5TH CLABIO
LATIN AMERICAN BIOIMPEDANCE
FLORIANOPOLIS – BRAZIL - 2024

Low power and miniaturized wearable medical device: prototype study

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Introduction

Diabetes: insufficient production of poor absorption of insulin;
Diabetes worldwide:
- 1.5 million deaths related;
- 1 in 10 individuals between 20 and 79 Years old;

Diabetes in Brazil:
- 214000 deaths in 2021;
- Spending related to 42 billion dollars

Introduction

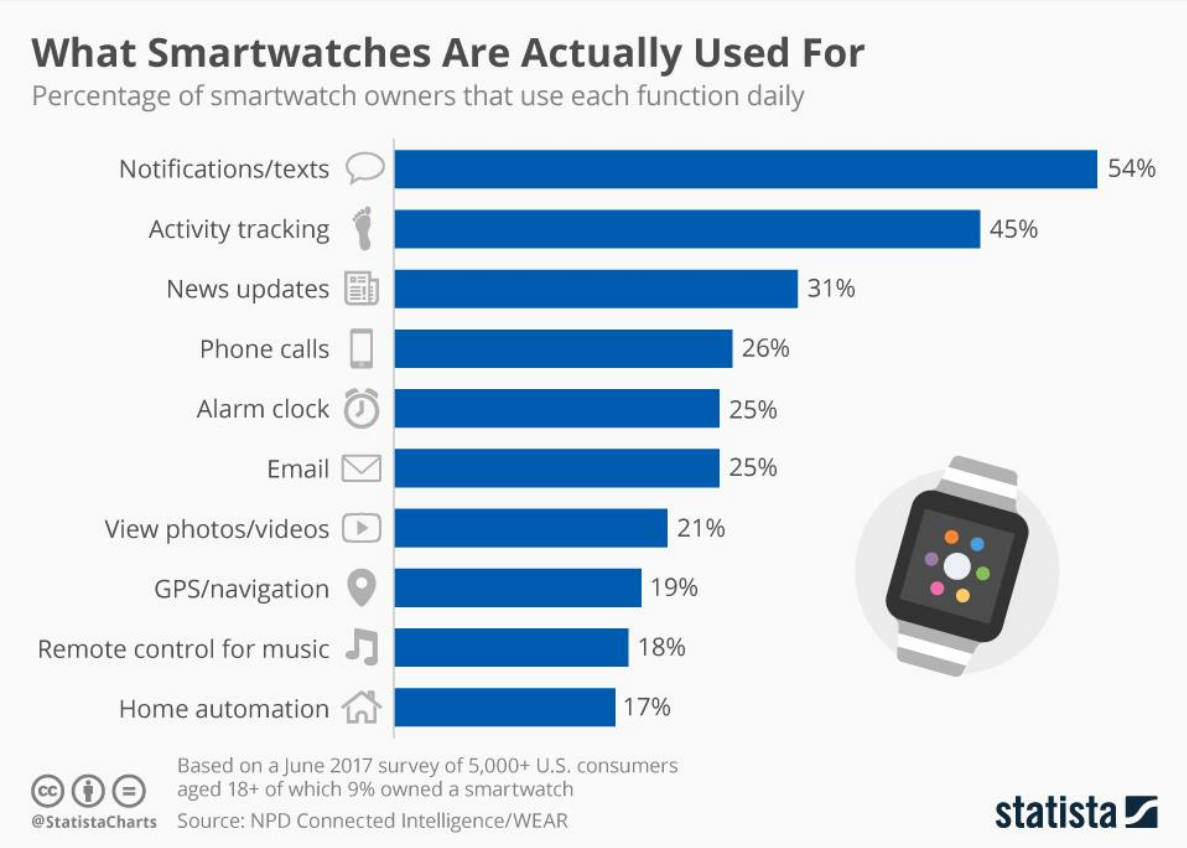
Finger prick
- Pain;
- Costly;
- Infections

CGM (Minimaly invasive)
- Costly;
- Sensor changings

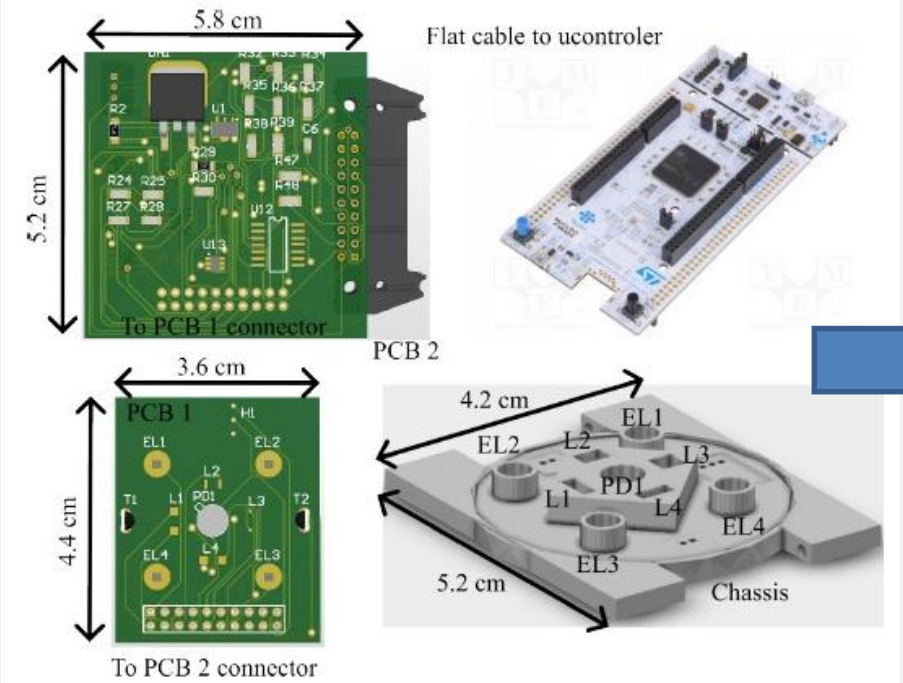
Wearable (Noninvasive)
- Convergence;
- No sensor changes;

Introduction

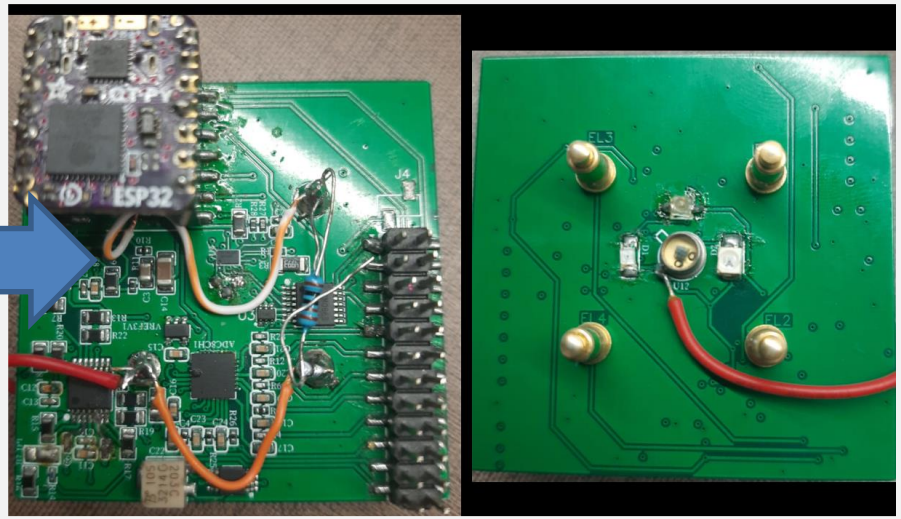
Research – wearables for medical
- Cardiovascular helth;
- Correlation – activity x diseases



Introduction

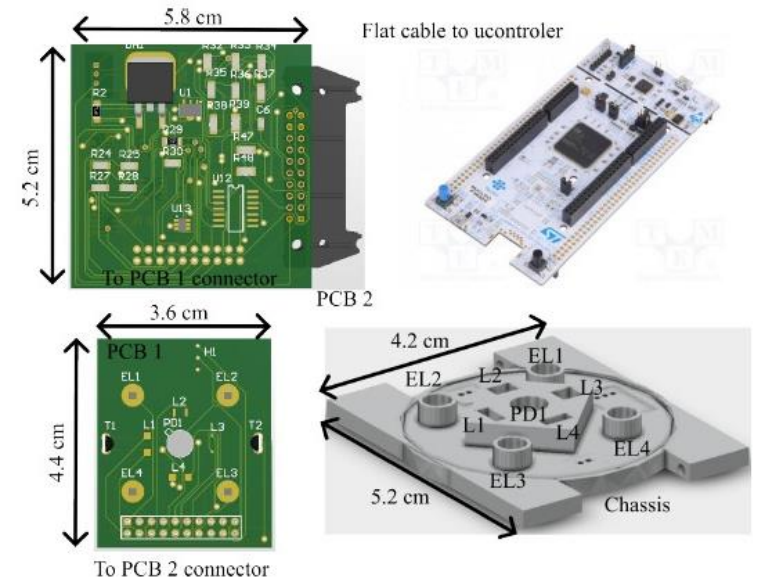


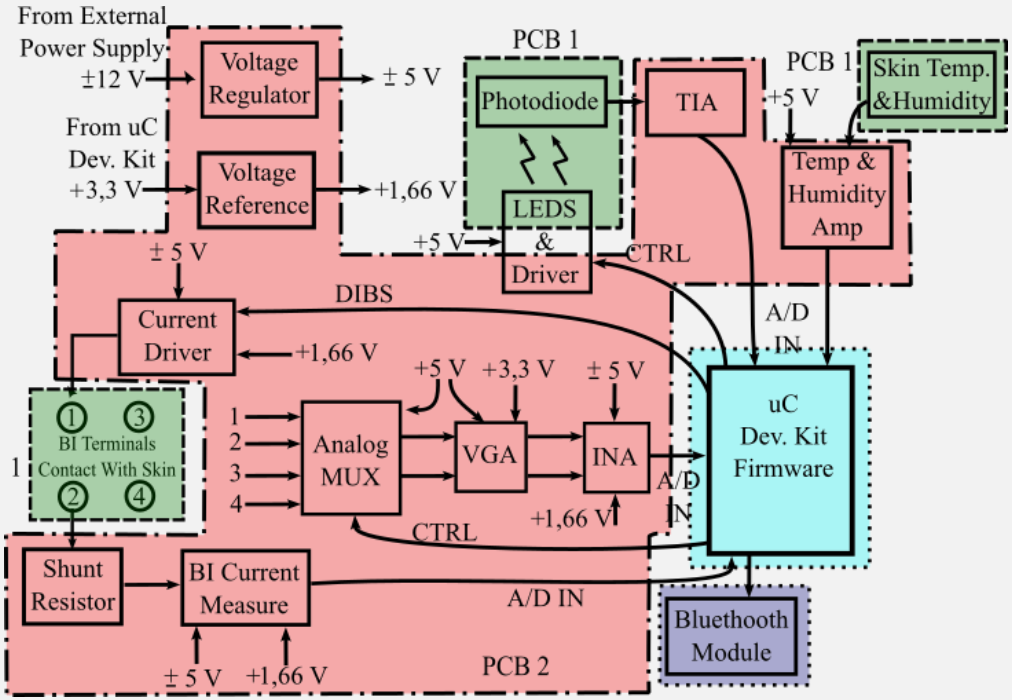
- High volume in two packages
- 9V Battery
- 5V simetric circuit power supply



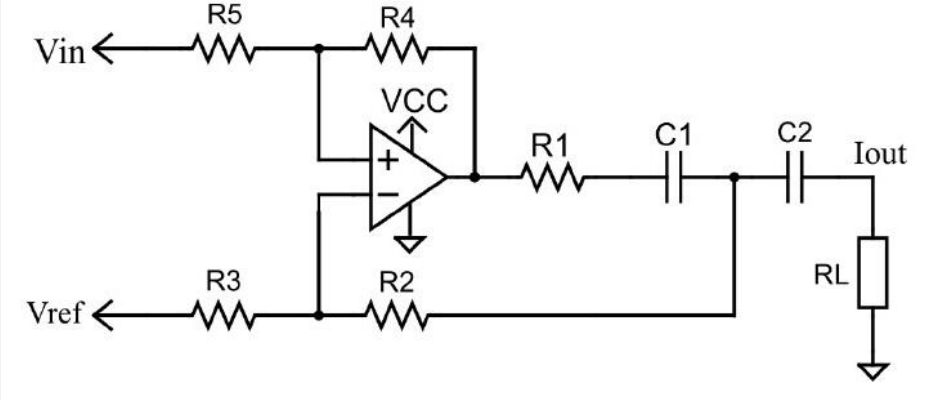
- smaller volume in one package
- 3.3 V Battery
- 3.3 V simple circuit power supply

Noninvasive Bioimpedance Glucometer: current prototype





Design of a Enhanced Howland Current Source for battery power supply



$$R4 = R5 \text{ and } R3 = R2 + R1$$

$$Iout = \frac{Vin - Vref}{R1}$$

Specifications	
Power supply	+3.3 V (single)
Output current	250 µAp
DIBS Amplitude (High level)	+ 3.3 V
Output Impedance	> 10 MΩ

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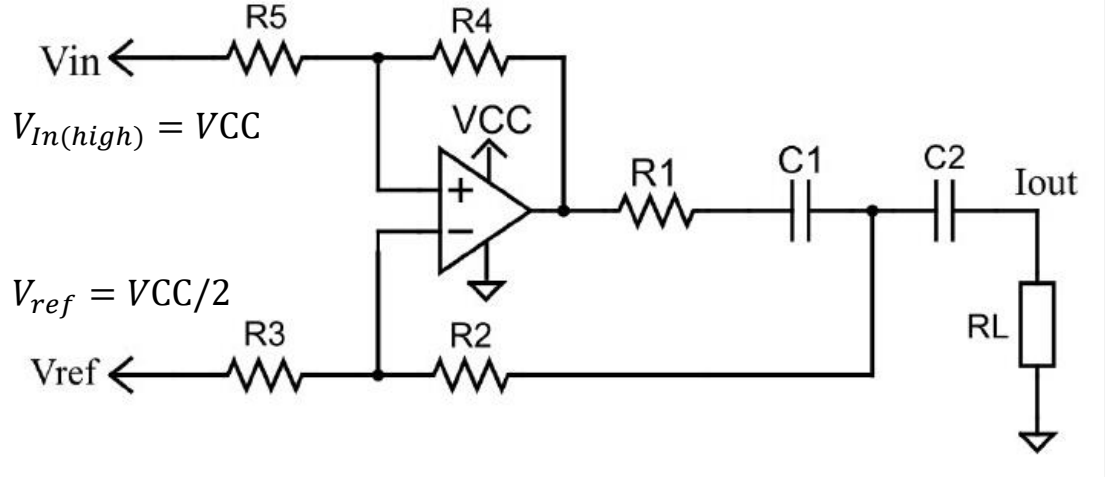


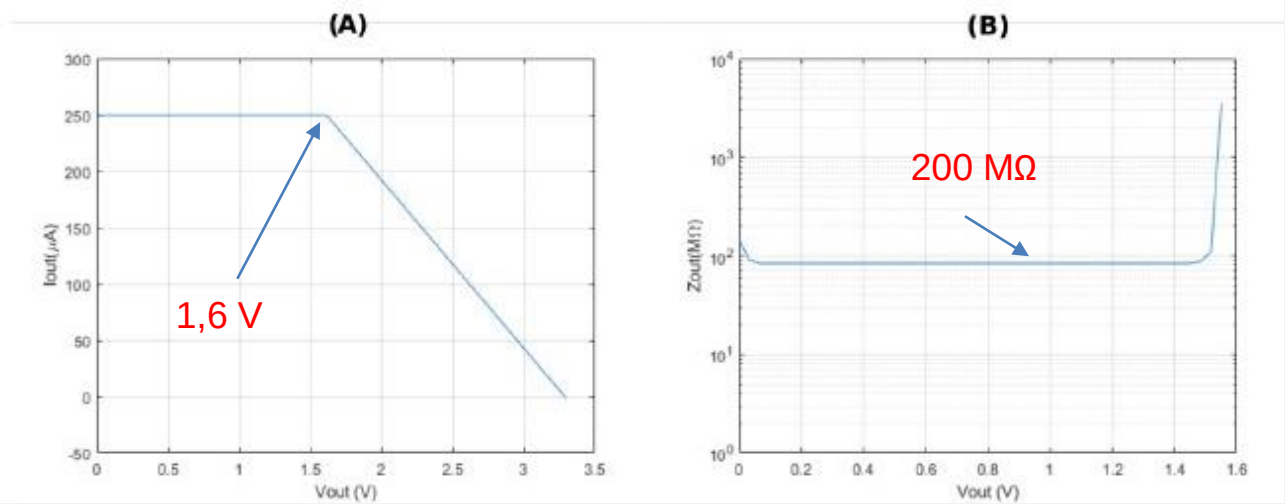
Component Value	
R1	6.6 kΩ
R4 = R5	10 kΩ
R2	100 Ω
R3	6.7 kΩ
C1 = C2	20μF
Opamp	OPA2354

$$R4 = R5 \text{ and } R3 = R2 + R1$$

$$Iout = \frac{Vin - Vref}{R1}$$

OPA2354 Characteristics	
GBW	250 MHz
SR	150 V/μs
Supply voltage (min)	2.5 V (single)
Quiescent current	4.9 mA

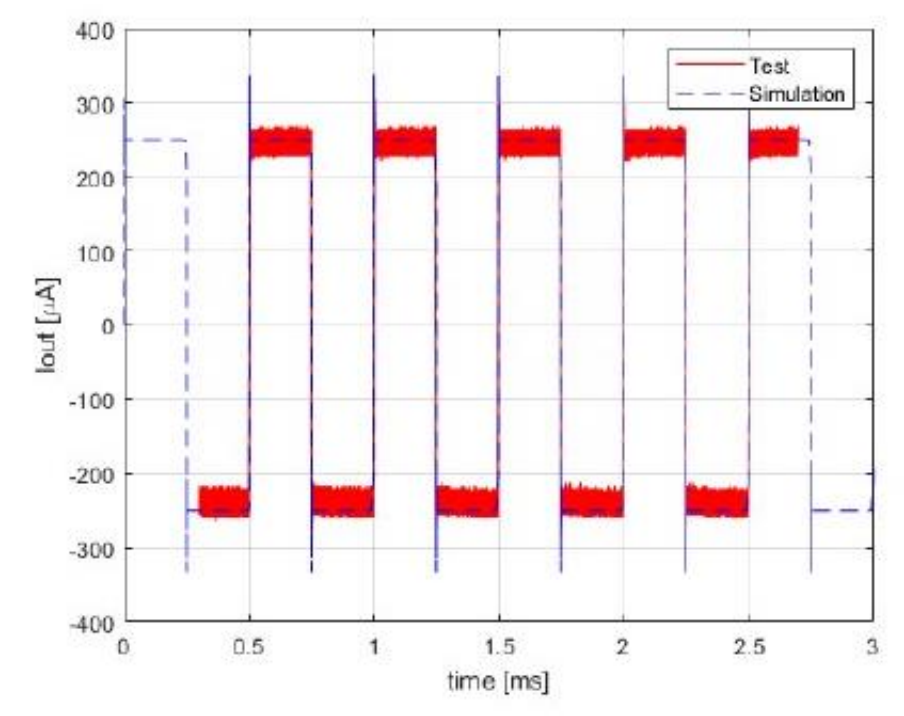
Results and Discussions

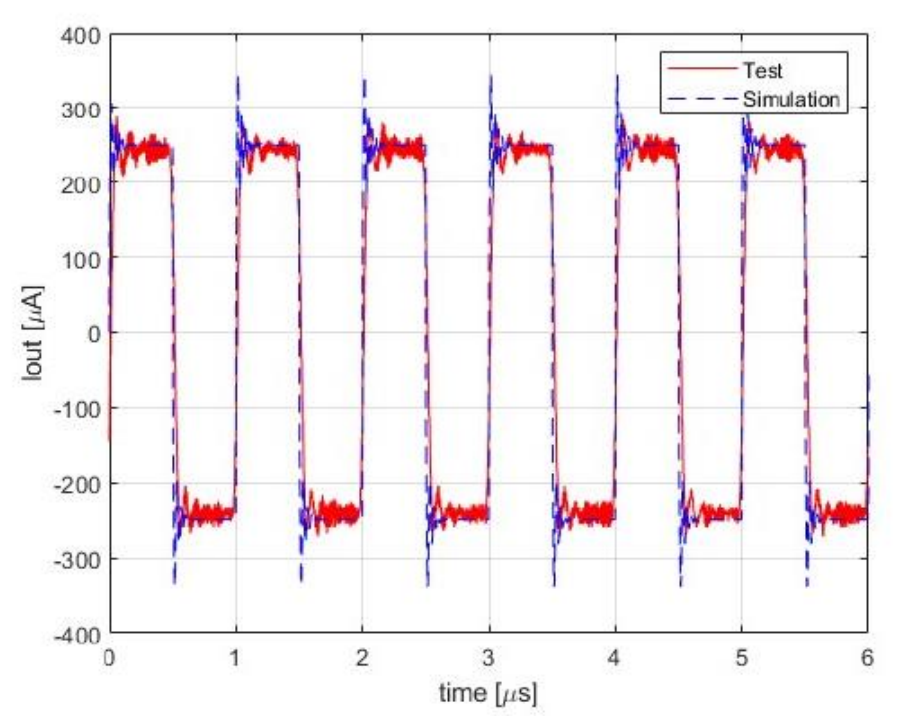


Topology	Iout $(0<T<100°C)$	Iout $(1.8<VCC<3.3\,V)$
EHCS	250.118 to 250.121	249.97 to 250.12

Monte Carlo Simulation	
Tolerance	Iout
1%	246 to 267 μA
0.1%	249.7 to 250.5 μA

Results and Discussions





Final Considerations

The project of a EHCS with low single power supply voltage is presented;

This and other contributions have resulted in a reduction in the volume of a system that is intended to be a wearable device in the future.

However, in order for this project to be scaled up to a comfortable wearable device with low battery consumption, it needs to be reduced to a microscopic scale. This will only be possible by developing an integrated circuit in CMOS technology. This work is in progress and can be verified in DOI: 10.2478/joeb-2024-0017.

The device in which the presented current source operates is currently being tested and the results are presented in the EGluco project dashboard available in https://egluco.bio.br/.

Both simulation and bench results have shown that the current source is robust and accurate with respect to temperature and component variations, and that it is capable of efficiently processing rectangular signals up to 1 MHz, thus having the necessary characteristics to process DIBS-type signals up to this frequency.

Acknowledgements

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