
- An "anti-noise" signal that is the inverse of the disturbance is generated
- When added to the incoming sound, the anti-noise reduces the perceived noise at the ear.

Algorithm Signal Flow



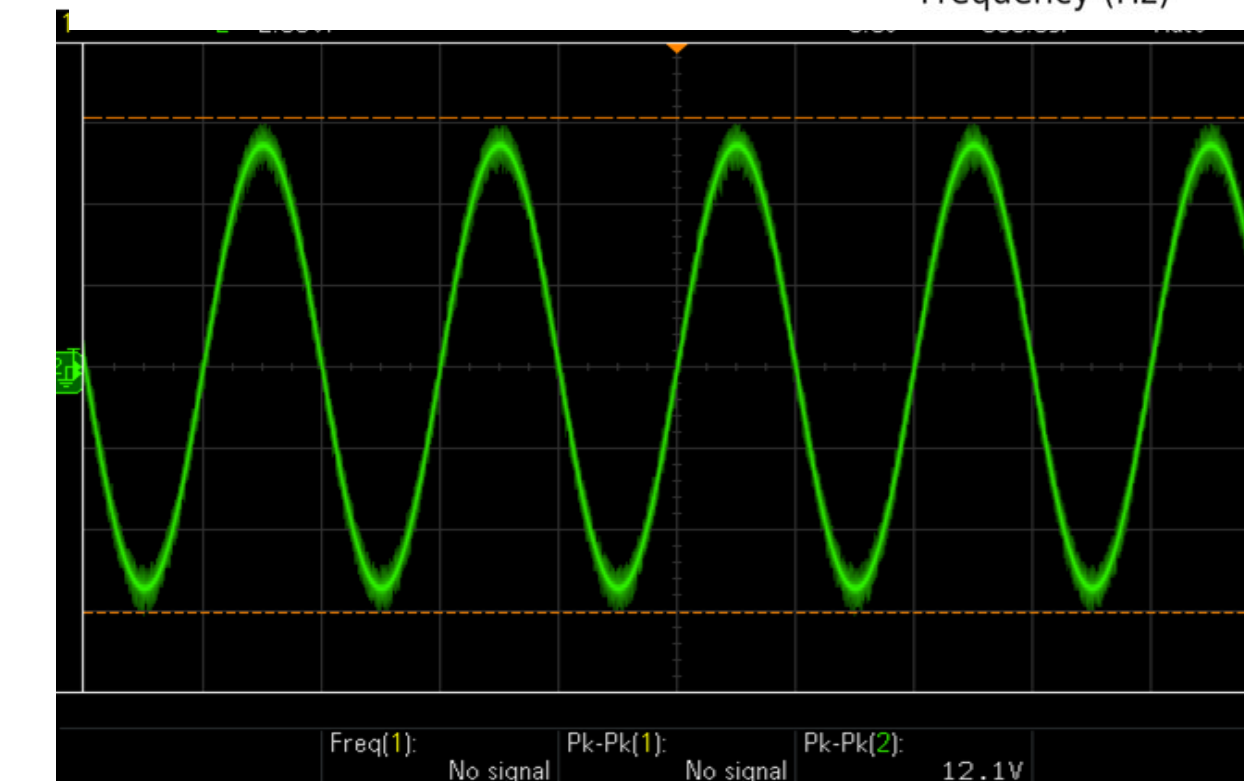
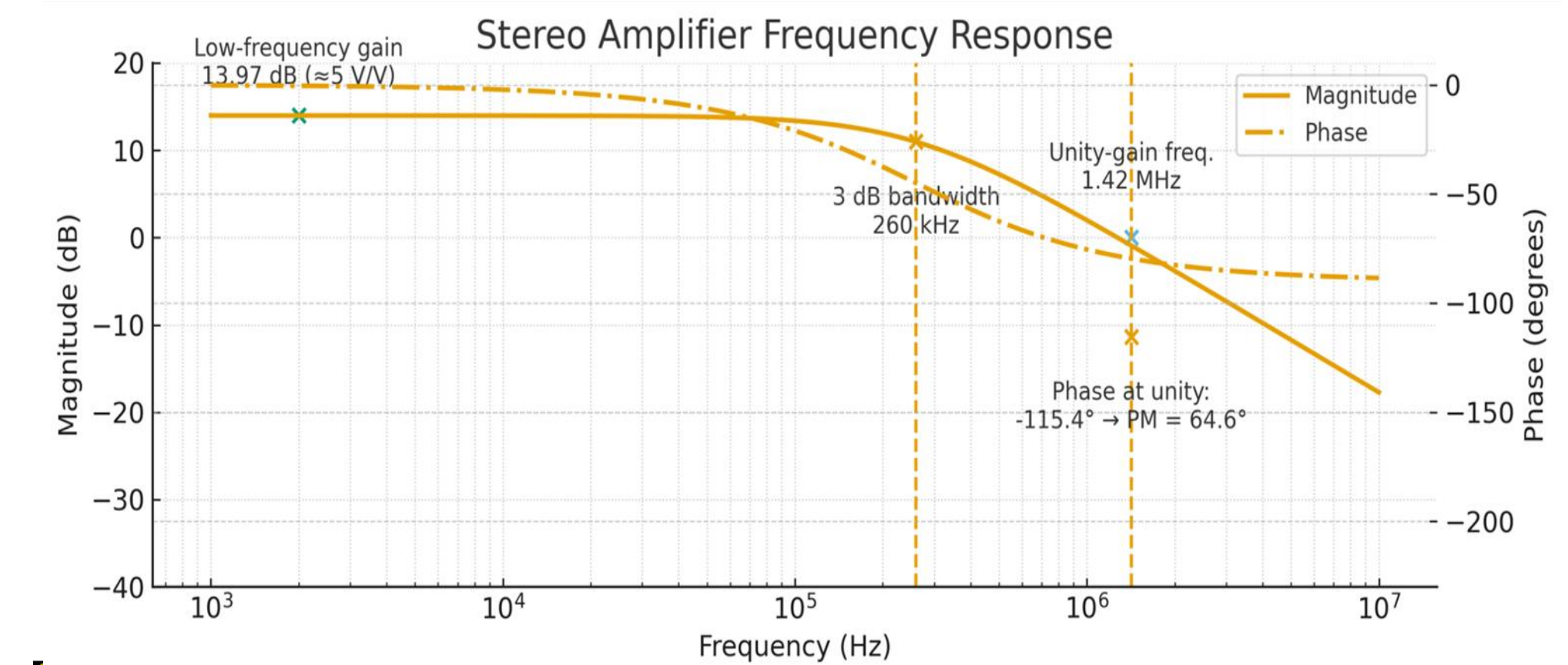
Secondary Path



- Simulation in Matlab shows theoretical effectiveness
- Effective in frequencies lower than 300 Hz
- Higher frequencies are more prone to errors in delay

Amplifier Results

- **AC (simulation):** 13.97 dB (5 V/V) low-frequency gain; 3 dB bandwidth ≈ 260 kHz; unity-gain ≈ 1.42 MHz with 64.6° phase margin (robustly stable).
- **Hardware:** 4-layer PCB meets expected gain; headphone output is clear with strong volume and low noise; bandwidth is currently narrower than the full audio band due to an unexpected dominant pole, so future work targets extending the bandwidth.



Conclusion

- Demonstrated basic ANC and amplification functionality.
- Limited performance due to budget and experience constraints.
- Wide-spectrum ANC would require more advanced hardware and development time.
- Key takeaway: importance of realistic design goals and iterative improvement.