Calibration Fixture for On-Skin Thermal Measurement System

Degree programme: BSc in Mechatronics and Systems Engineering (Medical technology | Robotics)
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Before deployment, epyShield™ wearable devices are calibrated to ensure optimal performance. This thesis project aims to design a calibration system integrating mechanical and thermal solutions, essential for improving the efficiency of the manufacturing process.

Introduction
This project aims to create a system for calibrating body temperature sensors. The current calibration method, which calibrates one device at a time, is time-consuming and restrictive. This project proposes a solution to calibrate multiple devices simultaneously with precision and efficiency.

Goals
The goal is to develop a system capable of calibrating approximately 50 devices simultaneously while reducing calibration time. The system must ensure a thermal accuracy of 0.07 °C with a repeatability of 0.02 °C, providing a reliable solution tailored to each step of the process.

Methods
The concept was developed iteratively by evaluating multiple technical approaches. After selecting the optimal solutions, the mechanical, pneumatic, and thermal design was created in 3D. Finally, the complete system was assembled, tested, and automated to ensure an efficient calibration process.

Results
The final system integrates mechanical, pneumatic, and thermal solutions. The vertical tower, consisting of 12 calibration stages, processes 24 devices simultaneously through an automated transfer mechanism between stages (Fig.1, A). The devices are mounted in pairs on carts (Fig.1, Nr. 2). Each stage is equipped with two heating systems (Fig.1, B), composed of heating pads (Fig. 1, Nr. 3), aluminum plates, and individually regulated temperature sensors (Fig. 1, Nr. 4). A pneumatic actuator, connected to a toggle linkage mechanism (Fig. 1, Nr. 1), ensures the movement of the mobile part and applies uniform pressure from the heating plates onto the devices. An automatic reloading system is integrated at the top of the tower, allowing for the preloading of an additional ten devices for continuous calibration. This setup ensures an uninterrupted workflow, capable of calibrating up to 50 devices without human intervention.

Outlook
The system offers a scalable solution for multi-device calibration with a robust mechanical design. Its modular structure allows for future upgrades and full automation, ensuring greater efficiency for precise thermal control. Initial tests were conducted using a simplified concept of the heating system and demonstrated an accuracy of approximately 0.04°C. It is necessary to repeat these tests with the exact final concept to confirm performance.

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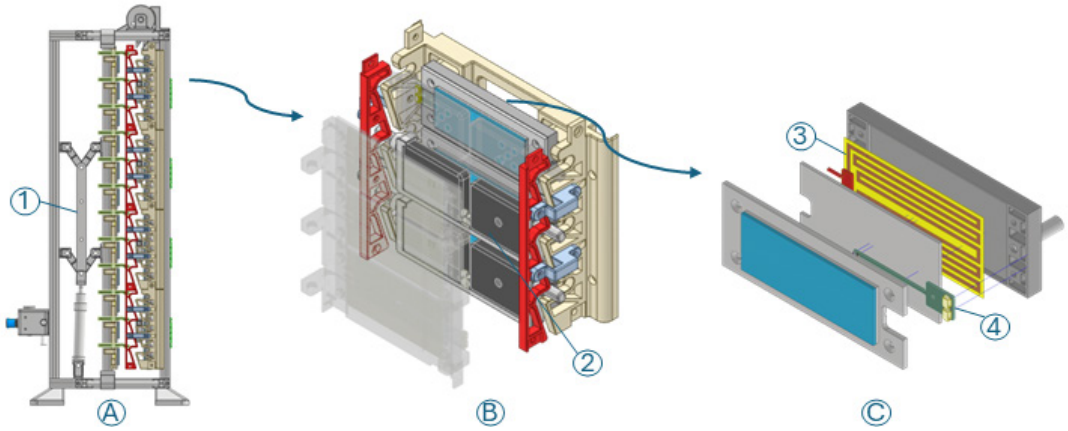

Section A represents the general concept, Section B shows the view of one of the four guides, and Section C provides an exploded view of the heating systems.