Master’s Thesis Engineering Technology

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Development of a Measuring System for a Textile-Based Organic Electrochemical Transistor

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Introduction

Modern healthcare increasingly demands non-invasive, comfortable, and accurate monitoring solutions. **Sensors** such as **textile-based Organic Electrochemical Transistors (OECTs)** (see Fig. 1) are highly promising due to their low operating voltage, high sensitivity, and biocompatibility.

OECTs operate similarly to **traditional transistors**, modulating current between drain (D) and source (S) via a gate (G) voltage (see Fig. 2). Their unique **electrolyte gating** and **ion-conductive polymers** enable direct interaction with biological environments but also **require more versatile and precise control during measurement** [1].

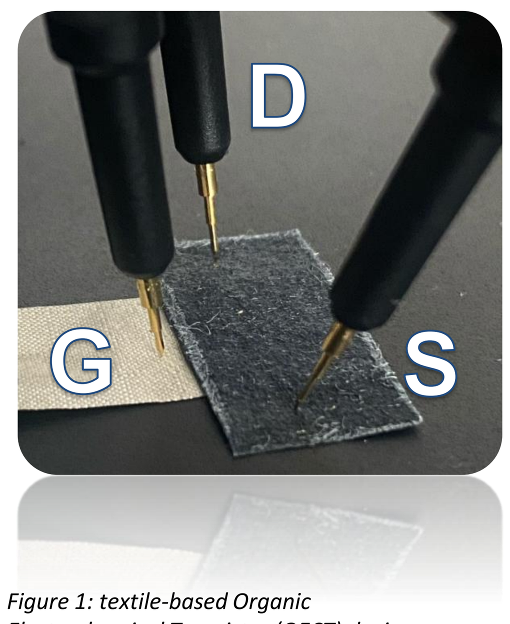


Figure 1: textile-based Organic Electrochemical Transistor (OECT) device in operation

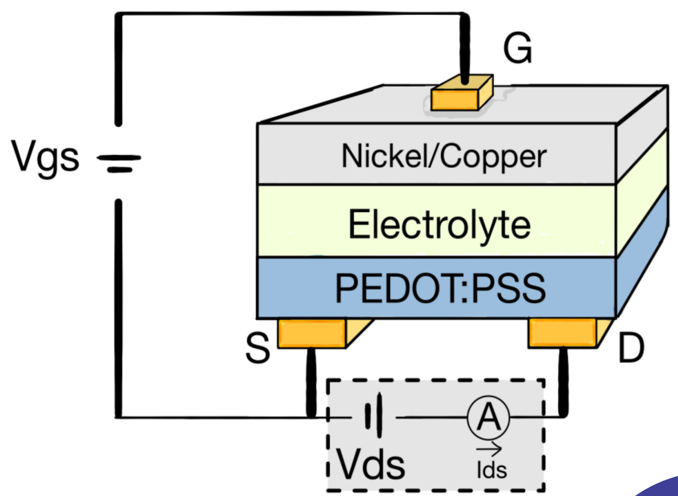


Figure 2: Schematic of Organic Electrochemical Transistor (OECT) device in operation

Goal

The goal of this study is to **replace** the **complex**, bulky **measuring setup surrounding OECTS** with a **compact, user-friendly measuring system**. The system must precisely apply gate and drain-source voltages while accurately measuring the resulting drain-source current. By **simplifying the measurement process**, this system aims to **make OECT characterization more accessible** and to accelerate material and sensor development.

The conceptual design of the measuring system is shown in Figure 3.

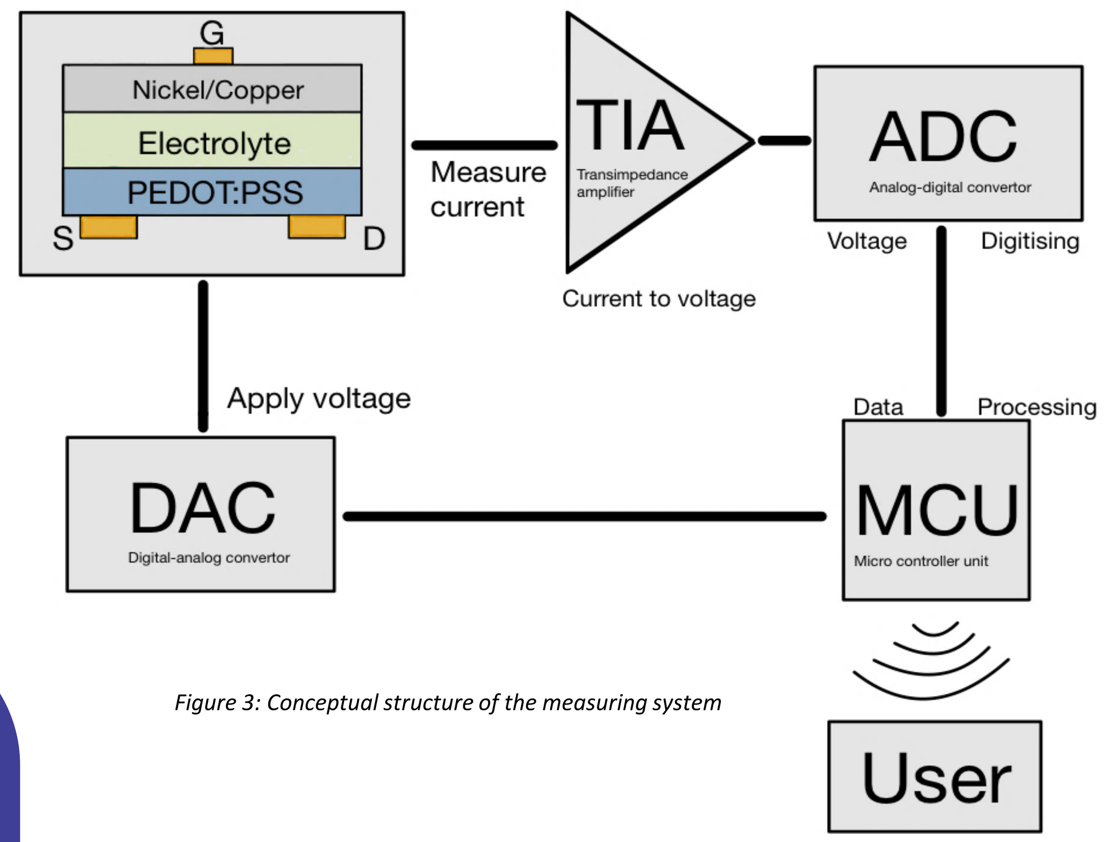
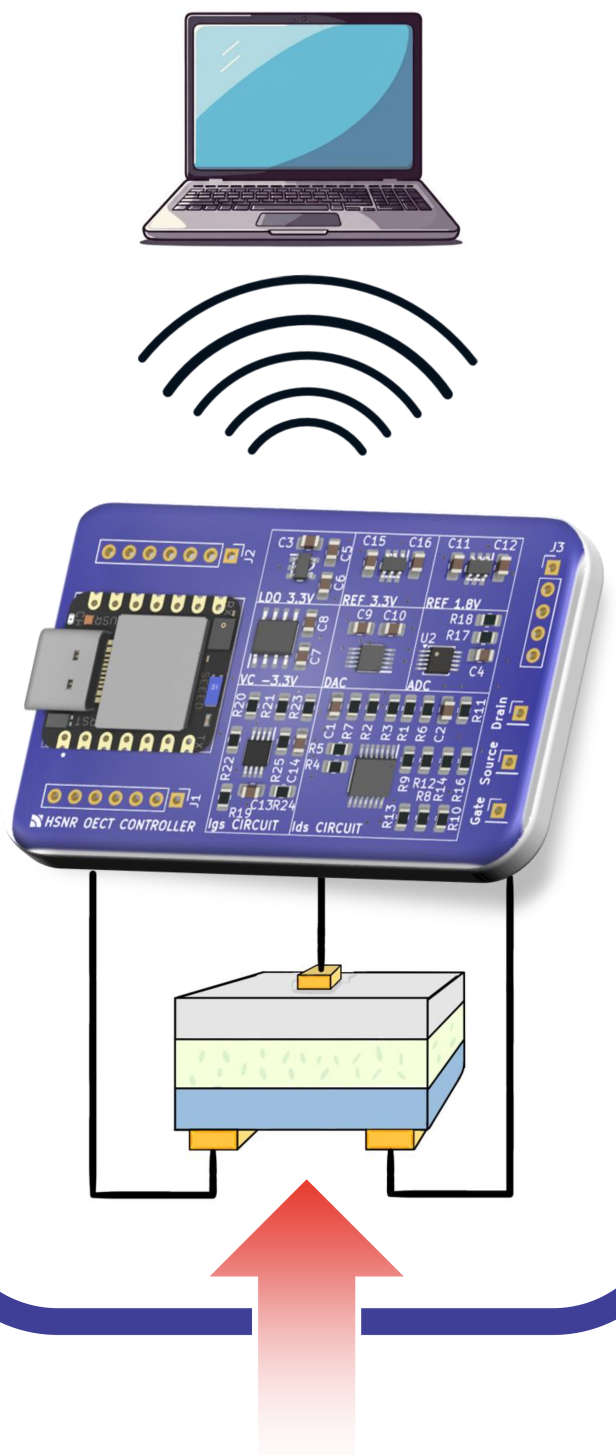


Figure 3: Conceptual structure of the measuring system



Software

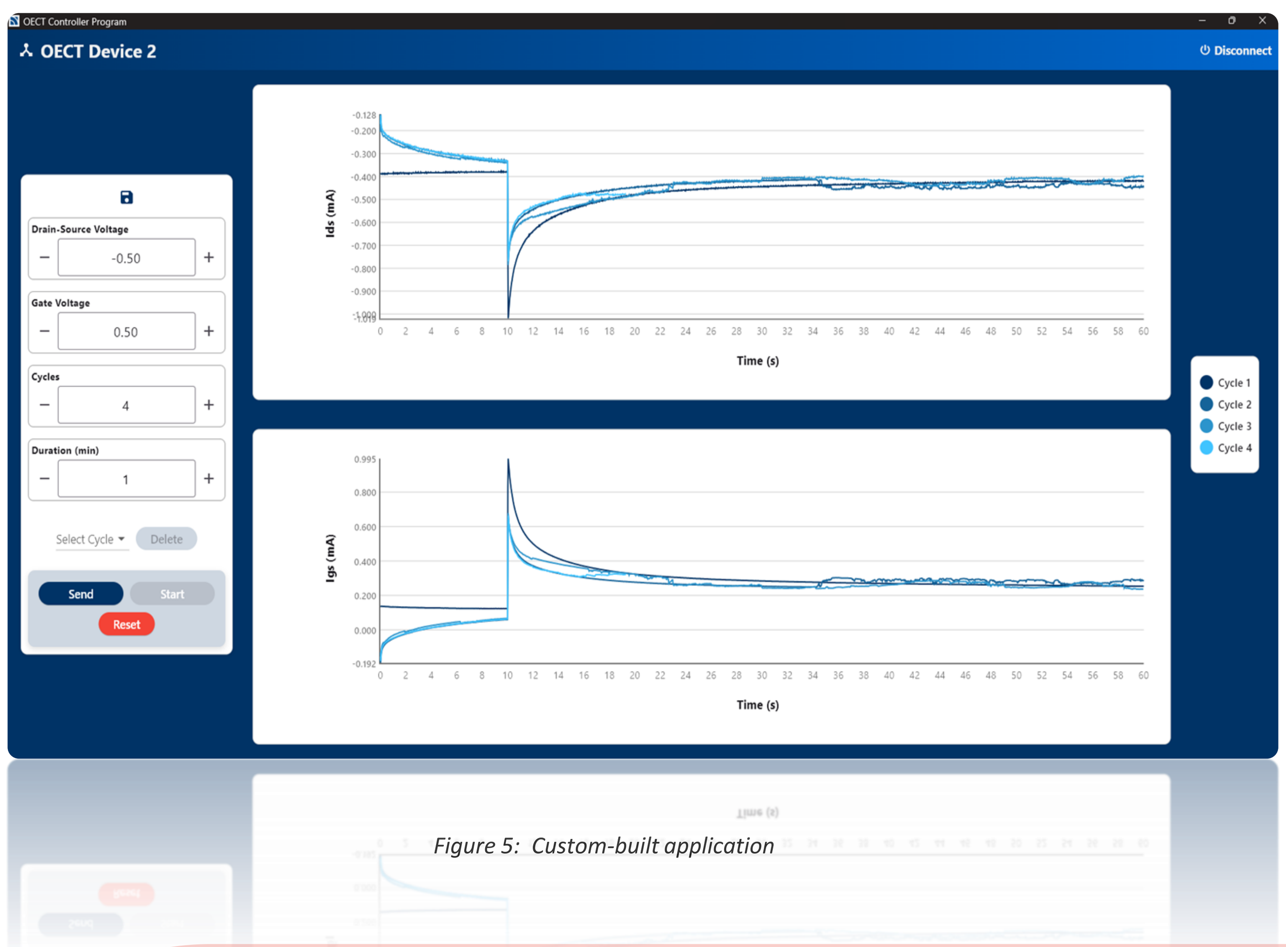


Figure 5: Custom-built application

Hardware

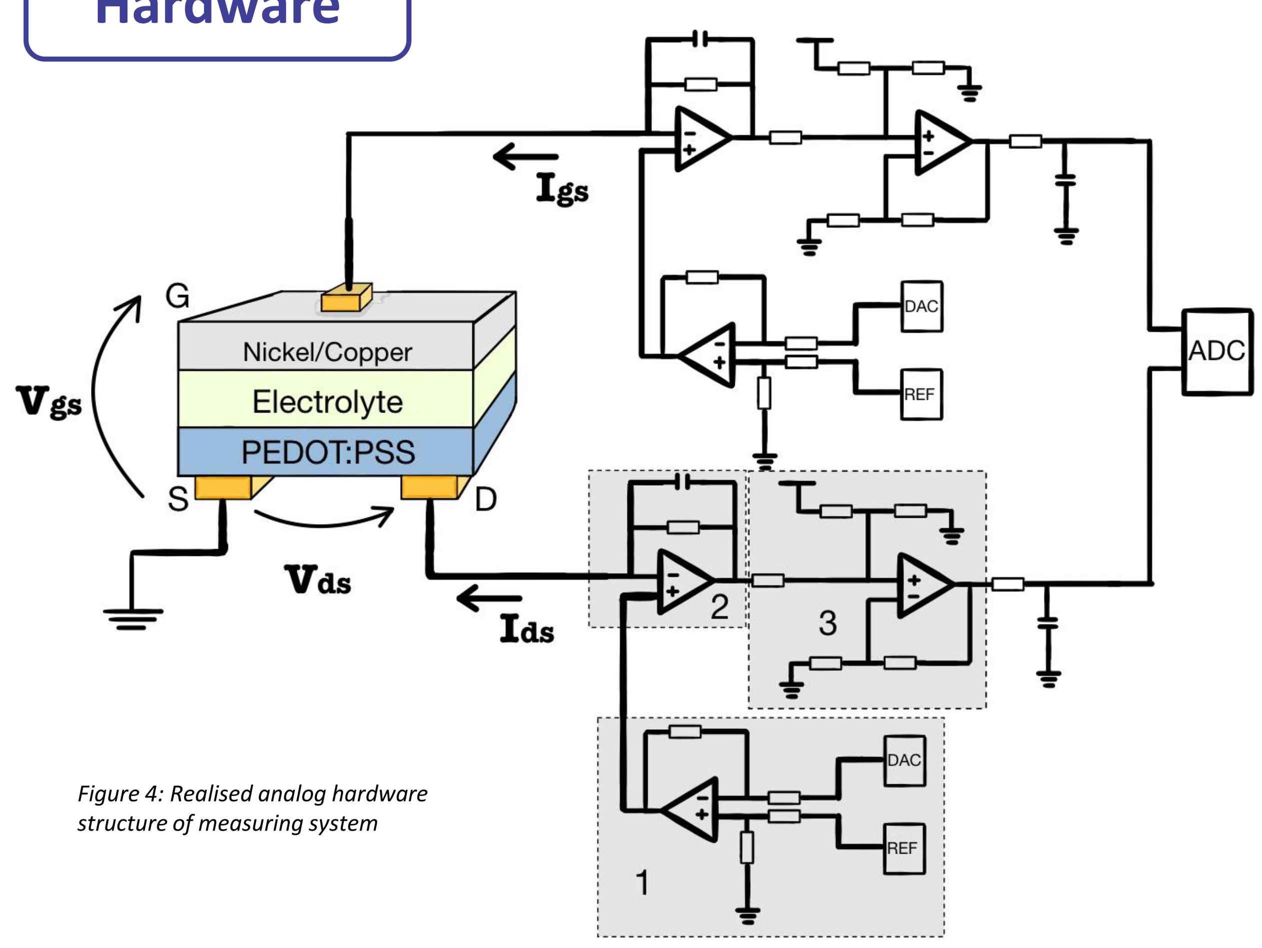


Figure 4: Realised analog hardware structure of measuring system

Results

This system integrates an AD5667 **DAC**, ADS1115 **ADC** and nRF52840 **BLE microcontroller**. **Differential amplifiers** (Fig. 4, Block 1) shift the DAC’s output to a ±1 V range, allowing control of gate and drain-source voltages applied to the OECT. **Two transimpedance amplifiers** (Block 2) convert the resulting gate-source (Igs) and drain-source (Ids) currents into voltages, with a **summing amplifier** (Block 3) removing offsets. The microcontroller computes the corresponding currents with an applied voltage accuracy of ±0.2 mV and current accuracy of ±8 µA across ±1 V and ±20 mA ranges. **Data is wirelessly transmitted via Bluetooth at 40 Hz to a custom-built application** (see Fig. 5), where **material scientists can configure measurement parameters**, such as drain/gate voltages, duration, and cycle count **and receive real-time plots of Ids and Igs** for immediate visualization and analysis.

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Prof. dr. ir. Anne Schwarz-Pfeiffer (HSNR)
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REFERENCES:
[1] R. Brendgen, T. Grethe, and A. Schwarz-Pfeiffer, “Textile Organic Electrochemical Transistor for Non-Invasive Glucose Sensing,” *Micro*, vol. 4, no. 4, pp. 530–551, Sep. 2024, doi: https://doi.org/10.3390/micro4040033.