Purpose of this document

This document is intended to support proposal preparation only. It provides a brief overview of the PMUT device, array structure, and indicative performance to help participants assess application feasibility. Detailed electrical interface information, operating conditions, and implementation guidance will be provided to shortlisted teams.

1. Introduction to PMUT Technology

A Piezoelectric Micromachined Ultrasonic Transducer (PMUT) is a micro-scale device that converts electrical energy into ultrasound, and ultrasound back into electrical signals, using a thin piezoelectric film.

Transmit (Tx) mode:

Applying an AC voltage to the piezoelectric layer causes it to expand and contract. Because the membrane is suspended over a cavity, this motion is converted into out-of-plane flexural vibration, generating ultrasonic waves in air.

Receive (Rx) mode:

Incoming sound waves cause the membrane to vibrate. The resulting mechanical strain in the piezoelectric layer generates electrical charge, which can be detected through the electrodes.

2. Overview of the PMUT competition kit

The PMUT competition kit is provided as a **PCB-based module** with the PMUT chip mounted on the board. A **protective cover** is placed above the PMUT chip to protect the bare device during handling.

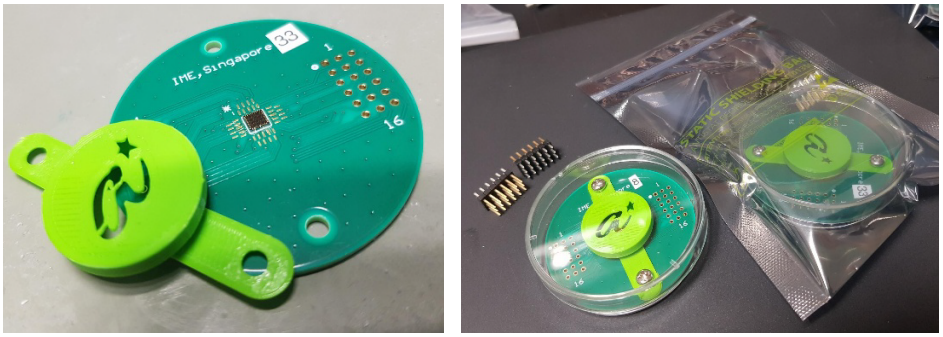

Figure 1. PMUT competition kit overview. The PMUT chip is mounted on a PCB and protected by a light green cover.

For acoustic testing, the PMUT can be evaluated from the **backside hole** without removing the cover. If needed, the protective cover can also be removed, allowing acoustic access and testing from the **top side** of the PMUT.

All PMUT electrical connections are routed through the PCB, so participants can **access the device through the side pins** for interfacing, testing, and system integration.

3. PMUT Device

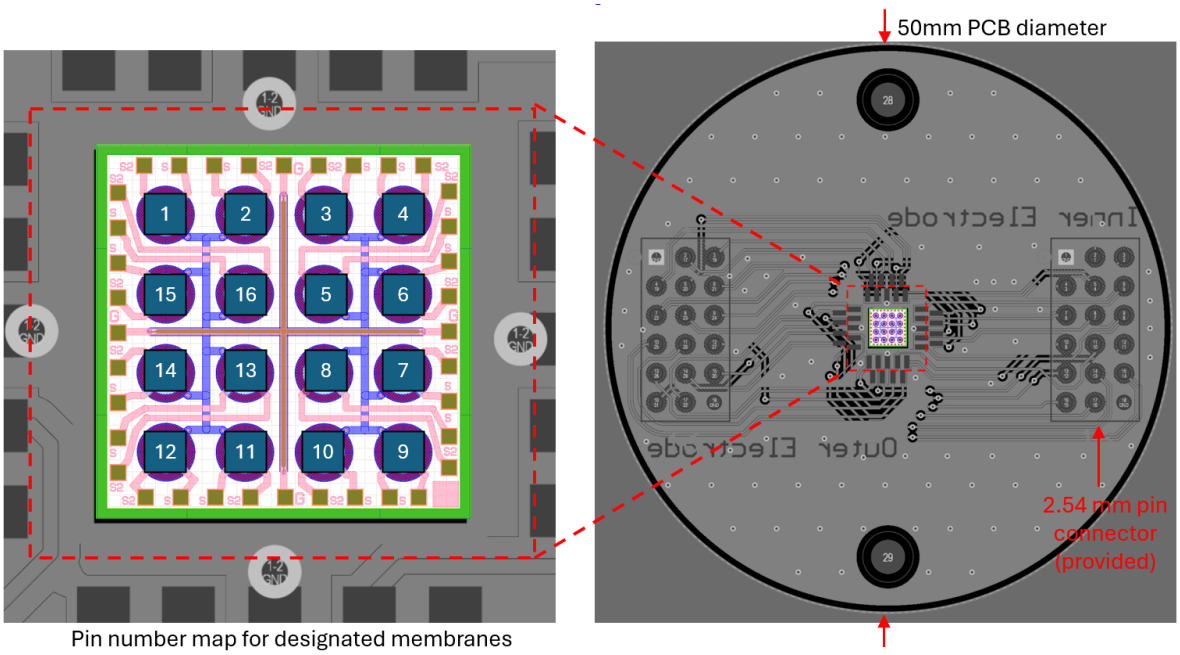

Figure 2. PCB board and designated membranes Map on PMUT array

The competition platform is based on a **50 mm diameter PCB** carrying a **wire-bonded 4 × 4 PVD PZT PMUT array**.

Key device features:

- **16 PMUT elements** in a 4 × 4 array
- Each PMUT has a **dual-electrode design**:
  - **Inner circular electrode**
  - **Outer annular electrode**
- Each PMUT has a diameter of **480 µm**
- Element spacing is **200 µm**
- Total array size is approximately **2520 µm × 2520 µm**

Each membrane uses a **common ground** as the bottom electrode of the PZT, with **two signal lines** on the top electrode corresponding to the inner and outer electrodes.

This dual-electrode design enables different actuation and sensing configurations, which may be useful for different application concepts.

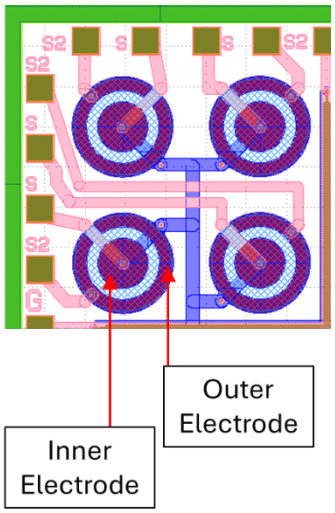

Figure 3. Zoom in view of PMUT array's Inner and Outer electrodes

4. Indicative Device Performance

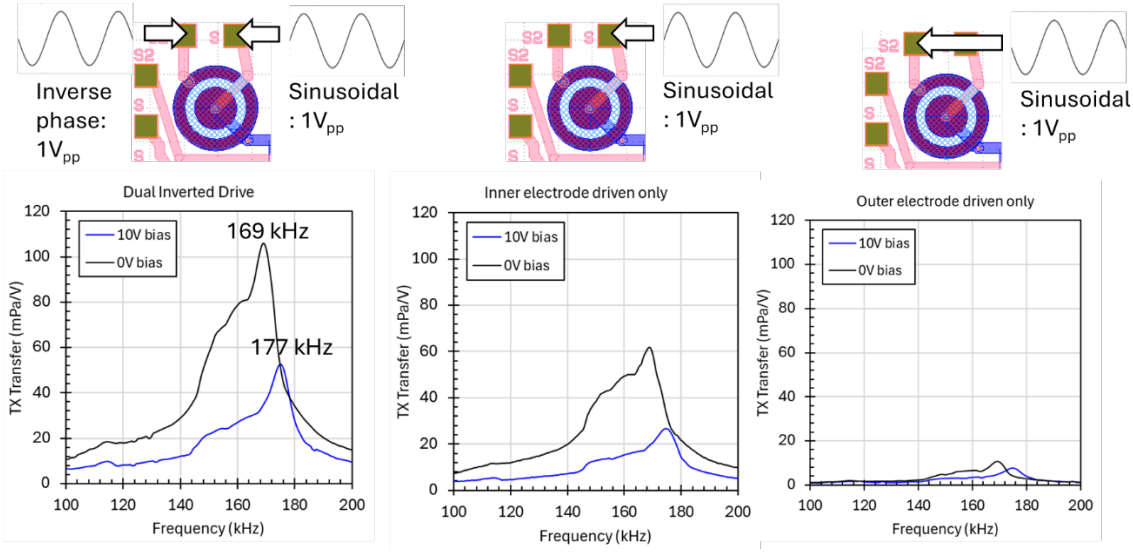

Figure 4. Transmit performance per membrane depending on driven electrode

The following results are provided as reference data to support concept development.

Transmit performance

Single-membrane transmit performance was characterized by measuring acoustic output with a microphone positioned **7.5 cm** from the device.

At **169 kHz** with **10 V bias**:

- **Outer electrode only: 10.6 mPa/V**
- **Inner electrode only: 61.8 mPa/V**
- **Inner + outer driven in anti-phase: 105 mPa/V**

These results indicate that electrode configuration has a strong impact on transmit performance.

Receive performance

Single-membrane receive performance was characterized through electrical measurement of the PMUT output signal.

At **177 kHz** without bias:

- **Inner electrode: 0.8 mV/Pa**
- **Outer electrode: 0.1 mV/Pa**

These results indicate that the device can support both transmit and receive functions for air-coupled ultrasonic applications.

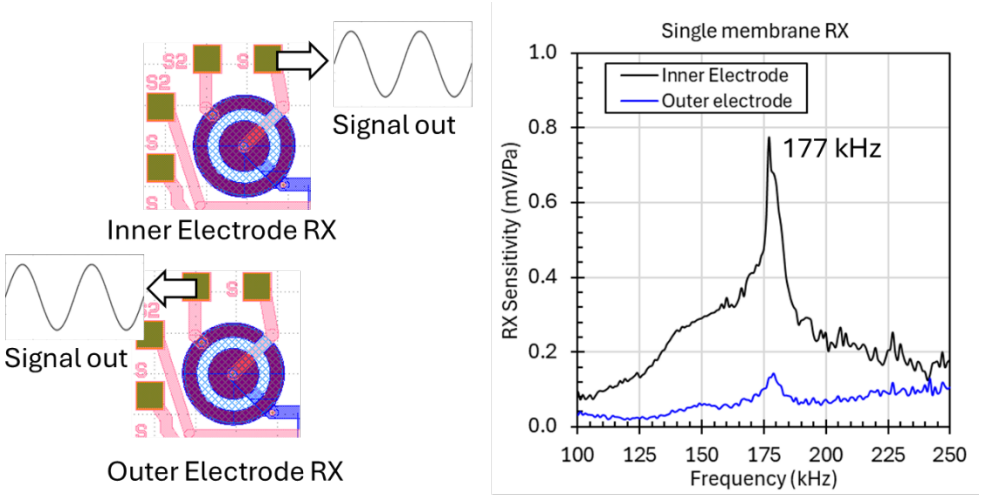

Figure 5. Receive performance per membrane depending on driven electrode