TECHNICAL DOSSIER // ACOUSTIC ENGINEERING & TRANSDUCER PHYSICS

Transducer Electrodynamics: Planar Isodynamic vs. Dynamic Cone

Lorentz Motor Symmetry, Modal Diaphragm Deformation, and Acoustic Phase Coherence

Published: October 30, 2026 | Distribution: Open Engineering Community | Document ID: LT-2026-B16-06

EXECUTIVE SUMMARY & MICROARCHITECTURAL SCOPE

The battle between planar magnetic and moving-coil dynamic headphone transducers represents fundamental differences in electrodynamic motor physics. Dynamic drivers rely on a centralized voice coil driving a conical dome diaphragm, inherently suffering from modal breakup distortion and acoustic phase smearing at high excursions. Planar magnetic drivers distribute an etched voice coil across an ultra-thin polymer membrane suspended between opposing neodymium bar magnets, delivering flat resistive loads, sub-0.05% THD, and planar acoustic wavefronts.

Acoustic Metric	Standard Dynamic (40mm)	Biocellulose Dynamic (50mm)	Planar Magnetic (80mm)	Flagship Planar (100mm)
Diaphragm Thickness	25 - 40 um	15 - 25 um	1.5 - 2.5 um	0.5 - 1.2 um (Sub-Micron)
Motor Topology	Concentric Voice Coil	Concentric Voice Coil	Opposing Push-Pull Bars	Single-Sided Fluxor Array
Force Distribution	Center Point Drive	Center Point Drive	Uniform Isodynamic Sheet	Uniform Isodynamic Sheet
Breakup Frequency	3.5 kHz - 5 kHz	6 kHz - 8 kHz	> 20 kHz (Piston Range)	> 35 kHz (Ultrasonic)
THD at 100 dB SPL	0.8% - 2.5%	0.4% - 1.2%	< 0.08%	< 0.02%
Impedance Characteristic	Inductive Peak at Resonance	Inductive Peak	Purely Flat Resistive	Purely Flat Resistive

1. Transducer Motor Physics & Force Distribution

Dynamic headphones utilize a circular copper or aluminum voice coil glued to the apex of a conical dome suspended in a circular magnetic gap. Force is applied exclusively at the perimeter of the coil. In planar magnetic transducers, an electrical conductor trace is photolithographically etched across the entire surface of an ultra-thin polymer membrane (Kapton/Mylar). When audio signal current flows through the serpentine trace, the Lorentz force F = I x B is distributed uniformly across the entire diaphragm.

2. Diaphragm Mass, Inertia, and Modal Breakup

A moving-coil dynamic cone has significant structural mass (tens of milligrams) required to prevent structural collapse under excursion. At high frequencies, different portions of the cone flex out of phase—a phenomenon known as modal breakup—producing severe distortion and frequency response jaggedness. Planar membranes weigh a fraction of a milligram, behaving as pure acoustic pistons across the entire audible spectrum.

3. Phase Linearity and Wavefront Geometry

Because planar drivers radiate acoustic energy uniformly across a large surface area (typically 70mm to 100mm in diameter), they generate a planar acoustic wavefront that mimics natural sound waves in open space. Dynamic drivers act as spherical point sources, interacting with the listener's outer ear (pinna) and ear canal with localized phase anomalies and comb filtering.

4. Electrical Impedance and Amplifier Driving Requirements

Dynamic drivers exhibit significant voice coil inductance, resulting in rising impedance curves at high frequencies and a massive reactive impedance spike at mechanical resonance (Fs). Planar magnetic drivers contain virtually zero inductance, presenting an almost purely resistive load across the audio band. However, due to lower electrical efficiency, planar headphones demand dedicated amplifiers with high current delivery capabilities.

STRATEGIC ENGINEERING TAKEAWAYS & DEPLOYMENT CHECKLIST

- **Isodynamic Lorentz Drive:** Uniform force distribution eliminates localized stress concentrations and cone breakup.
- **Sub-Micron Diaphragm Thickness:** Near-zero moving mass delivers instantaneous impulse attack and sub-0.05% THD.
- **Planar Wavefront Radiation:** Delivers authentic spatial acoustic imaging and phase-coherent pinna interaction.
- **Purely Resistive Impedance:** Presents zero reactive phase shift, requiring amplifiers with high linear current output.