

# A Literature Review on Piezo-MEMS for Ultrasonic Through-Metal Communication and Power Transfer



TECHNISCHE  
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## Motivation

Transmitting data and power through solid metal barriers without physical penetrations is a significant challenge in many engineering fields. Applications range from structural health monitoring in aerospace components to extracting sensor data from hermetically sealed industrial containers. Ultrasonic acoustic waves offer a promising physical layer for this purpose, enabling wireless communication directly through metallic structures.

This seminar will explore the use of on-chip piezoelectric MEMS (Micro-Electro-Mechanical Systems) as transducers for this task. The objective is to conduct a thorough review of the current state-of-the-art, identify the key challenges like acoustic coupling and signal attenuation, and evaluate the feasibility of this technology for practical applications.



## Your Tasks

Your work will consist of literature research and applied analysis. The main tasks are:

- **Literature Review:** You will conduct a structured search and review of scientific literature focusing on ultrasonic communication through solid media, particularly metals. The research should cover piezoelectric transducers (including pMUTs), acoustic coupling methods, signal modulation techniques, and challenges specific to metal as a transmission medium.
- **State-of-the-Art Summary:** You are expected to synthesize the findings into a comprehensive technical overview. This includes identifying key performance metrics (e.g., data rate vs. distance, bit-error-rate, power transfer efficiency  $\eta$ ) and the primary limitations of current systems.
- **Conceptual Calculations:** A key component of this work involves applying the reviewed principles to a defined scenario. This requires performing order-of-magnitude calculations to estimate parameters such as signal attenuation in a given thickness of steel or aluminum, the required acoustic power for a target signal-to-noise ratio, and the effects of acoustic impedance mismatch.
- **Final Report & Presentation:** You will document your research in a formal scientific report and present your findings to the research group.

## Your Profile

This seminar is suitable for students with the following qualifications:

- **Electrical Engineering, Mechanical Engineering, Physics, Mechatronics**, or a related field of studies.
- A background or strong interest in **MEMS, acoustics, wave propagation, or non-destructive testing**.
- The ability to independently **read and critically analyze scientific publications**.

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- Proficiency in fundamental engineering calculations. Experience with tools like **MATLAB** or **Python** is beneficial.



## Contact Information

If you are interested in this seminar topic, please reach out to:

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