Sensor platform of the Hybrid E-Tattoo

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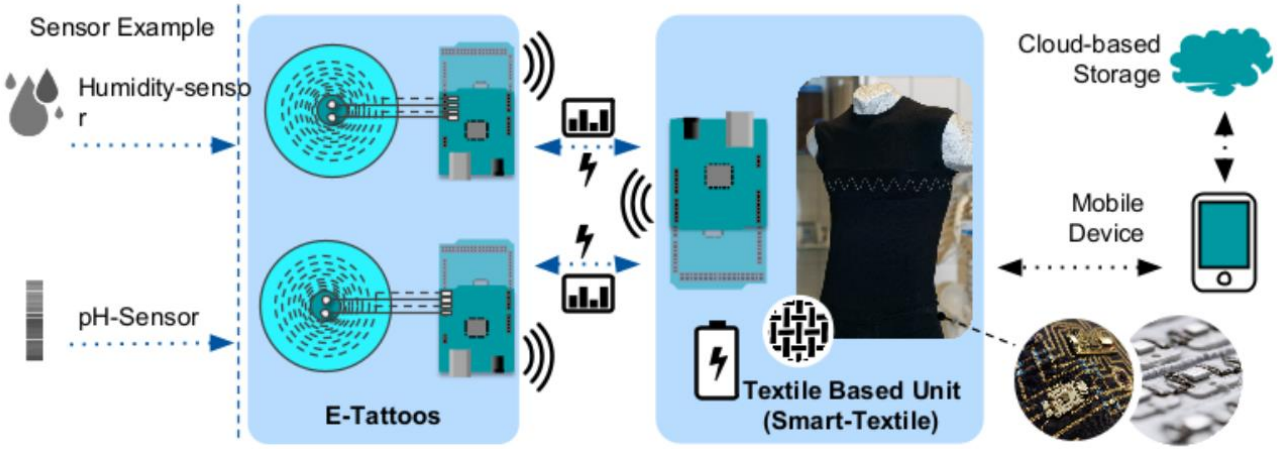
Supervisor: Thijs Vandenryt

In collaboration with imo-imomec

Introduction

- The Hybrid E-Tattoo project
  - Wearable Plug and Play healthcare device
  - Health monitoring
  - Combining smart textile and E-Tattoos (skin adhesives)



Introduction

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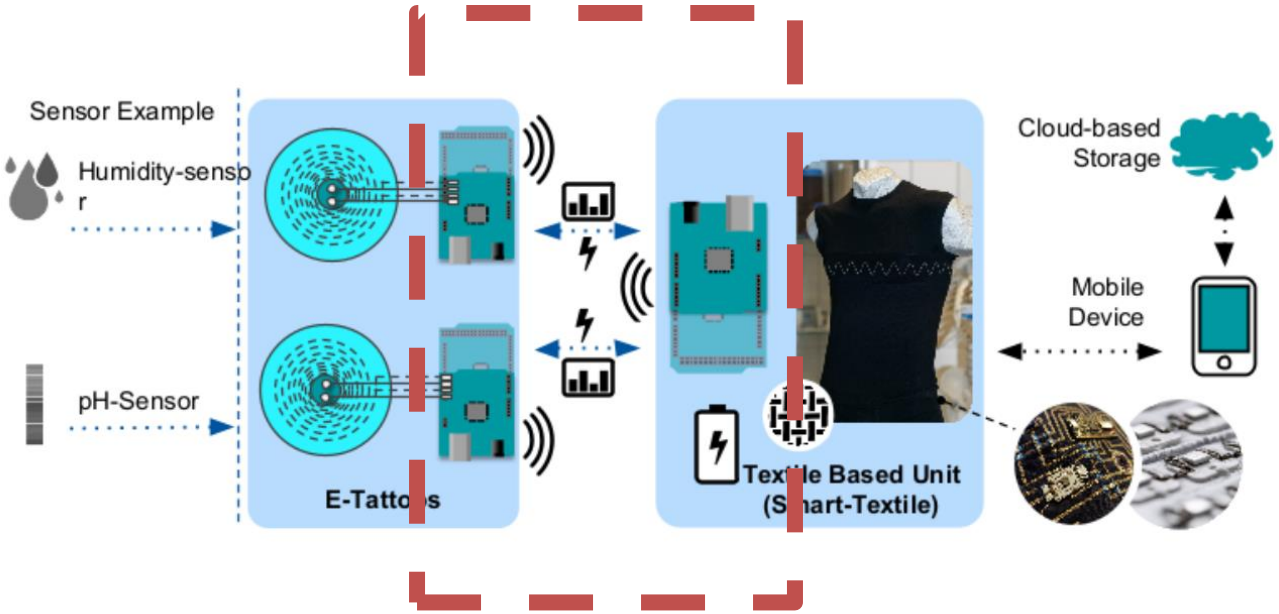
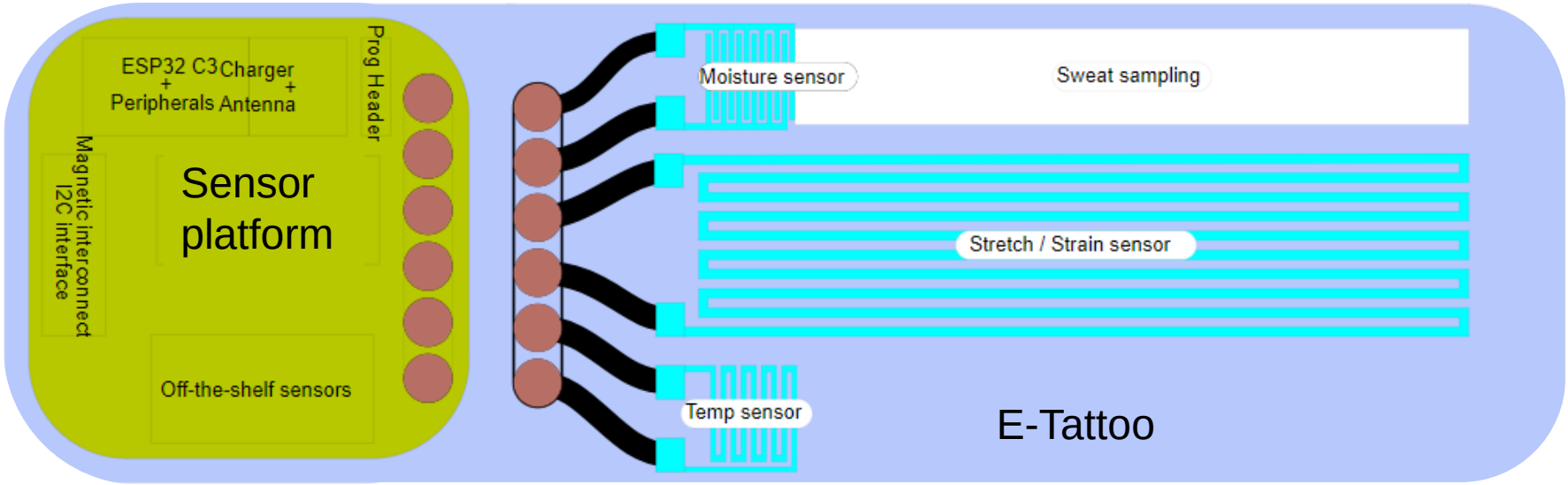


Sensor hub?

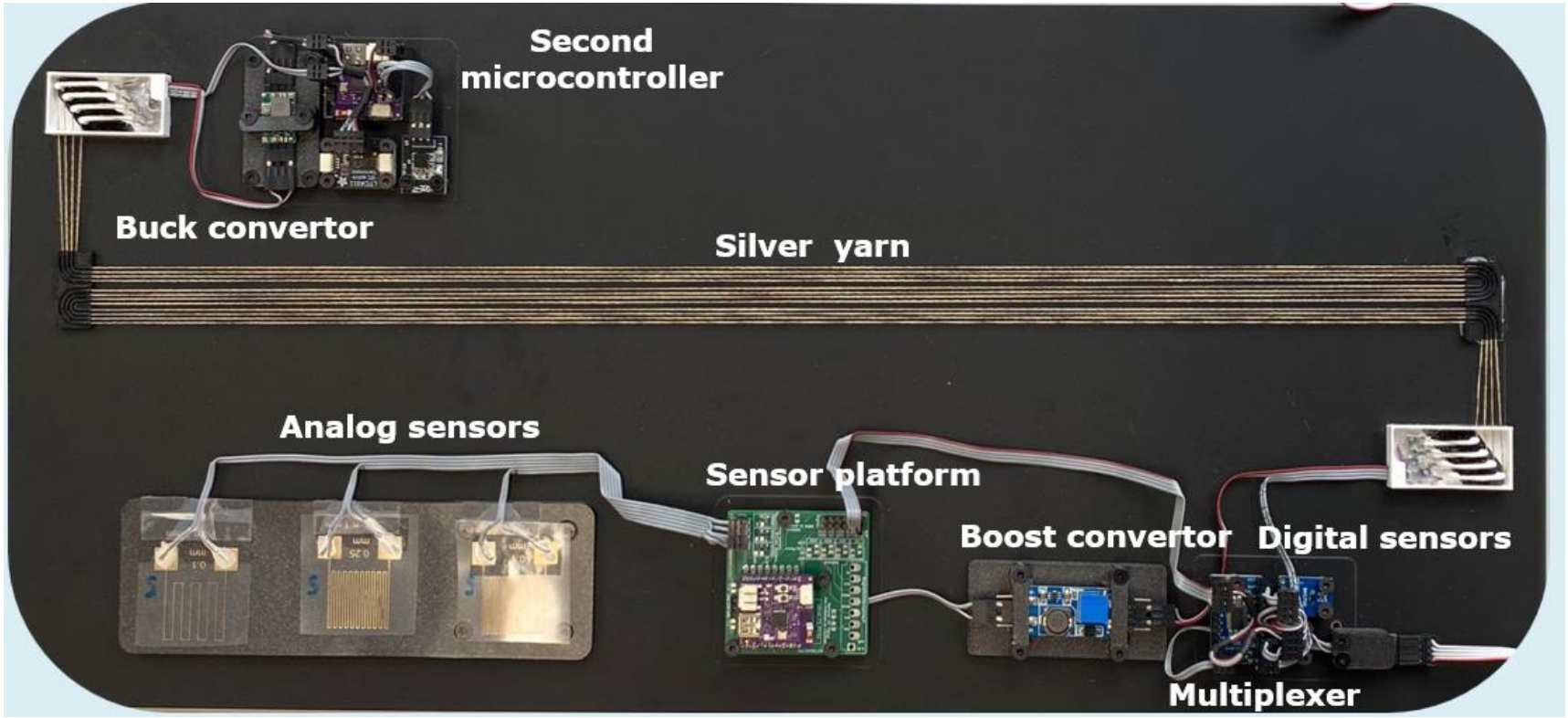
Goal

- The sensor platform of the Hybrid E-Tattoo
  - PCB with connections to all sensors and devices
- Showcasing that sensor platform works with demonstrator



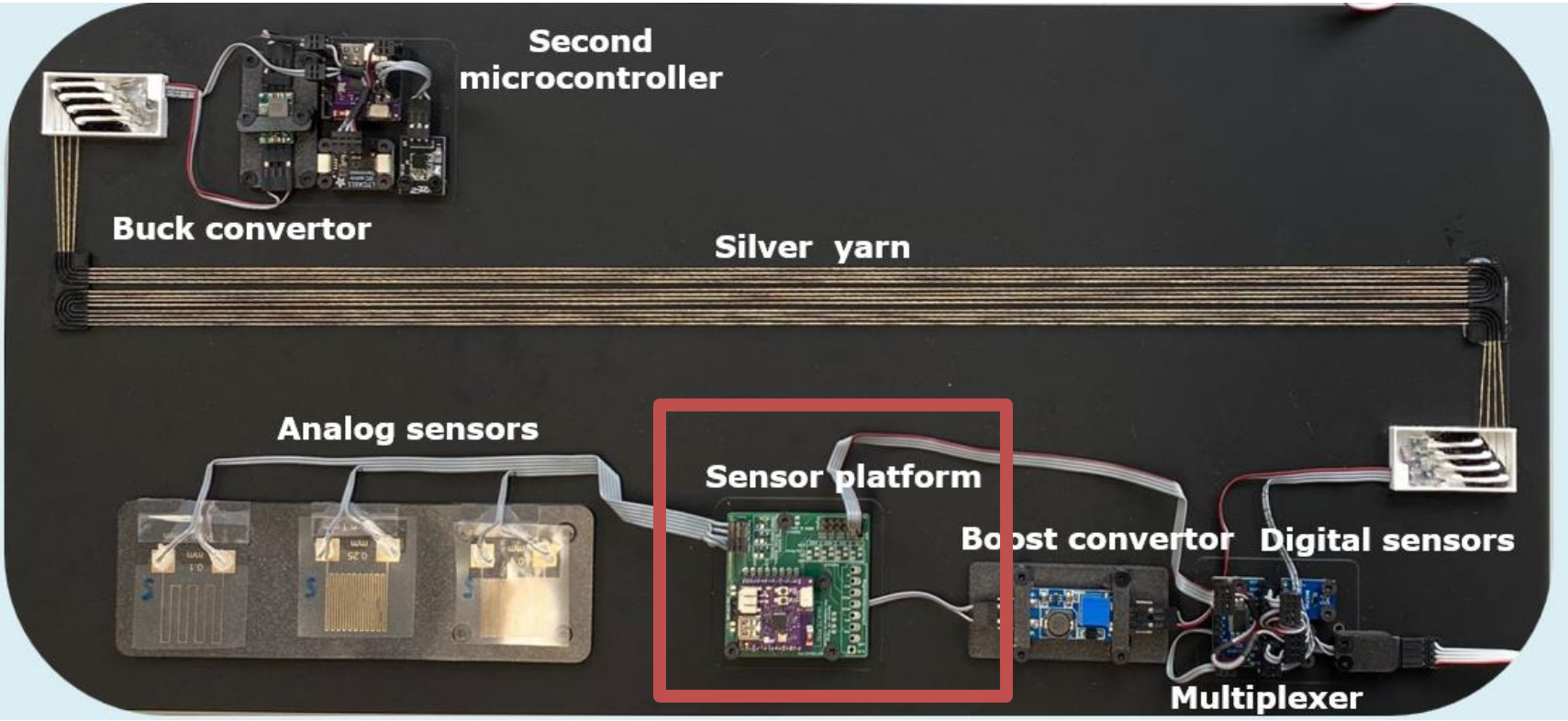
Materials & Results

- The demonstrator



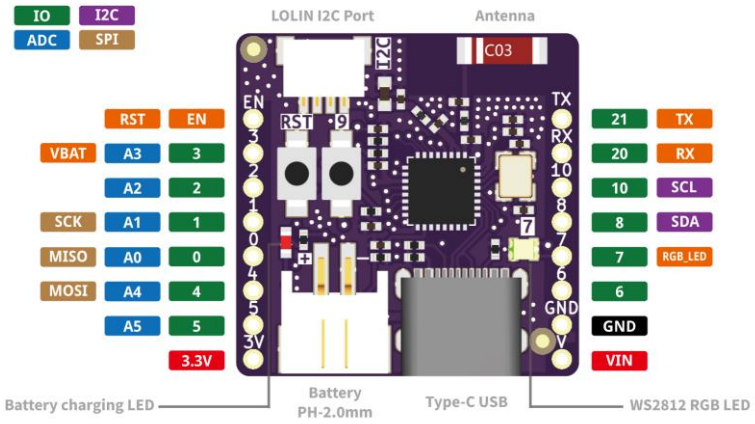
Materials & Results

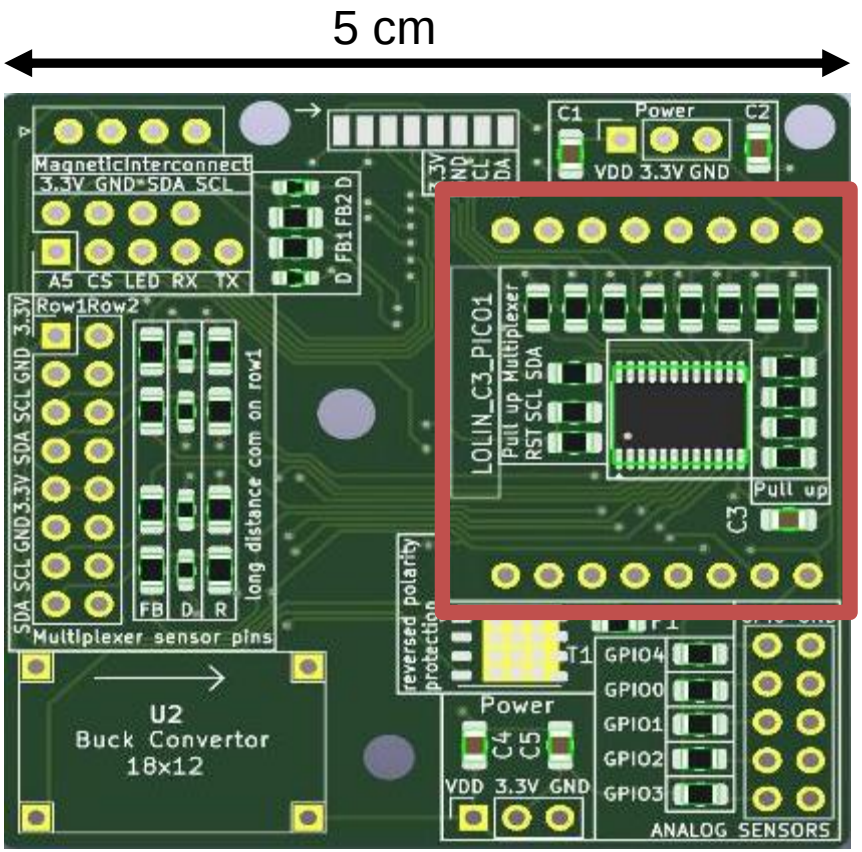
- The sensor platform (hub)



Materials & Results

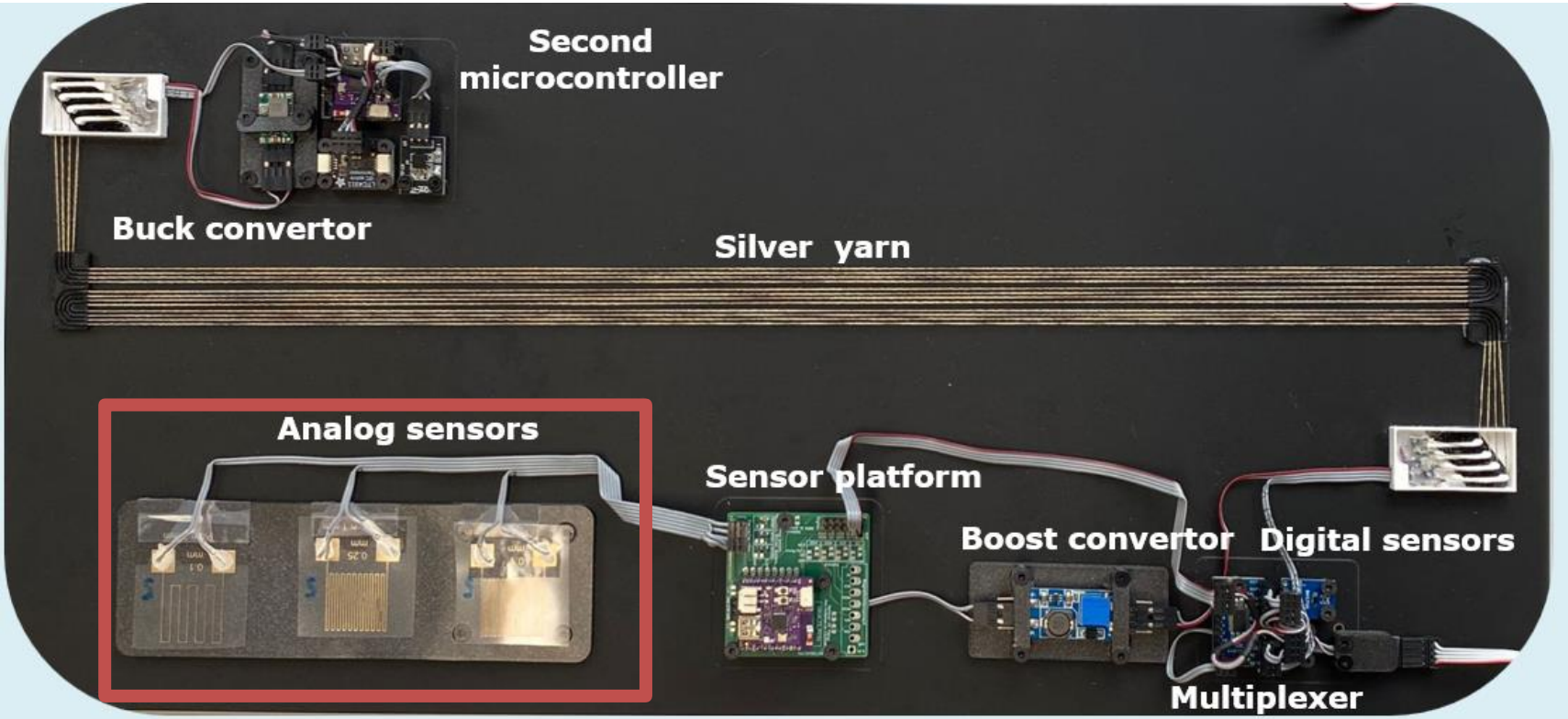
- The sensor platform PCB
  - Designed with Kicad
- Microcontroller: esp32 C3





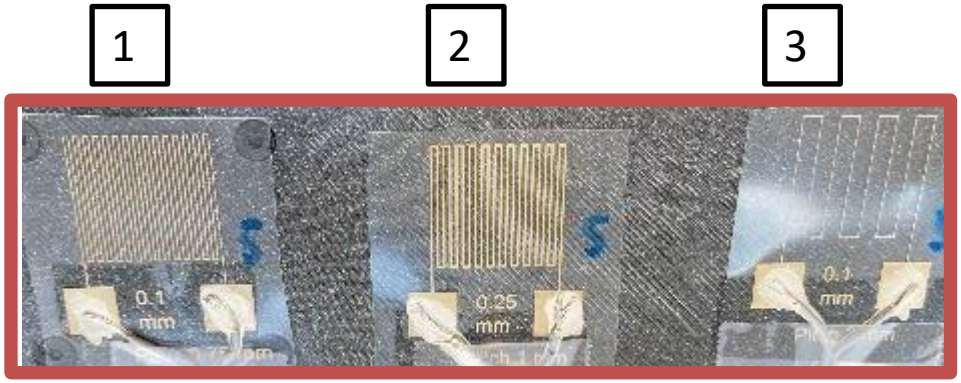
Materials & Results

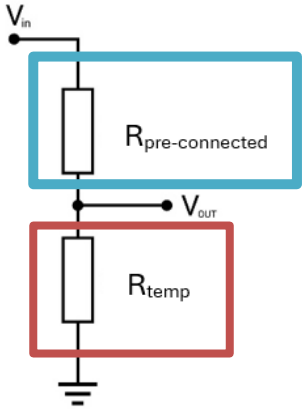
- The analog sensors

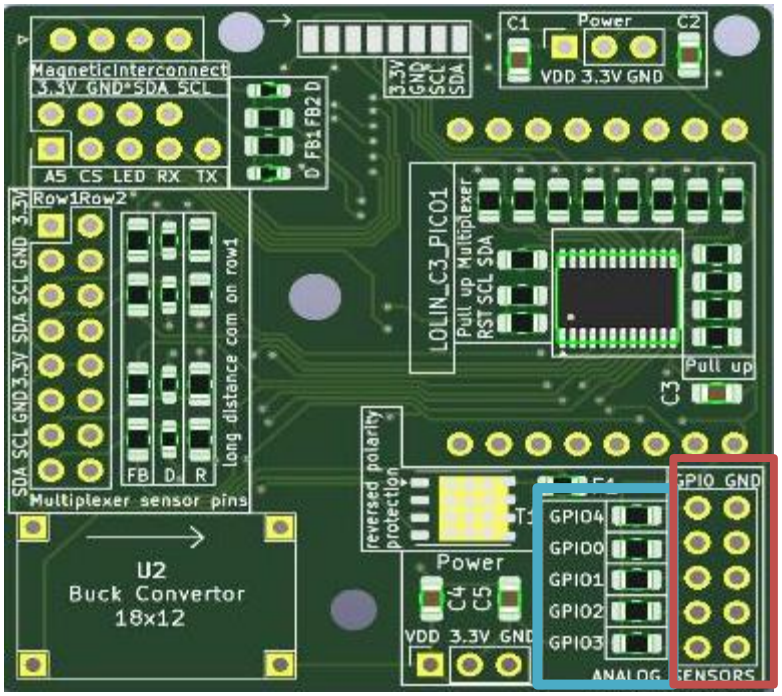


Materials & Results

- Screen printed analog Temperature sensors







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Materials & Results

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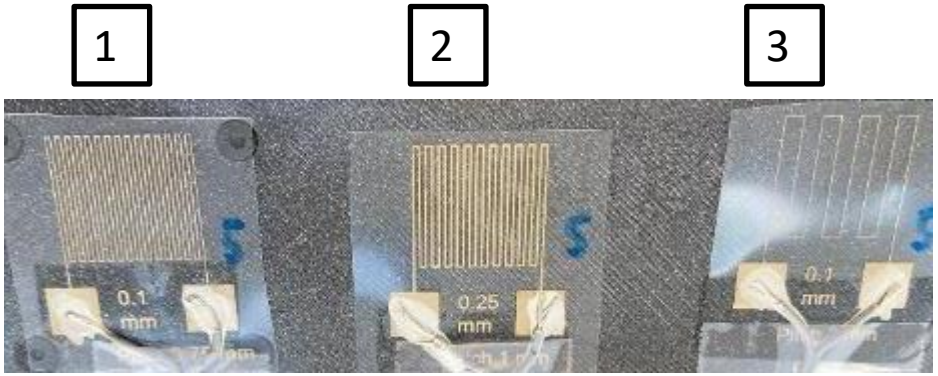
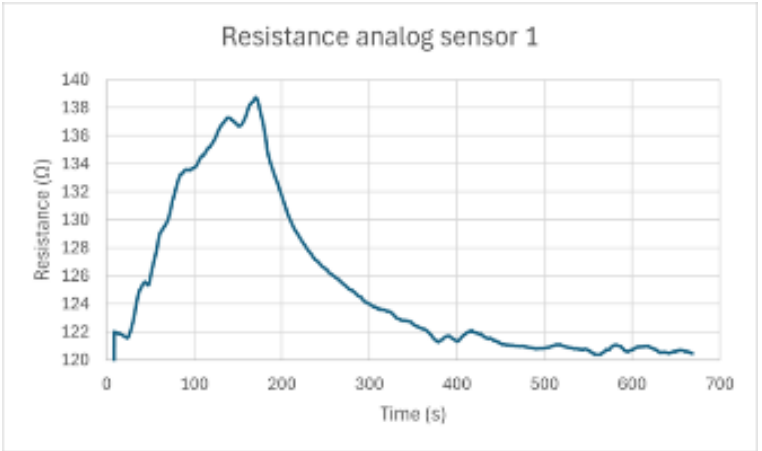
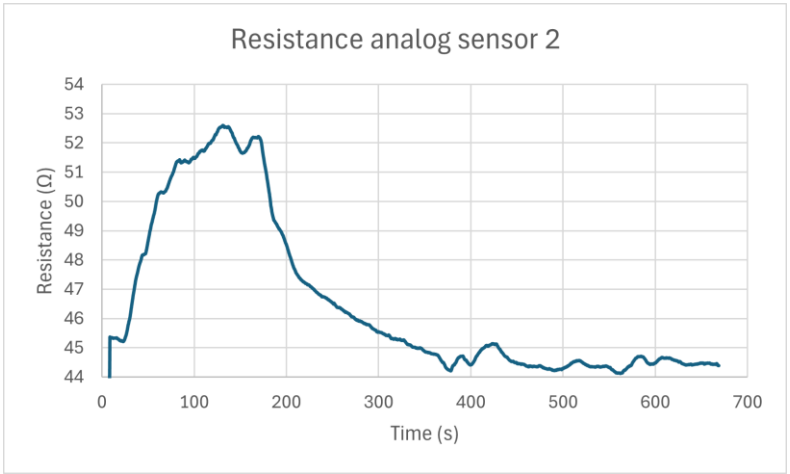
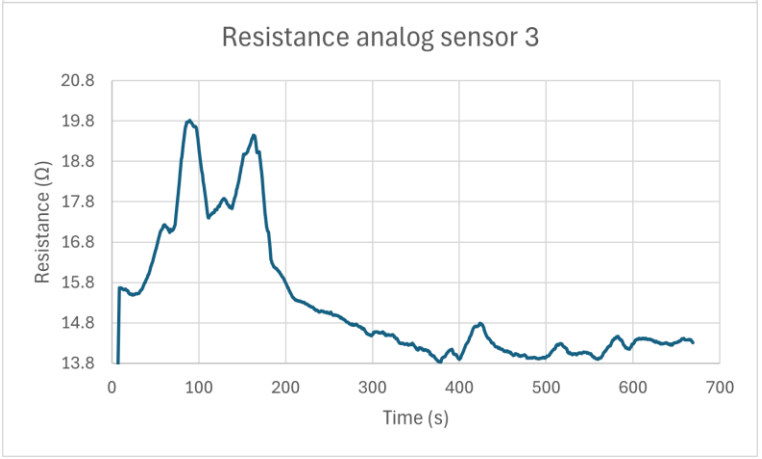


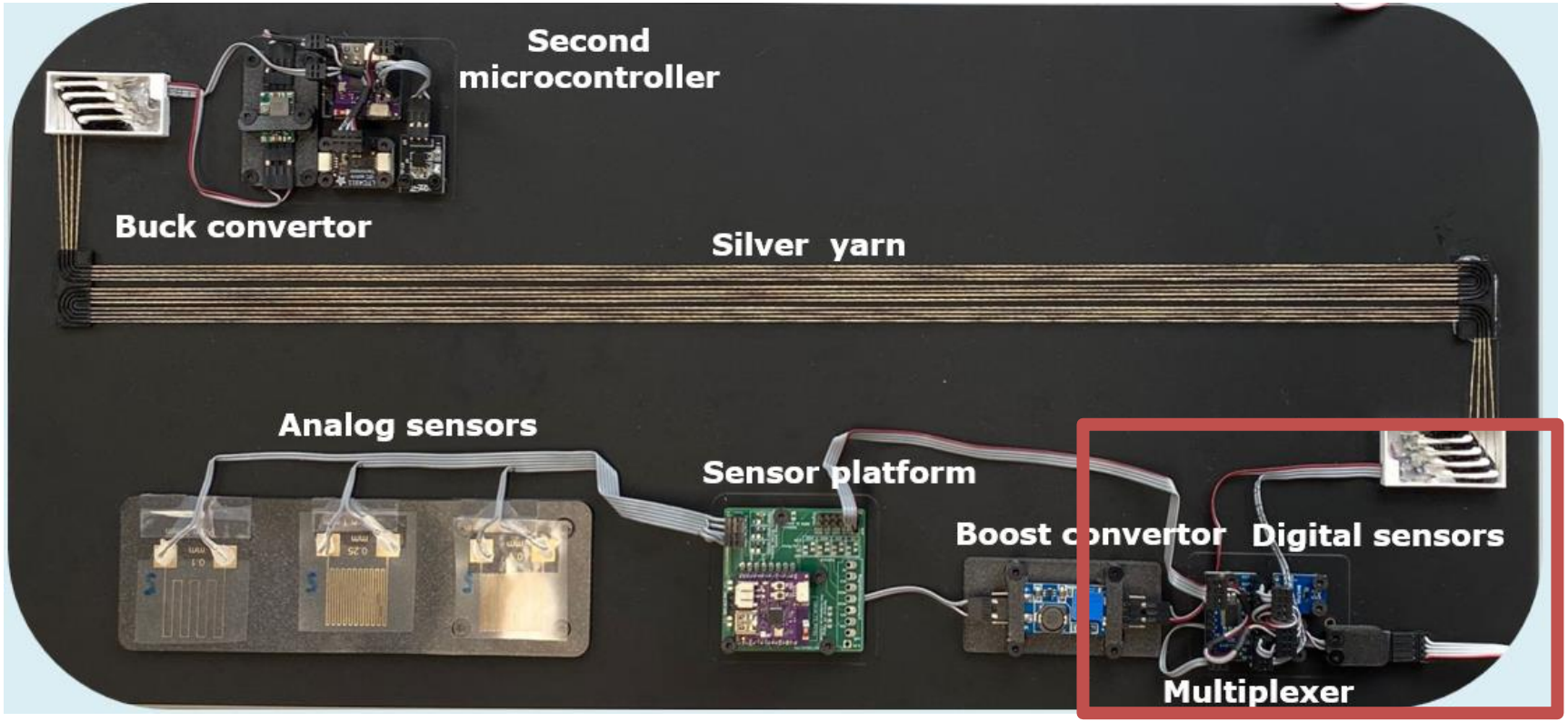






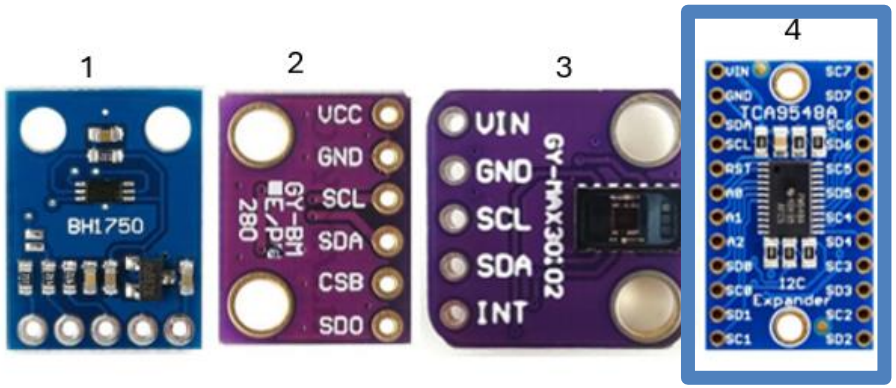
Materials & Results

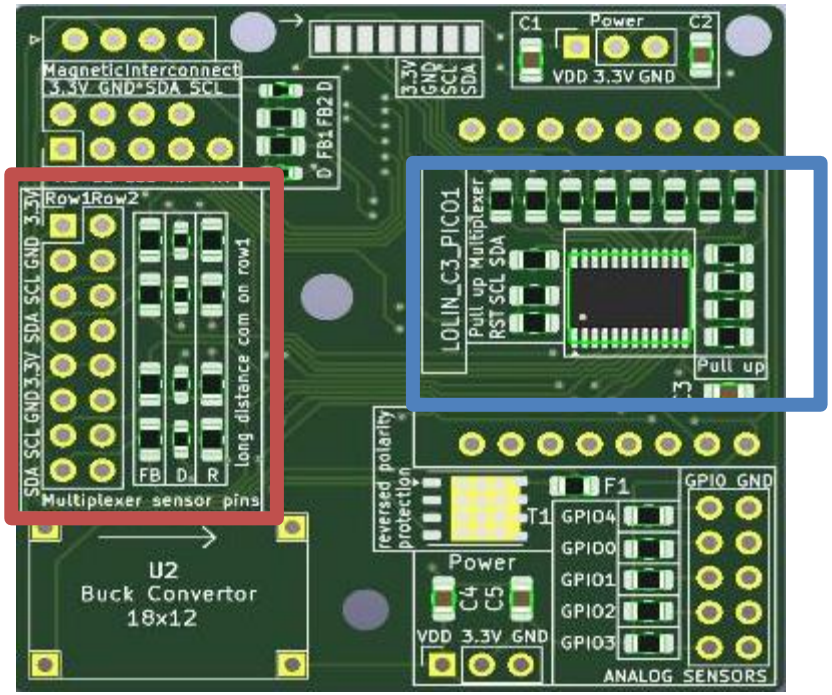
- The digital sensors and multiplexer



Materials & Results

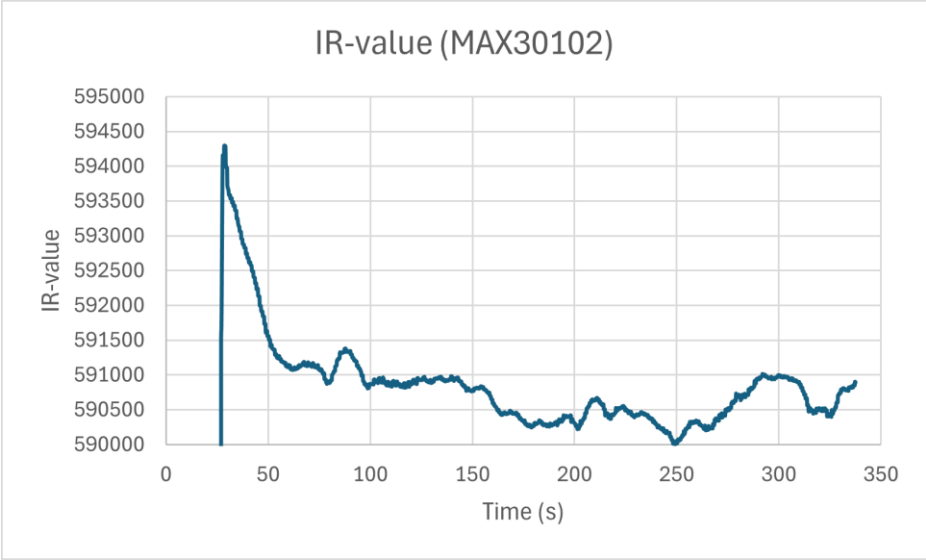
- Multiplexer and digital sensors
  - Off-the-shelf I2C digital sensors:
    - MAX 30102 PPG sensor (3)
  - I2C 1-to-8 Multiplexer (4)

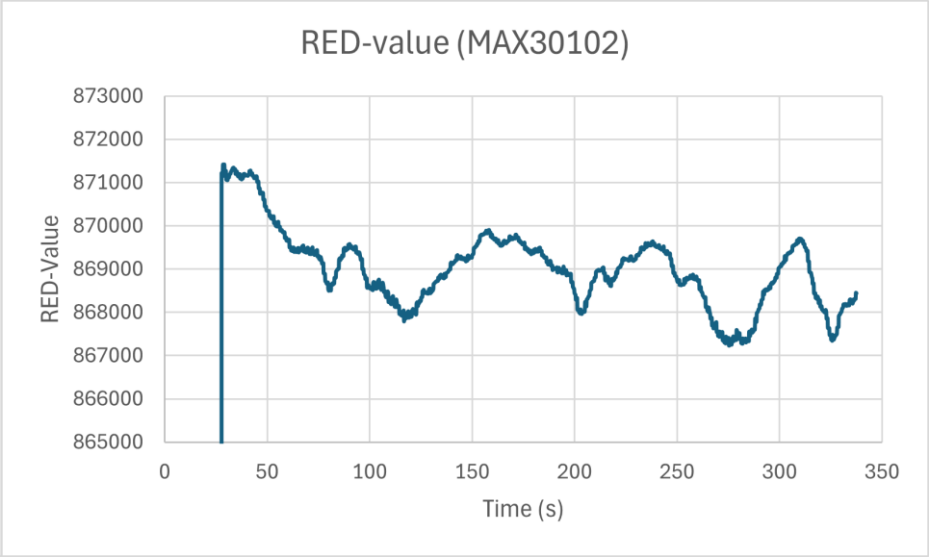




Materials & Results

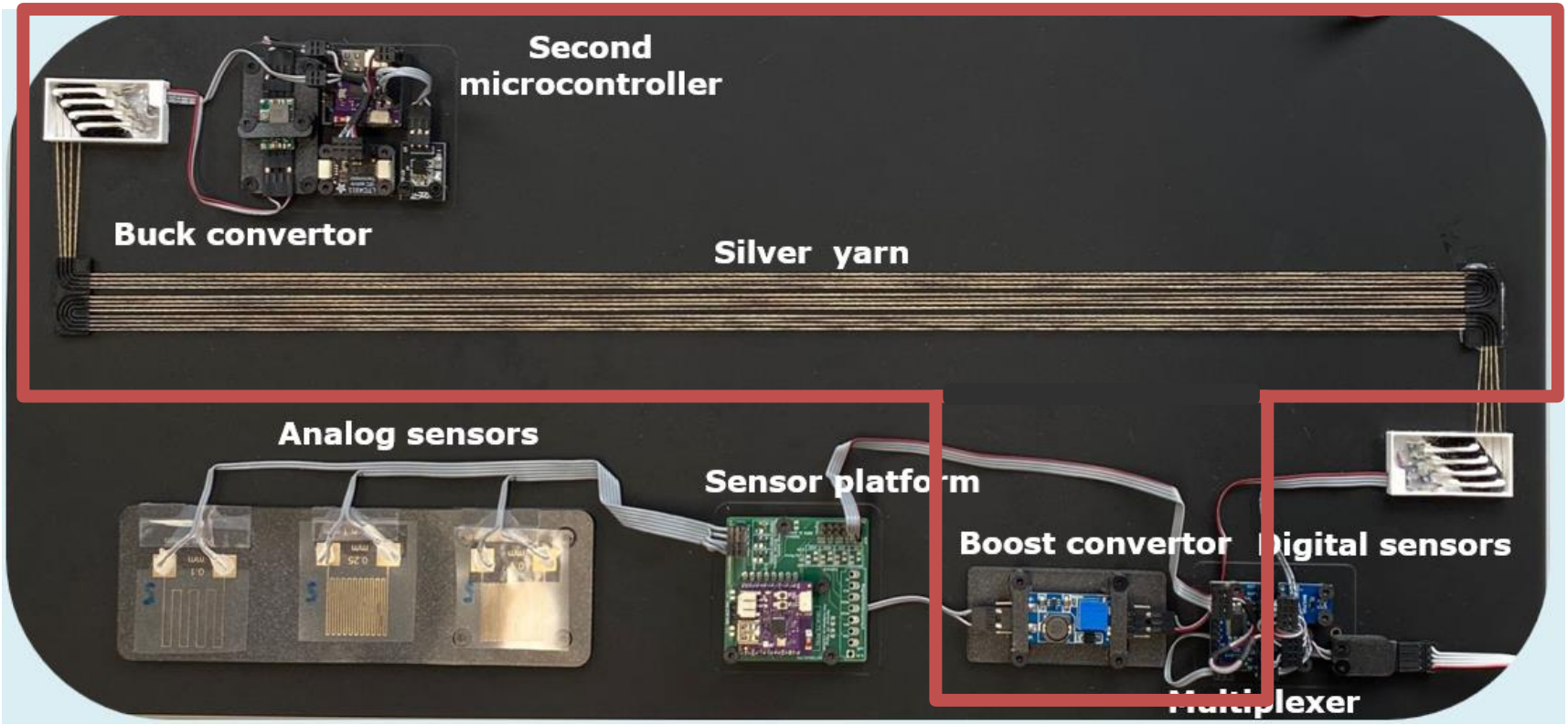
- The digital sensors and the multiplexer
  - PPG sensor:
    - Cable length +2 meters
    - Continuous data



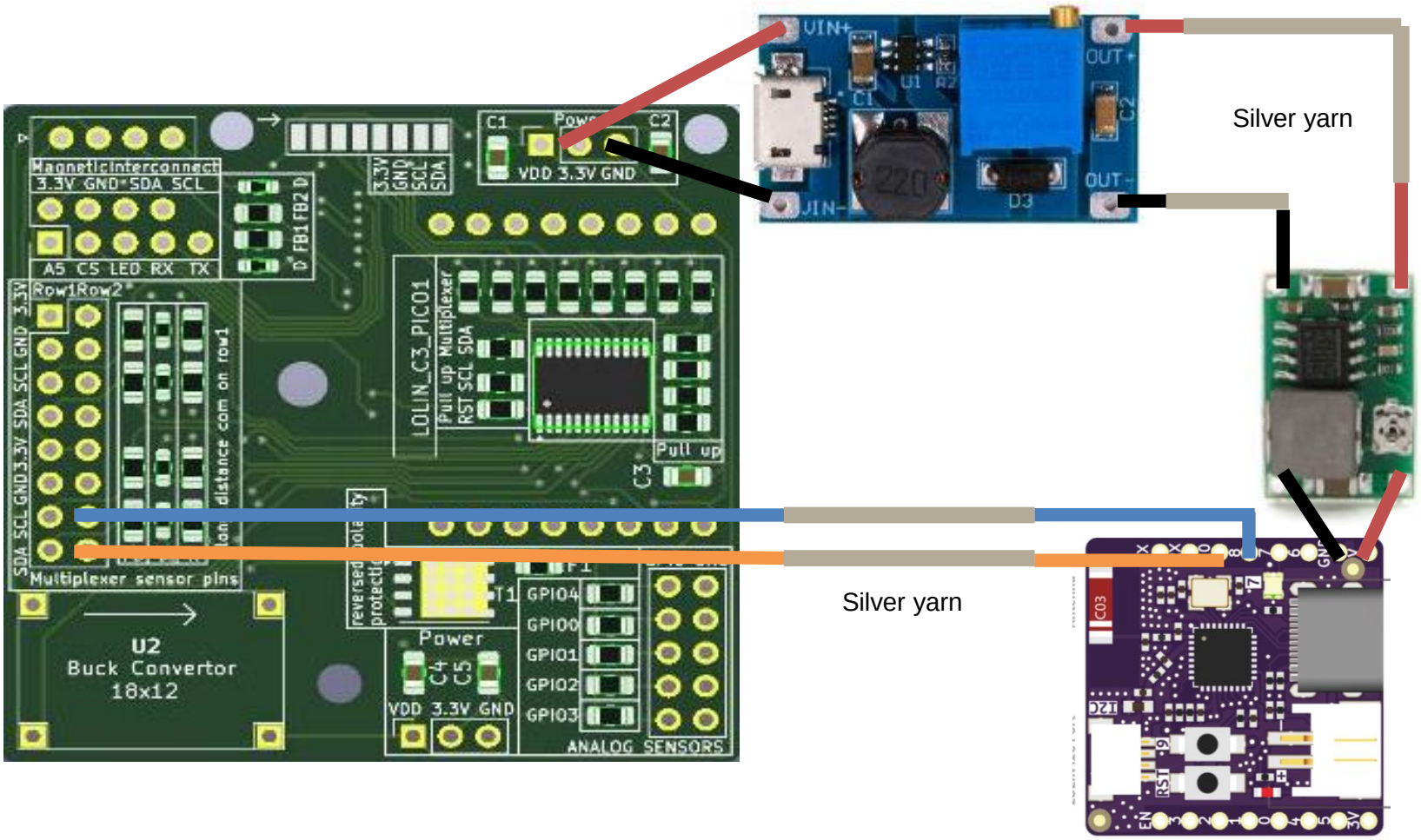


Materials & Results

- The demonstrator



Materials & Results



Materials & Results

- Communication to second microcontroller throughout silver yarn
  - Here is where problems occurred
    - Second microcontroller was powered and collected its data
      - Unable to send its data back to sensor platform through only silver yarn (1)
      - Able to send its data back through silver yarn where the ground was connected with a normal wire (2)

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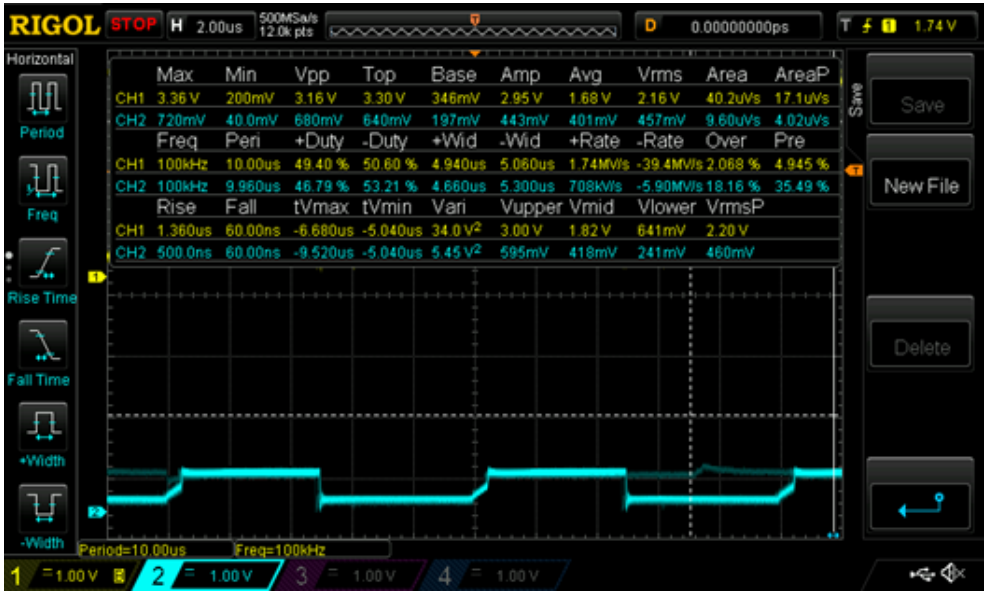
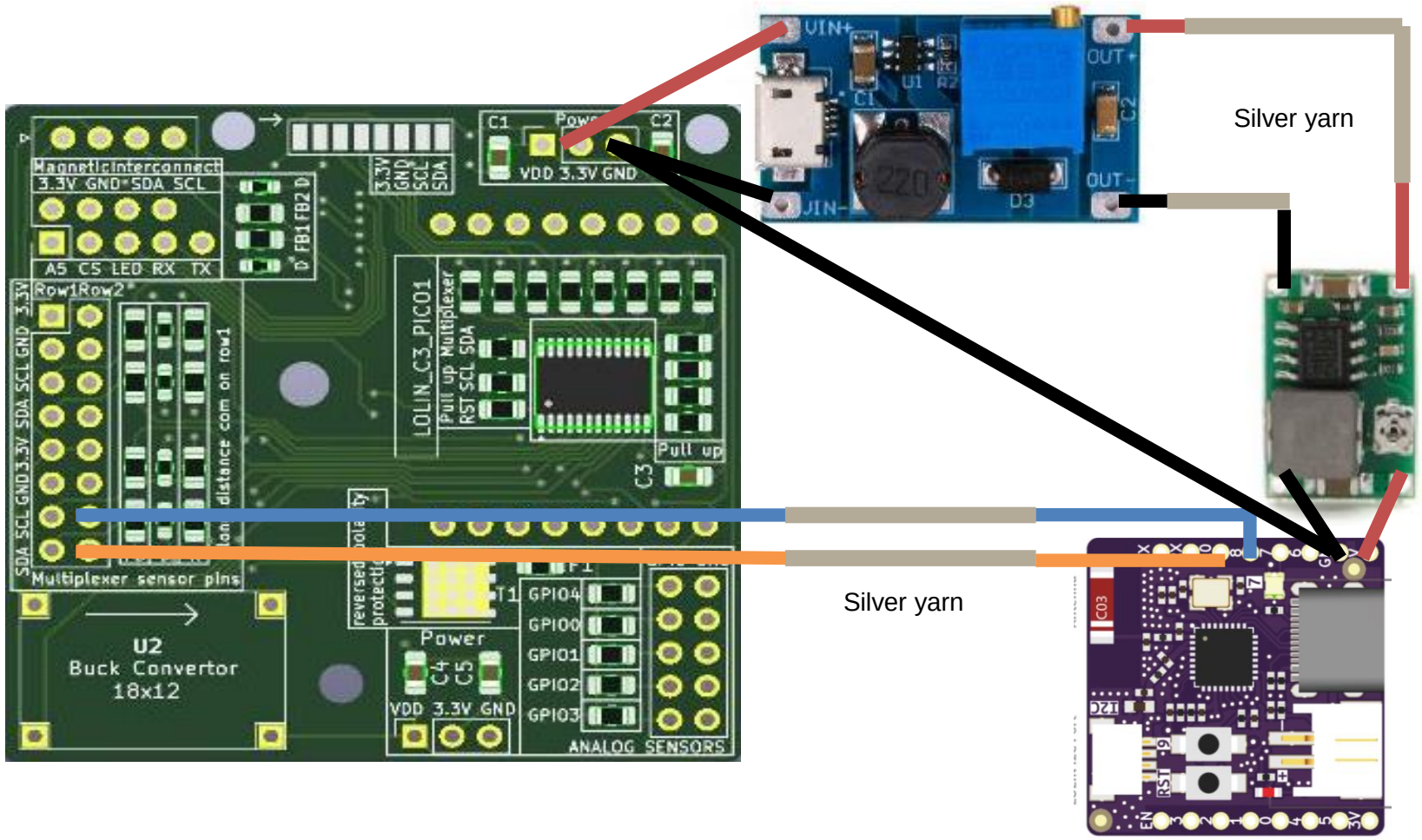


1

Materials & Results



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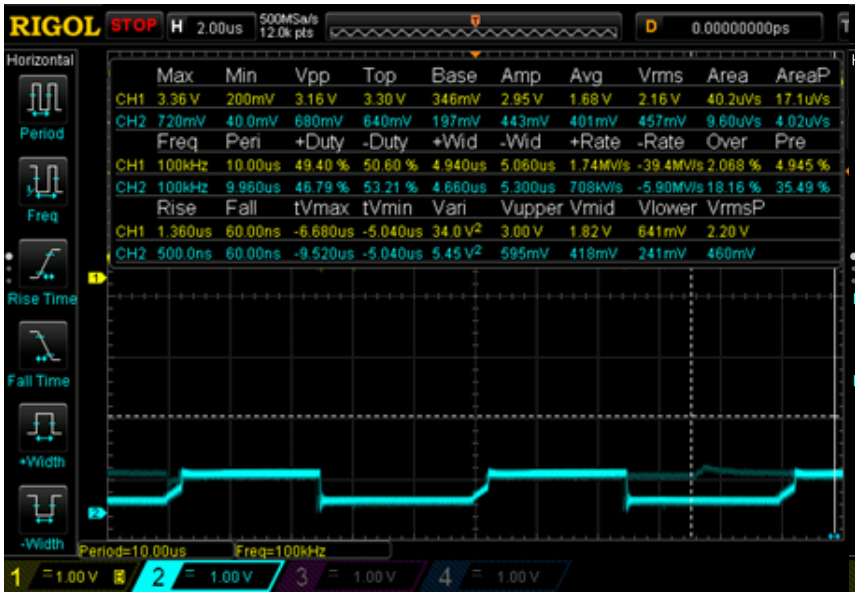
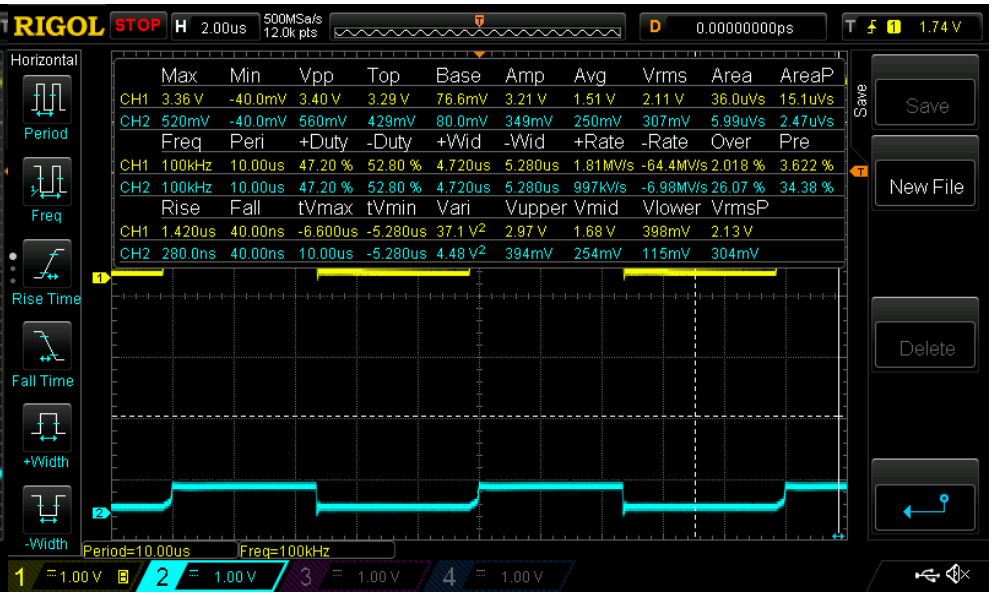


1



2

Materials & Results

- Communication to second microcontroller throughout silver yarn
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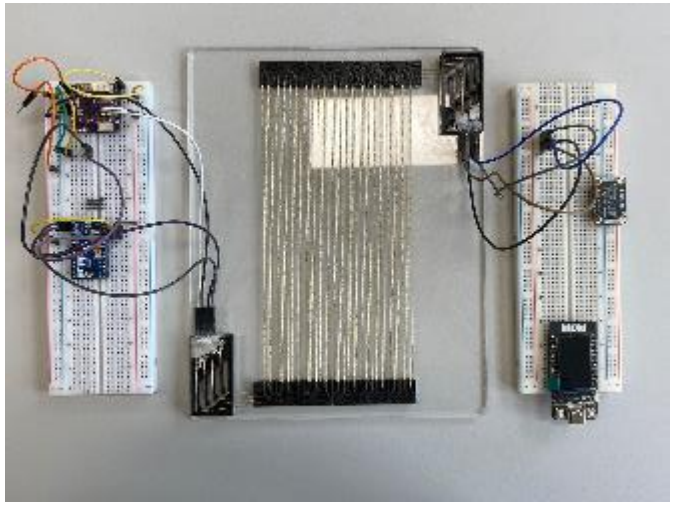
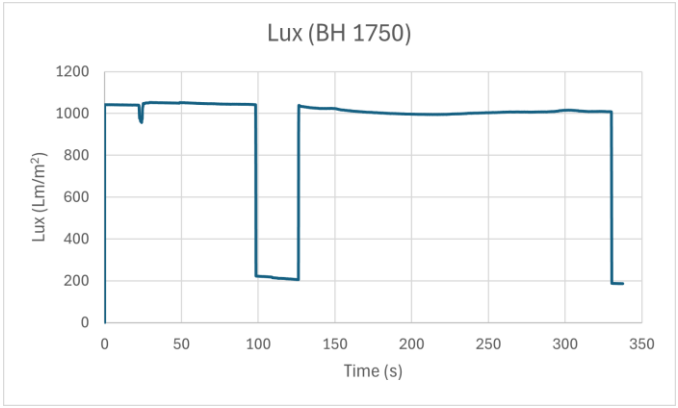
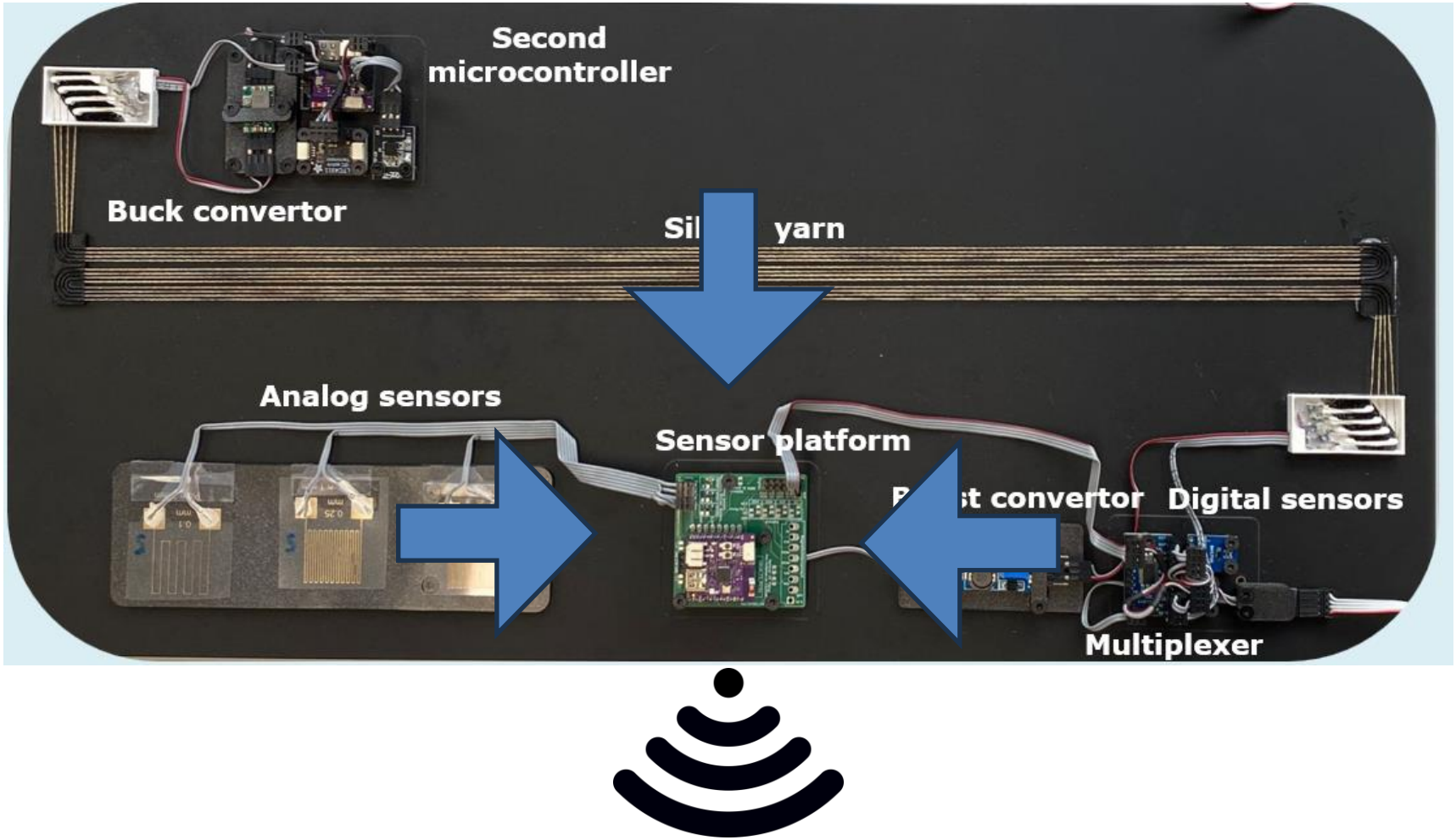
    - Second microcontroller was powered and collected its data
      - Unable to send its data back to sensor platform through only silver yarn (1)
      - Able to send its data back through silver yarn where the ground was connected with a normal wire (2)
  - However, readout from sensor throughout silver yarn works





Materials & Results

- Storing data in database



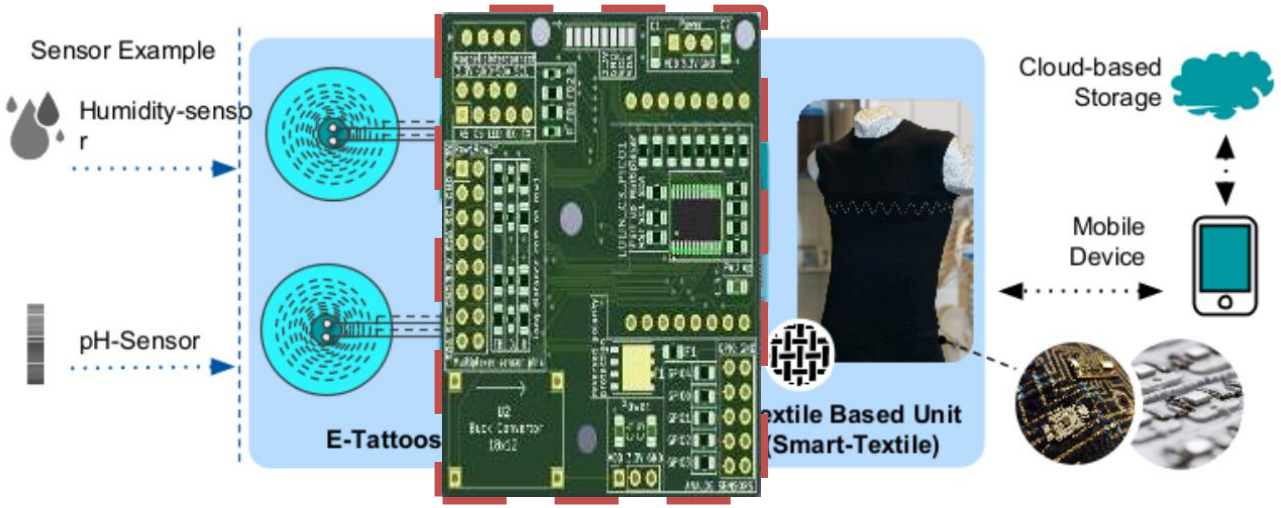
Materials & Results

- Stroring data in database
  - InfluxDB
    - Open-source time series database

Conclusion

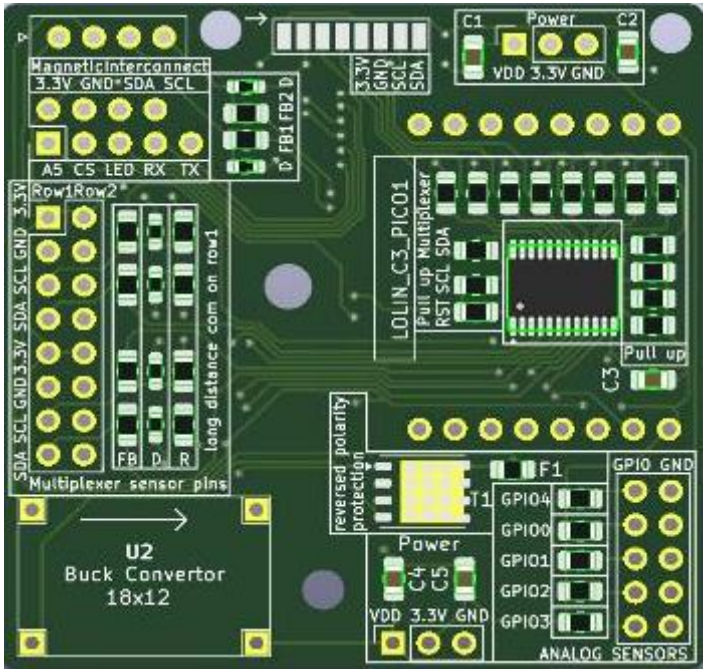
- The sensor platform fulfilled its role in the Hybrid E-Tattoo project
  - For the readout of the sensors
  - Not for the second microcontroller
- Designed from electronic perspective
  - User cases introduced -> design adapted accordingly
- Room for optimalization in every part of demonstrator
  - Analog sensors: Resolution can be optimized by ADC attenuation or with different pre-connected resistor values
  - Digital sensors: Calibration of sensors can be optimized

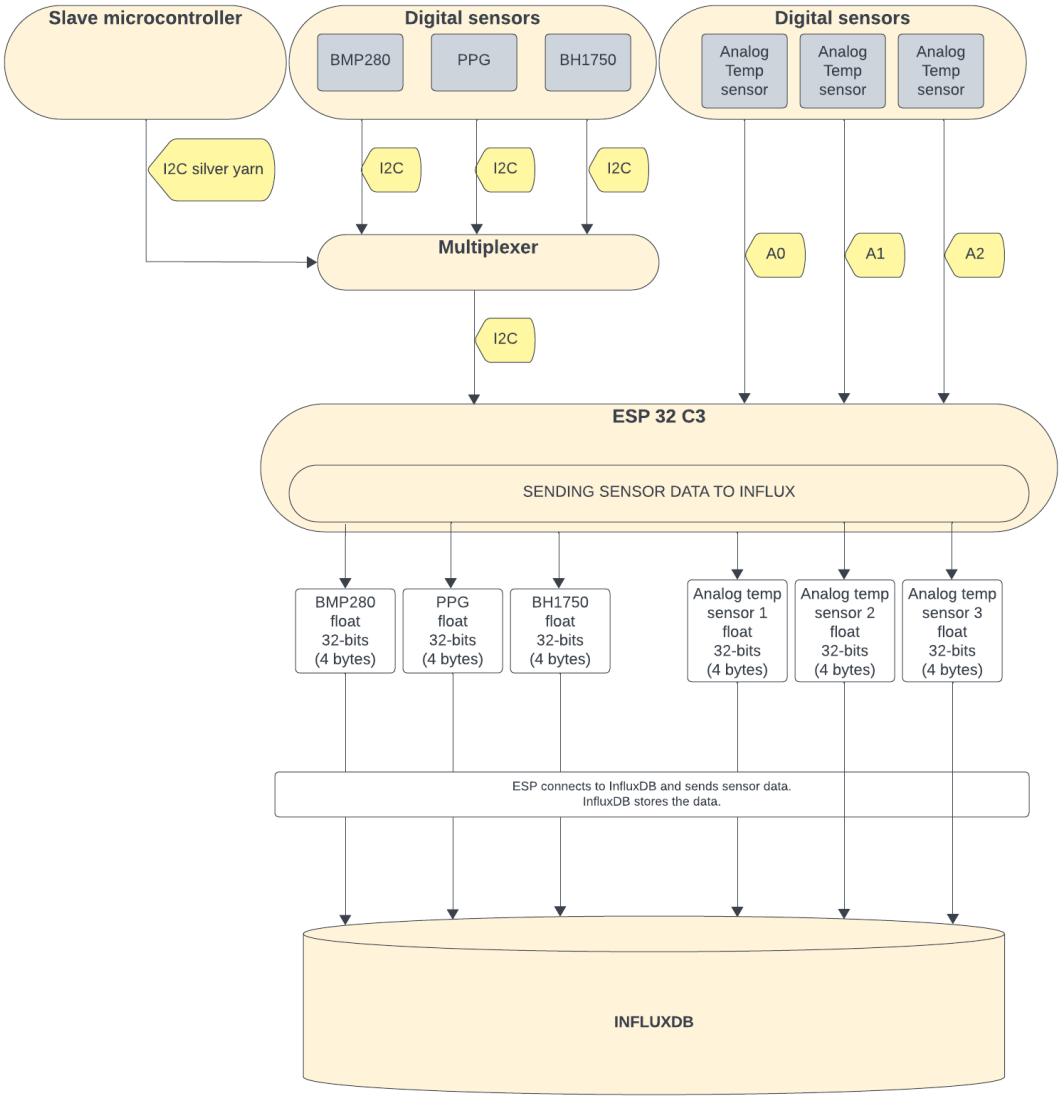
Conclusion



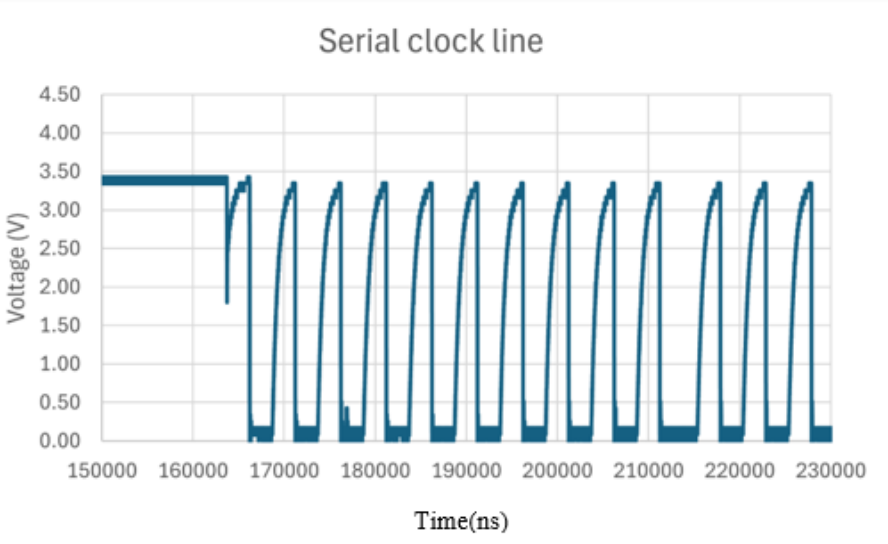
Sensor hub!

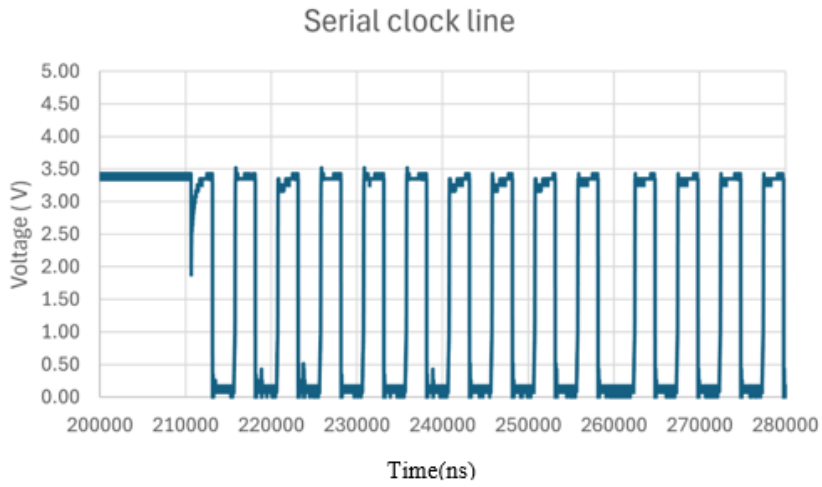
- The sensor platform
  - 5 x 5 cm custom PCB
  - Connections to all external sensors and devices
  - Not of the same prototype as the one used on the demonstrator
  - More optimized
    - Multiplexer chip, security and long-distance communication components
    - Transistor and fuse
    - Pull up resistors
    - Ferrite beads
    - ESD suppressors




Slave microcontroller
Digital sensors
BMP280
PPG
BH1750
Digital sensors
Analog Temp sensor
Analog Temp sensor
Analog Temp sensor
I2C silver yarn
I2C
I2C
I2C
Multiplexer
A0
A1
A2
I2C
ESP 32 C3
SENDING SENSOR DATA TO INFLUX
BMP280 float 32-bits (4 bytes)
PPG float 32-bits (4 bytes)
BH1750 float 32-bits (4 bytes)
Analog temp sensor 1 float 32-bits (4 bytes)
Analog temp sensor 2 float 32-bits (4 bytes)
Analog temp sensor 3 float 32-bits (4 bytes)
ESP connects to InfluxDB and sends sensor data.
InfluxDB stores the data.
INFLUXDB


LTC4311
I2C active
Terminator
GND
SDA
VIN
SCL
EN


Serial clock line
Voltage (V)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
150000
160000
170000
180000
190000
200000
210000
220000
230000
Time(ns)


Serial clock line
Voltage (V)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
200000
210000
220000
230000
240000
250000
260000
270000
280000
Time(ns)