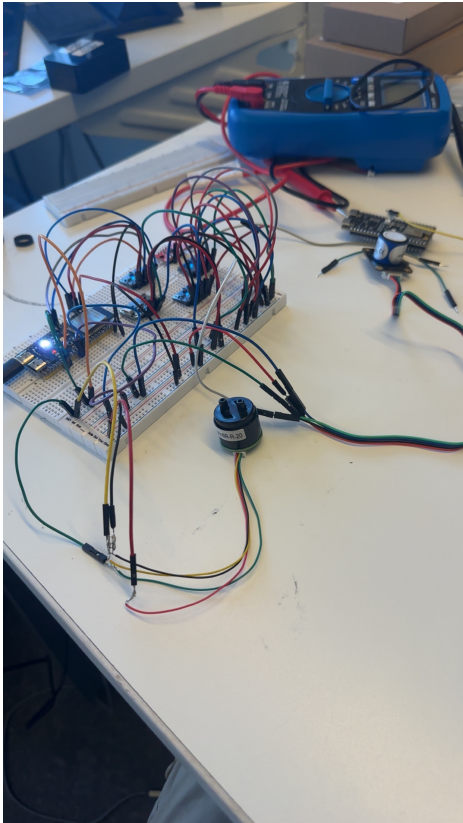
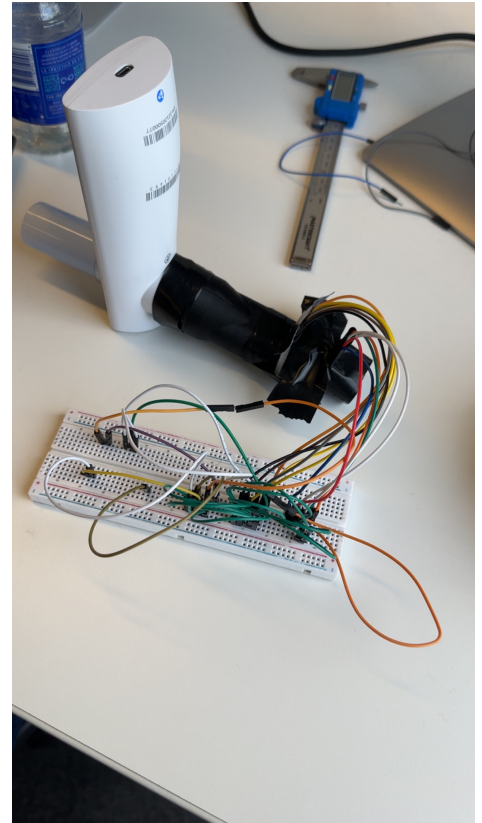


## ESP32 S3 Wearable Health and Respiratory Device

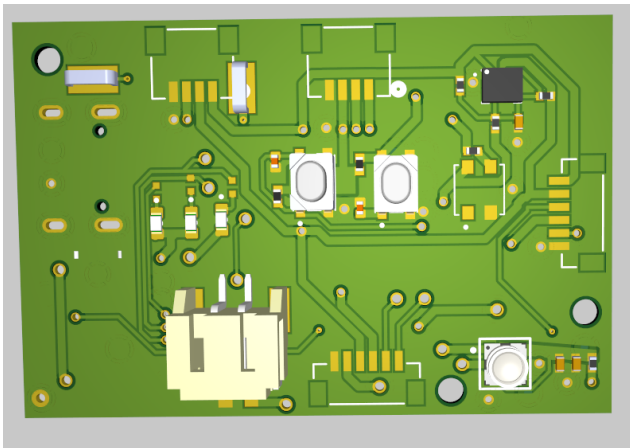
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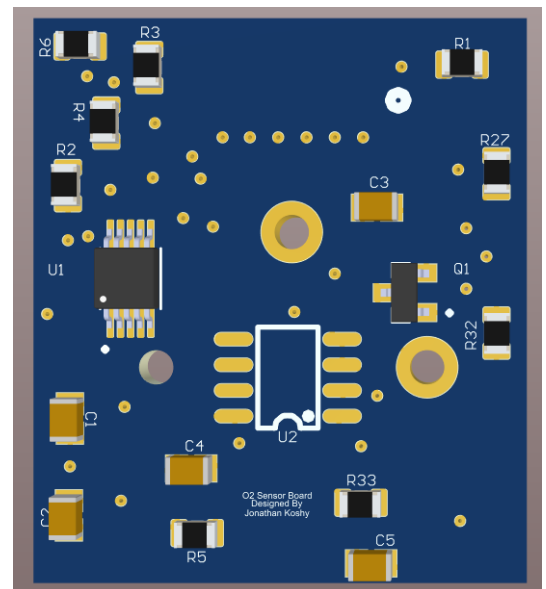
(a) Breadboard prototype



(b) Sensor and flow setup



(a) Custom Integrated ESP32-S3, Sensors, Power PCB



(b) O2 Sensor PCB

### Overview

Developing a next generation wearable that monitors cardiovascular, respiratory, and metabolic health. The device combines custom low noise PCBs around an ESP32 S3 with biomedical and environmental sensors to capture high resolution data in real time.

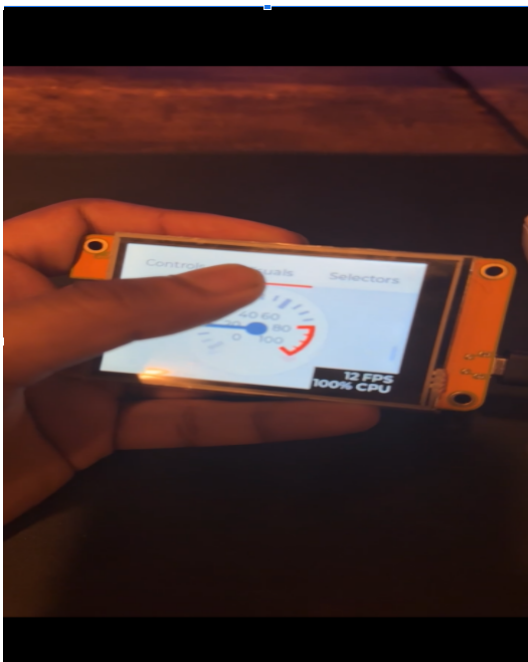
# Hardware Design

- Assembled multilayer PCBs integrating BMP585 pressure and temperature sensors, Max30102 optical pulse oximetry, SprintIR CO<sub>2</sub>, Gravity O<sub>2</sub>, and a compact IMU.
- Optimized analog layout and decoupling to reduce noise and improve wireless signal integrity while cutting board weight by twenty percent.
- Implemented USB C power management with ESD protection and verified production readiness with DFM checks.

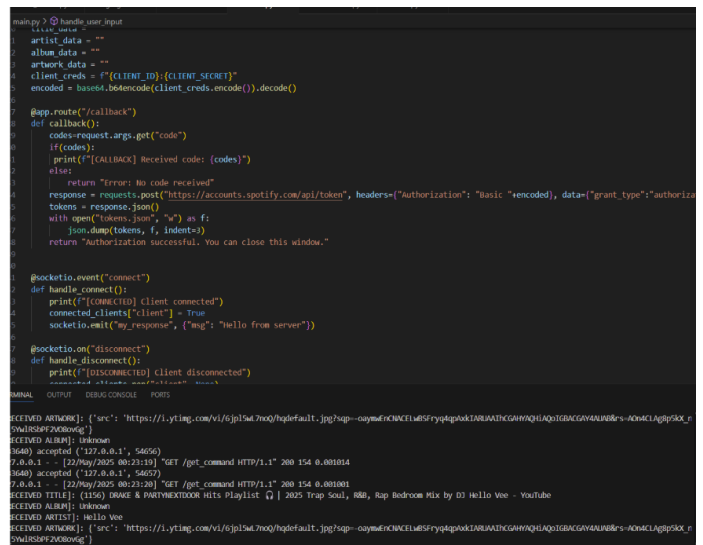
## Firmware and Data Pipeline

- Wrote multi sensor firmware in FreeRTOS with ESP IDF to poll I<sup>2</sup>C and UART devices and stream synchronized data to a mobile backend through BLE with latency under fifty milliseconds.
- Built power efficient dual core task scheduling on the ESP32 S3 for continuous acquisition of high rate biomedical signals without packet loss.
- Calibrated cardiac, respiratory, and gas sensors against lab instruments to keep measurements within plus or minus two percent of reference.

# ESP32 Media Controller Dashboard



(a) Media Dashboard



### (b) Backend Python Server

## Overview

Handheld touchscreen device that displays and controls YouTube, Spotify, and Discord media without touching the computer.

## Hardware and UI

ESP32 drives a 2.8 inch SPI TFT display and capacitive touch panel, with LVGL layouts for play, pause, skip, and volume.

## Browser Extension

Chrome extension calls the YouTube metadata API to pull video title, playback state, and timestamp, then packages JSON and sends it with WebSockets.



- Implemented USB C power input with ESD protection and verified manufacturability with production Gerbers.