PUIaudio

TECHNICAL WHITEPAPER

Audio and Haptics as Exciters

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New Product Annoucement: Audio & Haptics

PUI Audio is excited to launch its latest Exciter technology. This solution combines regular sound playback(audio) with physical vibrations (haptics). Instead of using a traditional speaker that pushes air, an exciter vibrates the surface it is attached to. This turns everyday materials and display screens into invisible speakers that you can both hear and feel.

Whether you are looking for bone conduction capabilities or compact solutions for integrated displays, our new featured exciters offer high-performance specifications in a variety of small form factors.

Featured Exciter Solutions

Part Number	LxWxH (mm)	Impedance (Ohms)	Power (Watts)	Resonant Frequency (Hz)	SPL (1W @1m)	Features
ASX02208	21.6 x 14.5 x7.9	8	3	950	95	Bone Conduction delivers sound without blocking the ears
ASX02404	25.4X12.7x 6.4	4	0.25	480	78	Unique Suspension Pre-applied 3M adhesive 9mm voice coil
ASX03504	38.5x18.5x8.0	4	1.5	370	83	Unique Suspension Pre-applied 3M adhesive 13mm voice coil

The new exciter design is a significant step change for compact audio and haptics integration. By focusing on magnetic efficiency and suspension travel, it effectively bypasses the usual trade-offs found in miniature transducers.

Key Design Elements:

High-Efficiency Magnetic Circuit

The use of a neodymium magnet is the foundation behind this performance. Because neodymium provides a much stronger magnetic field than traditional ferrite magnets of the same mass, it maximizes the magnetic flux interacting with the voice coil.

- **Increased Sensitivity:** Higher sensitivity means the exciter converts electrical energy into mechanical movement more effectively.
- **Low Power Requirements:** Because it is so efficient, you don't need a high-wattage power stage to achieve audible volume, allowing for much smaller, cooler-running amplifiers and better battery life in portable applications.

Advanced Linear Suspension

Small exciters often struggle with "bottoming out" or distorting when pushed. This proprietary suspension seems to solve that through:

- **High Physical Excursion:** This allows the voice coil to move further without hitting mechanical limits, resulting in a surprising amount of tactile force for its size.
- **Linearity:** By remaining linear throughout that movement, the exciter avoids the muddy distortion typically associated with small components driven at high volumes.

Application Guide: Integrating Audio & Haptics with Exciter Technology

For design engineers, combining audio and haptics is a matter of mechanical and electrical synchronization. By utilizing a single transducer, an exciter, to handle both audible frequencies (20 Hz – 20 kHz) and tactile vibrations (10 Hz – 300 Hz), designers can create continuous, durable, and intuitive interfaces.

Unlike traditional speakers that move air, exciters convert electrical signals into mechanical vibration, which is transferred directly to a surface or structure. That surface becomes the sound & haptics source.

1. Matching the Sound to the Feel

The primary goal is congruency ensuring sound and feel occur simultaneously. A lag of even 30ms can result in a 'mushy' user perception.

- Waveform Correlation: Use the same source signal. For a heavy button press, overlay a high-frequency sine wave (audio click) onto a low-frequency square wave (haptic thud).
- Amplitude Scaling: Haptics require higher displacement than audio. Use specialized drivers (e.g., TI DRV2605) to boost tactile impact without distorting the audible tone.

2. Mechanical Integration: The Surface as the Diaphragm

Since exciters rely on a rigid mounting surface to radiate energy, your material choice dictates the performance of both audio and haptics.

- Material Selection:
    - For Audio: Thin, lightweight materials with high bending strength (like polycarbonate or aluminum) provide the best treble extension.
    - For Haptics: These require a surface with some flexibility to allow for displacement. If the housing is too thick (>3 mm), the haptic effect will be "numb."

- Mounting Location: Place the exciter at 2/5 of the panel width and 3/5 of the panel height. This offset prevents the buildup of "standing waves," which cause dead spots in audio and inconsistent haptic intensity across the panel.

3. Application Examples for Design Engineers

A. Medical: Handheld Surgical Laser

- The Problem: Surgeons need to know the laser is firing without looking away from the patient or hearing loud beeps that distract the team.
- The Design Solution: Integrate a small PUI exciter inside the handle.
  - Haptic: A subtle, low-frequency pulse (approx. 150 Hz) mimics the "rhythm" of the laser pulses.
  - Audio: A localized, low-volume "hum" is projected directly through the surgeon's hand via bone conduction.
  - Engineer's Note: Use IP67-rated adhesive to seal the exciter to the internal chassis, ensuring the tool remains sterilizable.

B. Industrial: Gloved-Hand HMI (Human Machine Interface)

- The Problem: Operators in noisy factories wear heavy leather gloves and cannot feel standard touchscreen haptics.
- The Design Solution: Mount a high-output (HD) exciter to the back of a 1.5mm stainless steel faceplate.
  - Haptic: Use a "High-G" burst (>2 G acceleration) to penetrate the glove material.
  - Audio: Utilize the entire steel plate as a "flat panel speaker" to project a sharp 2kHz alert tone that cuts through ambient machinery noise.
  - Engineer's Note: Rib the internal plastic housing to isolate the vibration, preventing the entire machine from rattling.

C. Security: Vandal-Proof Access Keypad

- The Problem: Outdoor keypads are prone to "vandalism by poking" (destroying speaker grilles).
- The Design Solution: A seamless 5mm glass overlay with an exciter coupled behind it.
    - Haptic: A "sharp" 250 Hz sine wave pulse mimics a mechanical switch click.
    - Audio: A high-pitched "chirp" for successful entry.
    - Engineer's Note: Since glass is highly reflective, use Digital Signal Processing (DSP) to flatten the frequency response, preventing the audio from sounding "tinny."

4. Technical Selection Checklist

When selecting a PUI Audio exciter, calculate target displacement (Xmax):

$$X_{max} \propto (V * Bl) / (M_m * f^2)$$

Where V = Voltage, Bl = Force Factor, Mm = Moving Mass, and f = Frequency.

Example Design Problem: Control Interface

Scenario: Design a sterile, glass-surfaced panel that provides a 1.5G 'click' at 150Hz and a 1kHz audio tone.

Step 1: Mass & Force Calculation

- Total Mass (Mtotal) = Panel Mass (150g) + Exciter Mass (25g) = 175g (0.175 kg).
- Required Force (F) = 0.175 kg * (1.5 * 9.81 m/s^2) = 2.58 Newtons.

Step 2: Displacement Verification

- $X = a / (2\pi f)^2 = 14.715 / (2 * 3.14 * 150)^2 \approx 16.5$ µm.

Engineering Note: Ensure the exciter Xmax exceeds 16.5 μm to avoid mechanical clipping.

- Force Factor (Bl): Does the exciter provide >2.6N for this specific mass?
- Resonant Frequency (F0): Is it tuned away from the enclosure natural resonance?
- Adhesive Selection: Is the 3M VHB or epoxy rated for the operating temperature?
- DSP Requirements: Does the firmware support crossover for simultaneous audio/haptics?

Conclusion

By combining high-performance audio with physical touch feedback into a single, compact component, this new exciter technology offers design engineers a path toward more interactive and reliable interfaces. Bypassing the historical size and performance limitations of traditional miniature speakers, the integration of powerful neodymium magnets and advanced linear suspension ensures both energy efficiency and crystal-clear clarity.

Whether the goal is to penetrate heavy leather gloves in a noisy factory floor, maintain strict sterility in a surgical suite, or protect an outdoor keypad from vandalism, these exciters transform everyday materials like steel, glass, and plastic into high-fidelity sound and haptic surfaces. By utilizing the provided technical checklist and engineering guidelines, development teams can balance physical force and acoustic performance to design next-generation, intuitive user experiences.