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ECG SENSOR

Electronic System Engineering

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PROJECT SPECIFICATIONS



01 MAIN TASK

The project aims to design an ECG sensor integrated in a chest band

02 PURPOSE

The main objective is to provide users with real-time monitoring of their heart rate during sport activity

03 DATA MANAGEMENT

Data collected by the device can be easily visualized on a connected device to facilitate monitoring and enhance performance





DEVICE SPECIFICATIONS

01 **LOW POWER DEVICE**

02 **LOW COST**

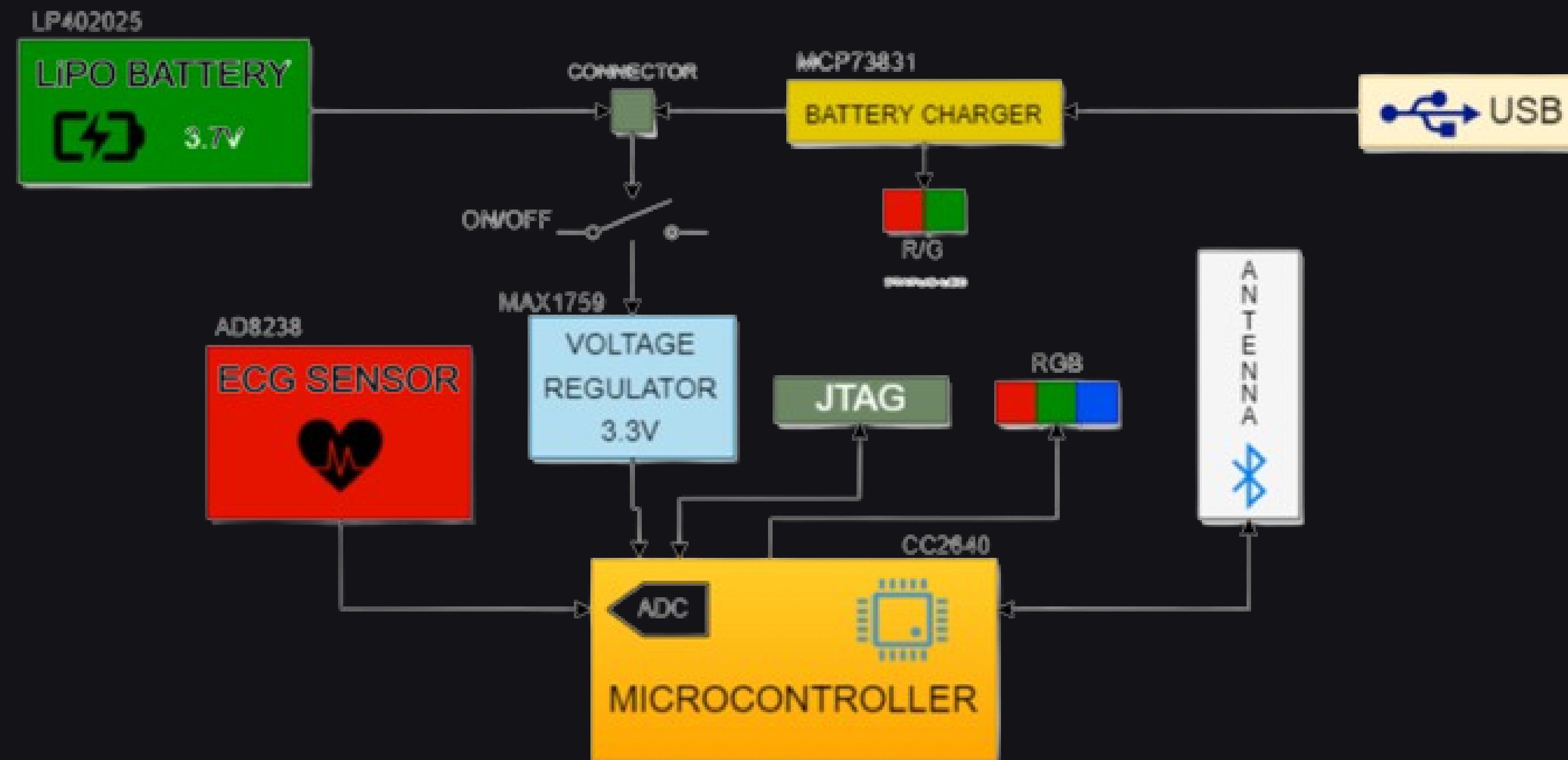
03 **PORTABLE DEVICE**

04 **BLE COMMUNICATION
FOR FITNESS
MONITORING**

05 **RECHARGEABLE
BATTERY VIA USB
CONNECTOR**

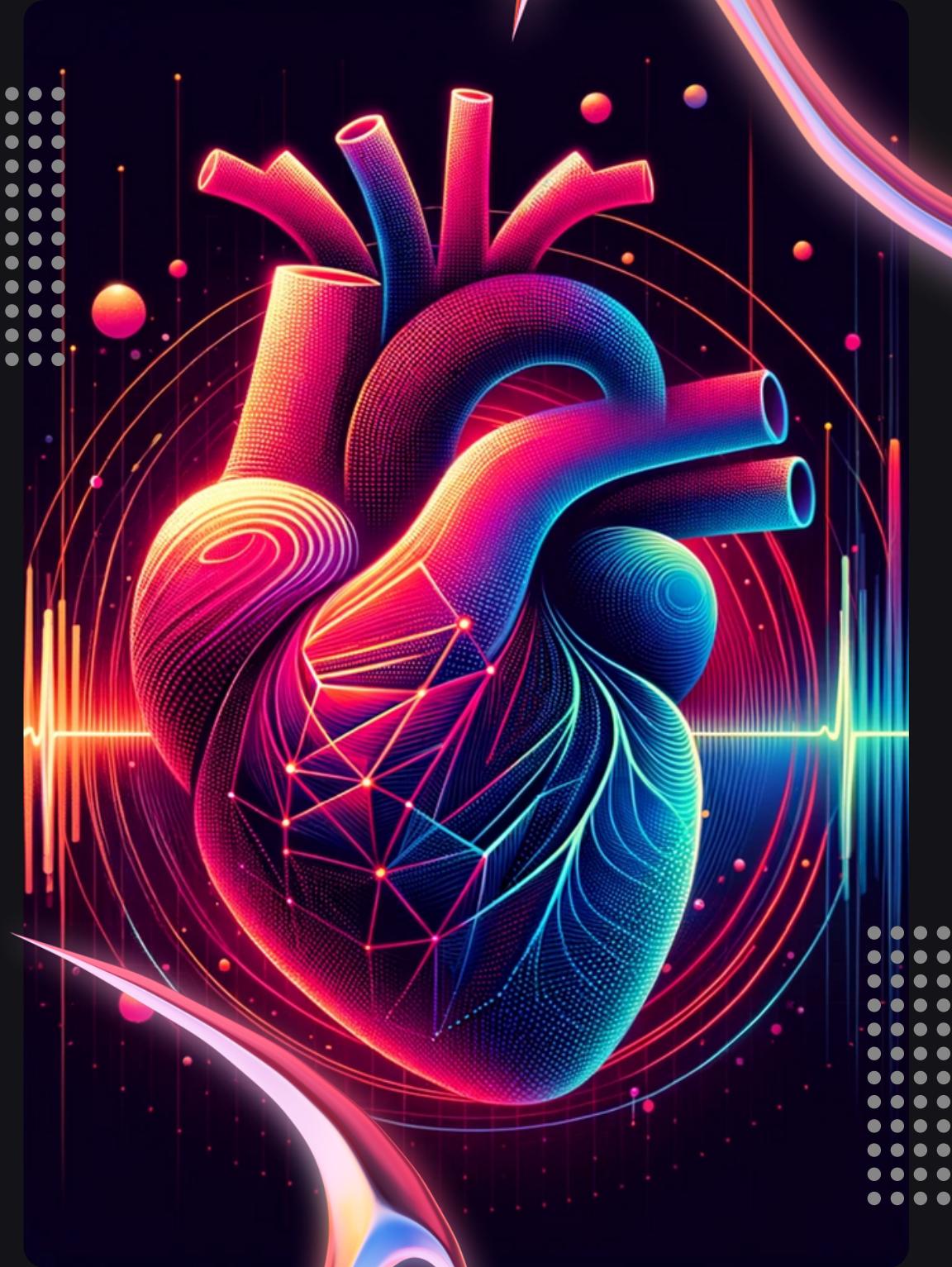


BLOCK DIAGRAM





ELECTRONIC COMPONENTS



ECG SENSOR

**AD8232 -
ANALOG
DEVICES**



- 01 LOW SUPPLY CURRENT**
170 μ A
- 02 SUPPLY VOLTAGE**
2.0-3.5 V
- 03 CMRR**
80dB
- 04 HIGH SIGNAL GAIN**
 $G=100$
- 05 LOW PRICE**
€4.55 (Farnell)



ALTERNATIVE ECG SENSORS

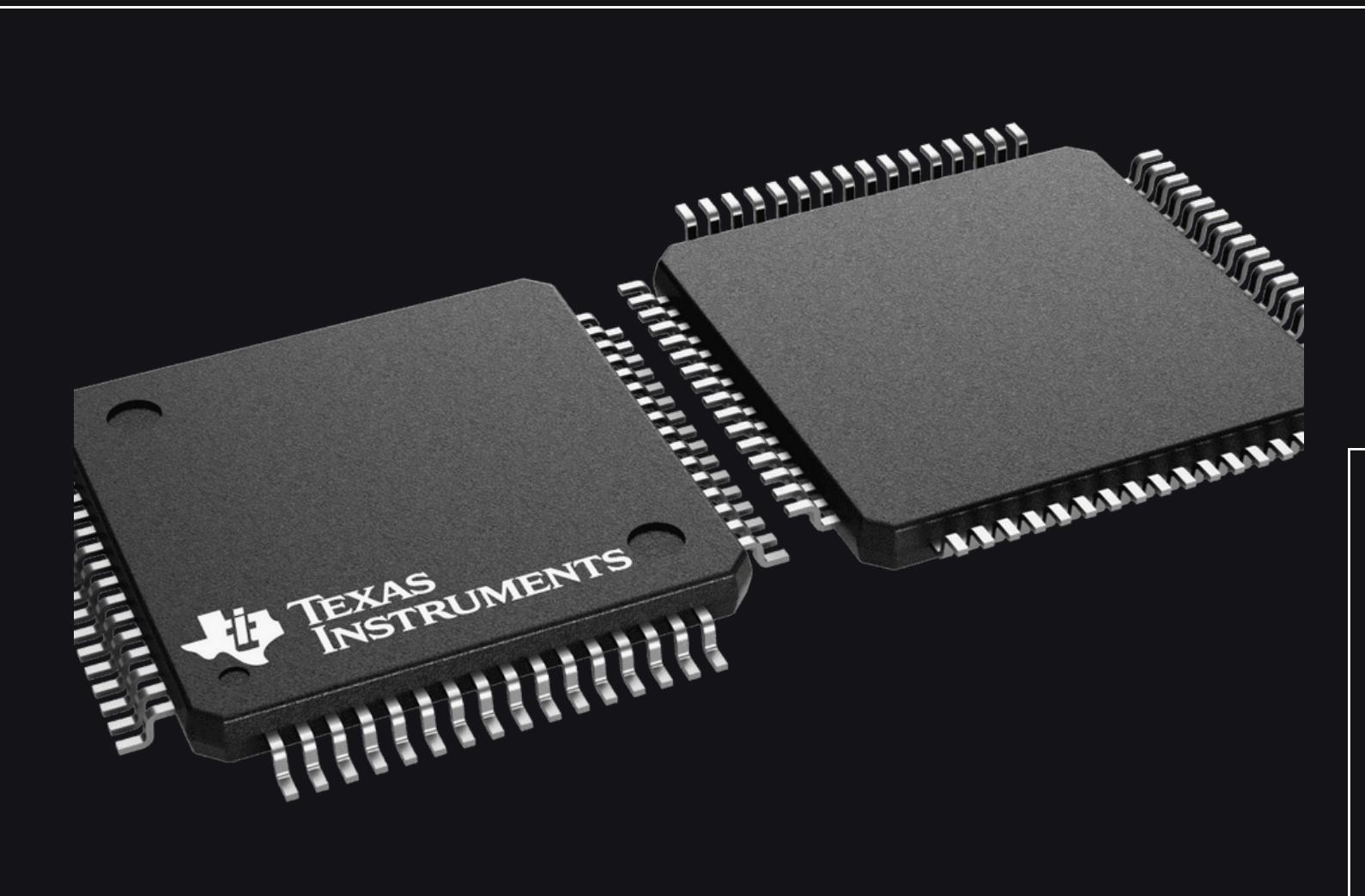
ADS1194 - TEXAS INSTRUMENTS

- Higher supply Voltage
- Higher supply Current
- Integrated ADC
- High complexity

MAX30003 - ANALOG DEVICES

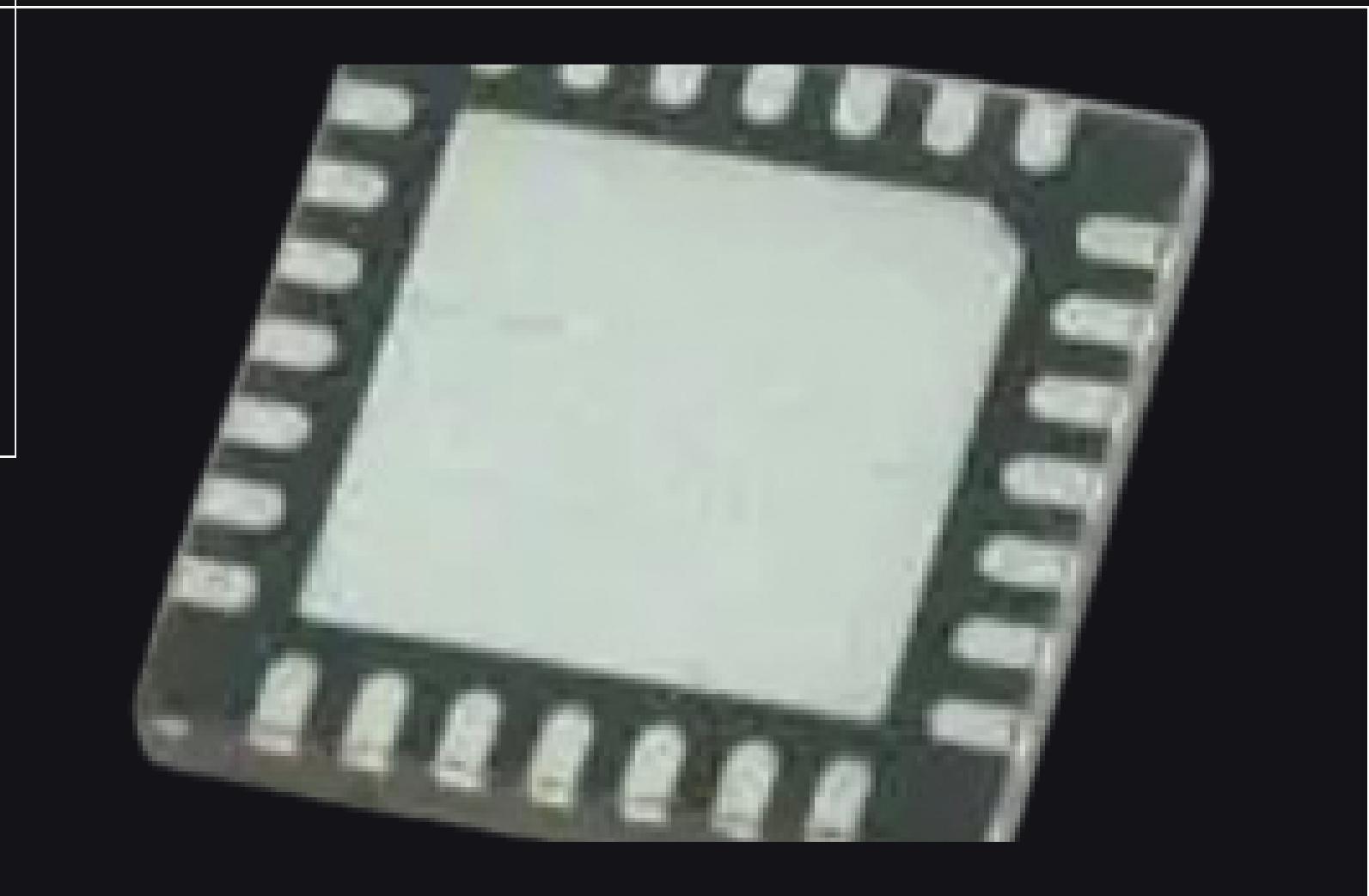
- High quality
- Very high cost
- Low voltage (2 V)
- High ADC resolution





ADS1194 - TEXAS INSTRUMENTS

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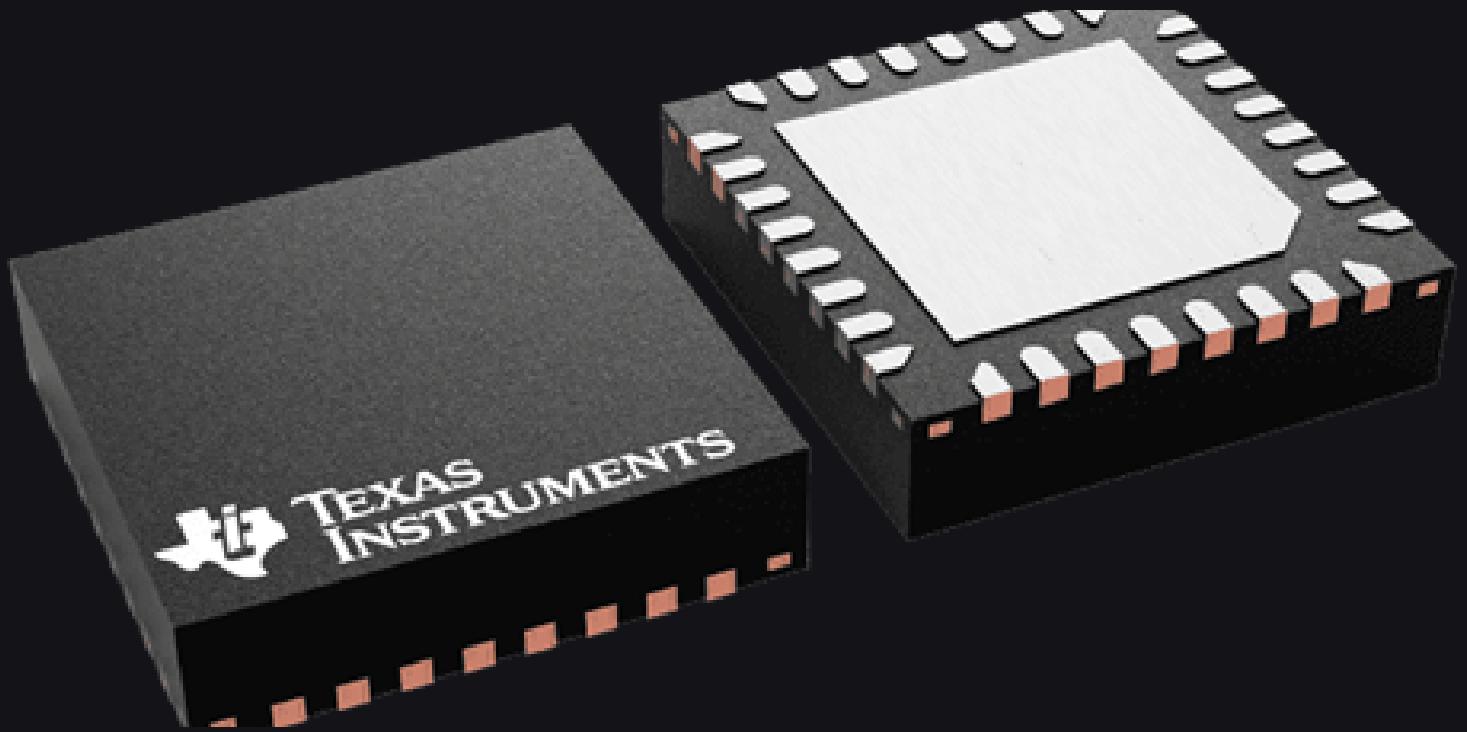


MAX30003 - ANALOG DEVICES



MICROCONTROLLER

CC2640 - TEXAS INSTRUMENTS



01 ARM CORTEX M3

02 SUPPLY VOLTAGE

1.8 - 3.8 V

03 INTEGRATED
BLUETOOTH MODULE

04 INTERNAL ADC

12 bit (8 channels)

05 CLOCK FREQUENCY

Up to 48 MHz

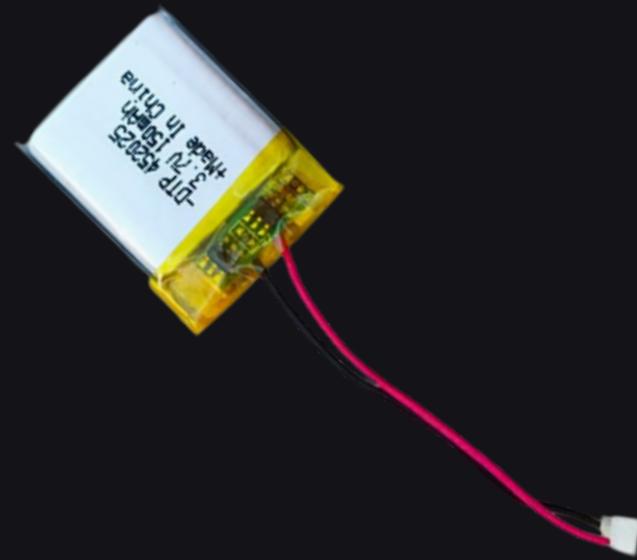
06 LOW PRICE

€3.88 (Mouser)

POWER COMPONENTS

LP402025

Rechargeable
LiPO Ion Battery
150 mAh



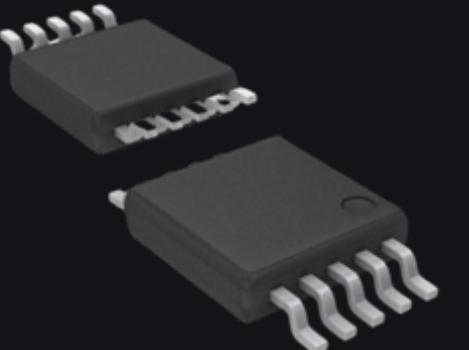
MCP73831

USB Battery
charger



LP402025

Buck/Boost
converter



RGB LED

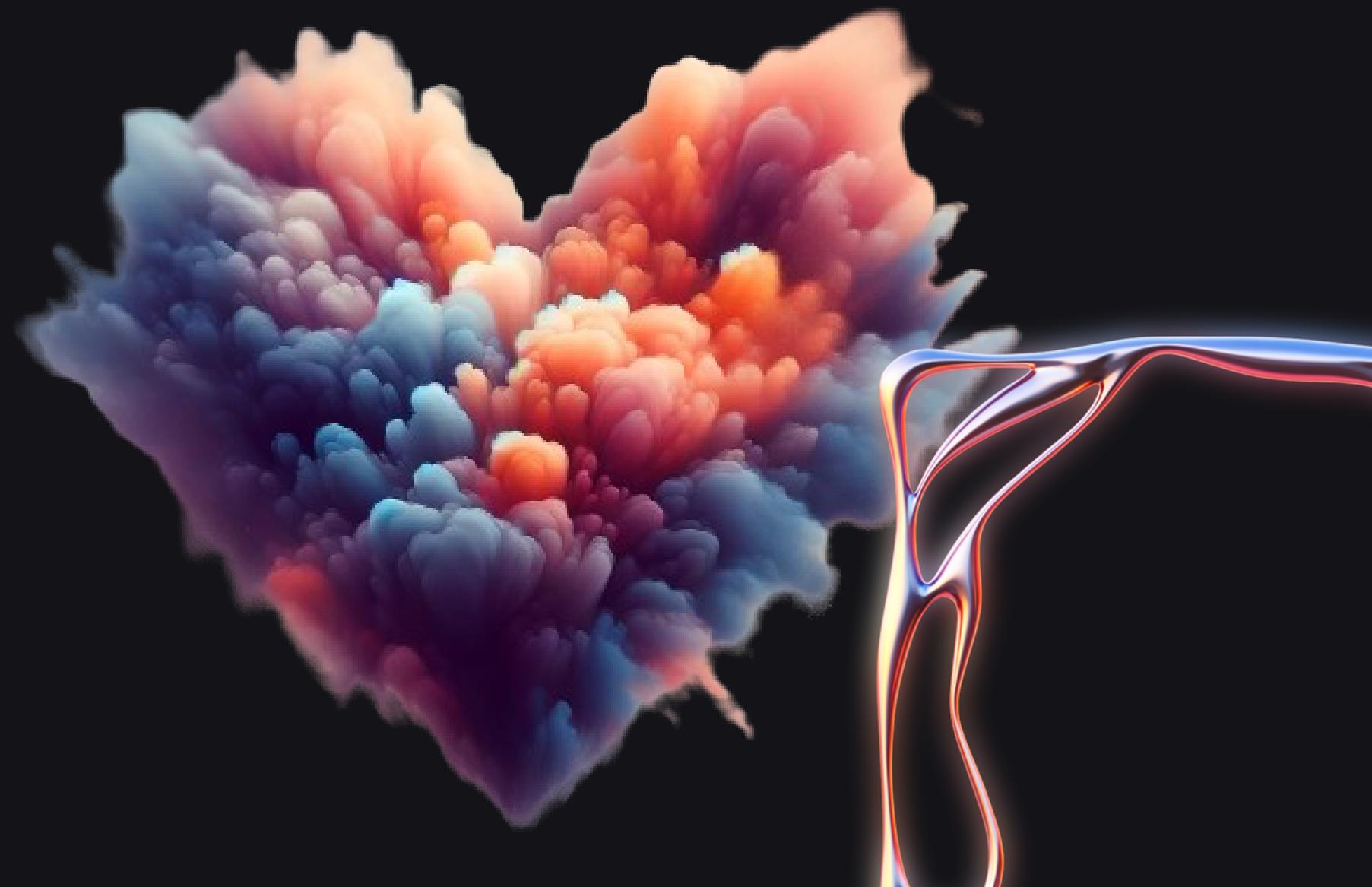


**ON/OFF
SWITCH +
PASSIVE
COMPONENTS**





POWER CONSUMPTION





POWER CONSUMPTION

MAIN POWER CONTRIBUTION

- CC2640 Microcontroller : Active-Mode 1.45 mA + 31 uA/MHz, Stand-by-Mode 1.5 uA; transmitting Mode 9.1 mA
- RGB LEDs : 5 mA x 3, reverse current 10 uA
- AD8232 ECG sensor : 170 uA (in normal conditions)

In typical sport activities, where there is a need to monitor cardiovascular activity, predicting the amount of time the device is actively used could be difficult because it varies on the application.

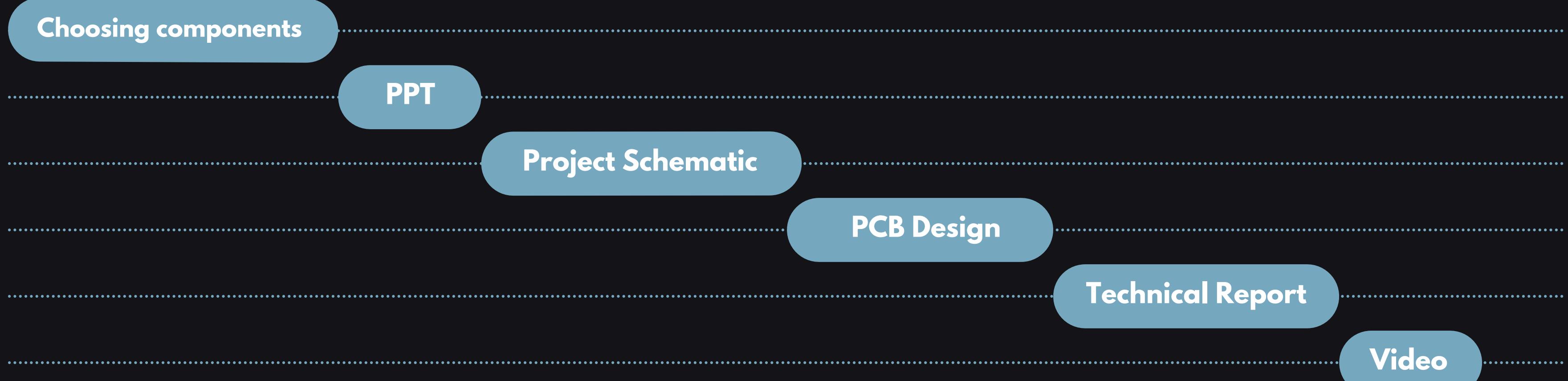
AVERAGE CURRENT CONSUMPTION

It is reasonable to consider the system always active , (needs to sample @ 250 Hz) and transmitting the data via Bluetooth for 10 ms every second, and the LED blinking for a tenth of a second, for each second :

- Microcontroller : (normal mode) $(1.45 + 0.031*48)mA + (\text{transmitting mode})(0.01 * 9.1)mA = 3.02 mA$
- ECG sensor : 0.17 mA
- LED : (active mode) $(0.1 * 5)mA + (\text{rev current})(0.9*0.01)mA = 0.51 mA$

TOTAL BATTERY DURATION = 150 mAh / (3.02 mA + 0.17 mA + 0.51 mA) = 40 h

GANTT DIAGRAM



6th Nov
2023

13th Nov
2023

20th Nov
2023

30th Nov
2023

4th Dec
2023

11th Dec
2023

18th Dec
2023

25th Dec
2023

1st Jan
2024

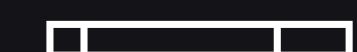
8th Jan
2024

14th Jan
2024

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MARKET ANALYSIS





COST ESTIMATION

	1 PCB	10 PCB	100 PCB	1000 PCB
• AD8232 (ECG Sensor)	4.25 €	3.81 €	3.61 €	3.61 €
• CC2640 (Microcontroller)	4.01 €	3.58 €	2.94 €	2.94 €
• Battery Charger MCP73831	0.69 €	0.69 €	0.56 €	0.56 €
• Buck/Boost converter MAX1759	6.88 €	6.22 €	5.15 €	5.15 €
• LEDs and passive components	12.19€	9.39€	6.83€	6.83€
• Electrodes & Soldering	18.20€	18.20€	18.20€	18.20€
• PCB	38.83€	6.84€	1.80€	0.74€
• Stencil	\	\	0.33€	0.03€

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COMPETITORS

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As competitors, we consider a broader range of devices incorporating ECG sensors. Beyond traditional chest straps, smartwatches and medical devices are also assessed.



ECG CHEST STRAP

GARMIN



01 DESCRIPTION

ECG chest brand provides accurate heart rate tracking and shares workout information with online training apps

02 PRICE

€69.99

03 LINK

[https://www.garmin.com/it-
IT/p/649059](https://www.garmin.com/it-IT/p/649059)

SMART WATCH



TECH FEEL

01 DESCRIPTION

Smartwatch with ECG that combines the main features of a smartwatch with comprehensive heart monitoring

02 PRICE

€149.99

03 LINK

https://www.techmadeshop.eu/index.php?id_product=1074&controller=product

POR TA BLE ECG

ALIVECOR



01 DESCRIPTION

Pocket-sized ECG for smartphones without the need for cables or contact gel

02 PRICE

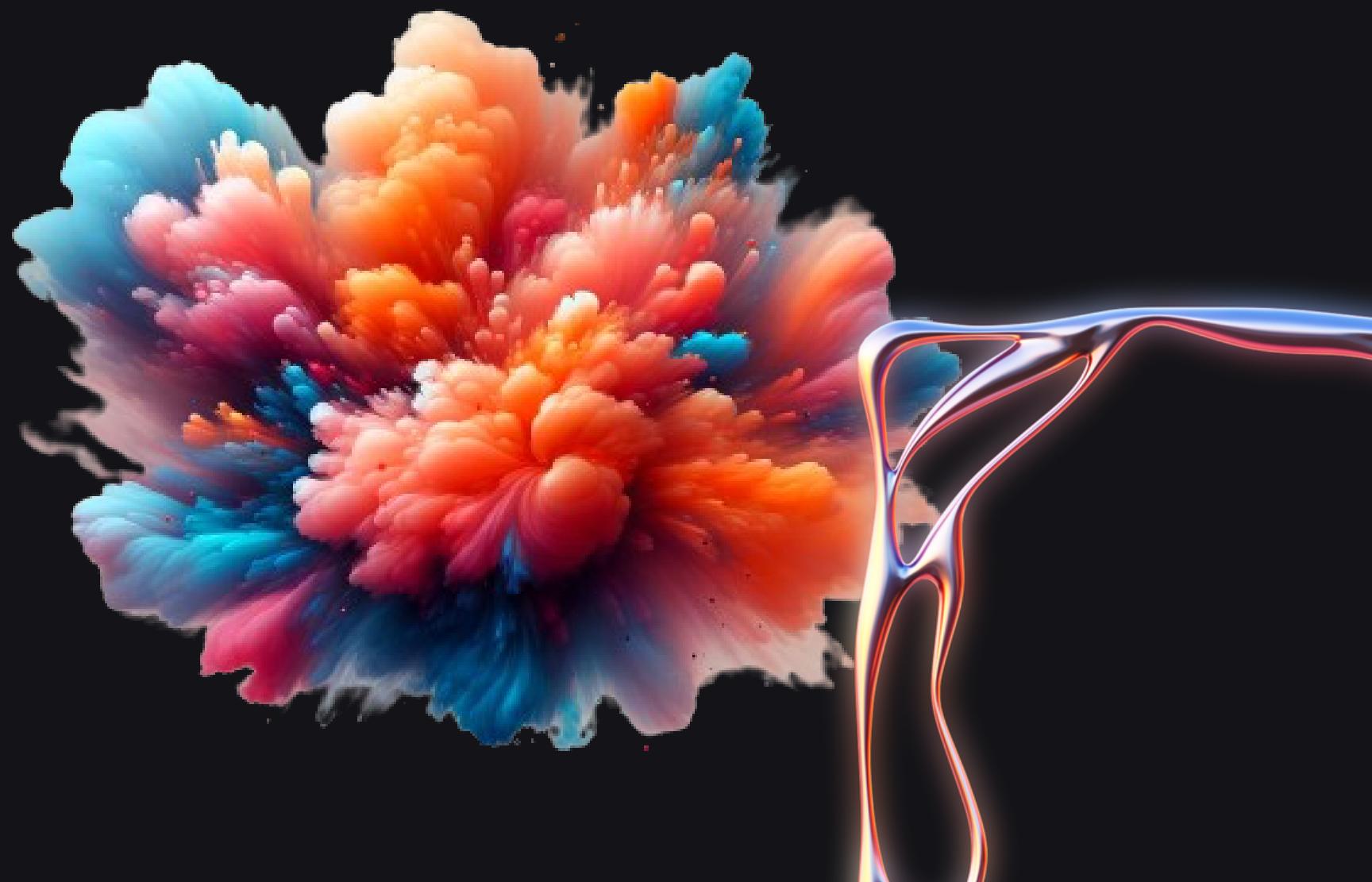
€199.00

03 LINK

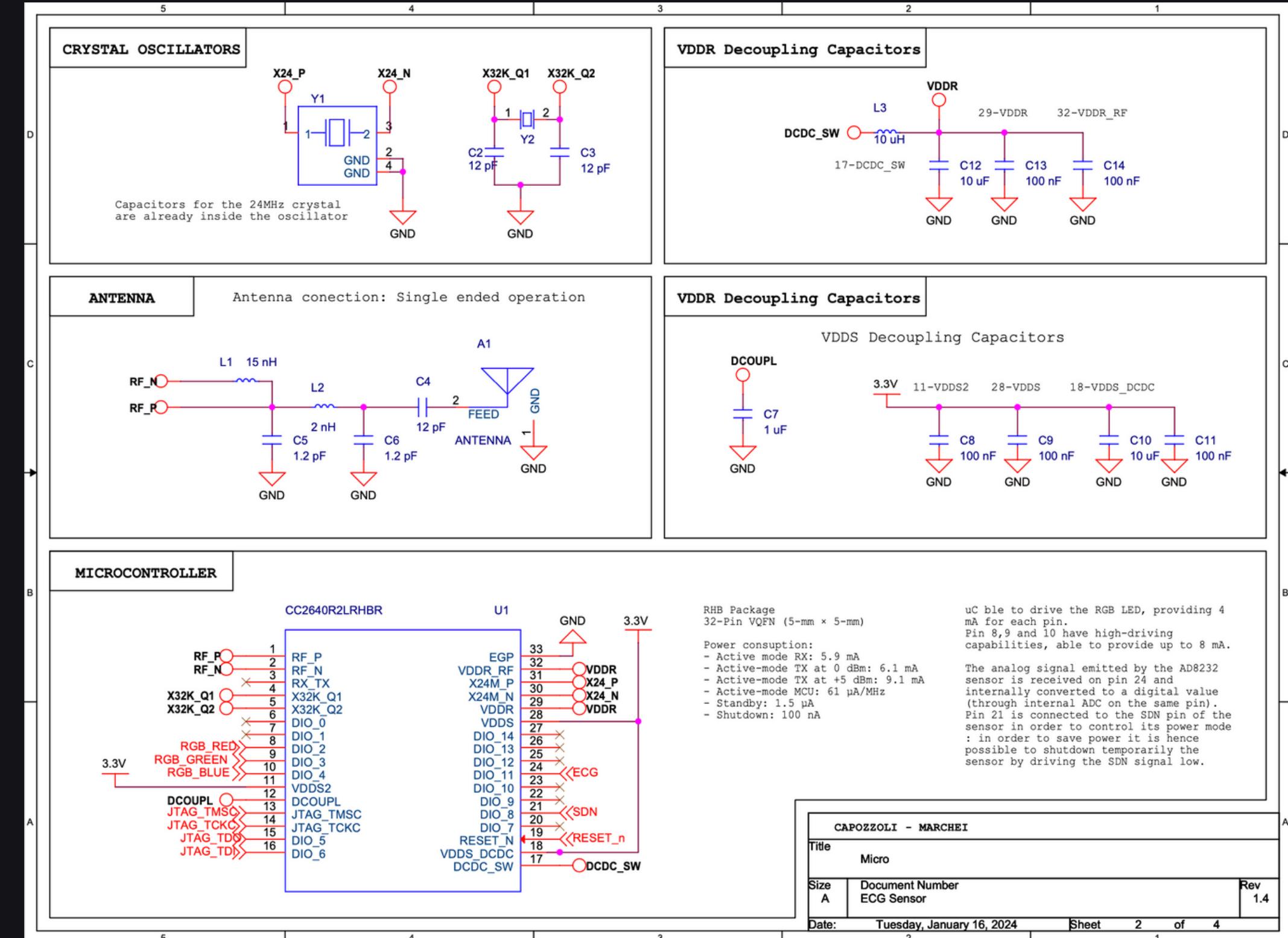
<https://shop.de.alivecor.com>



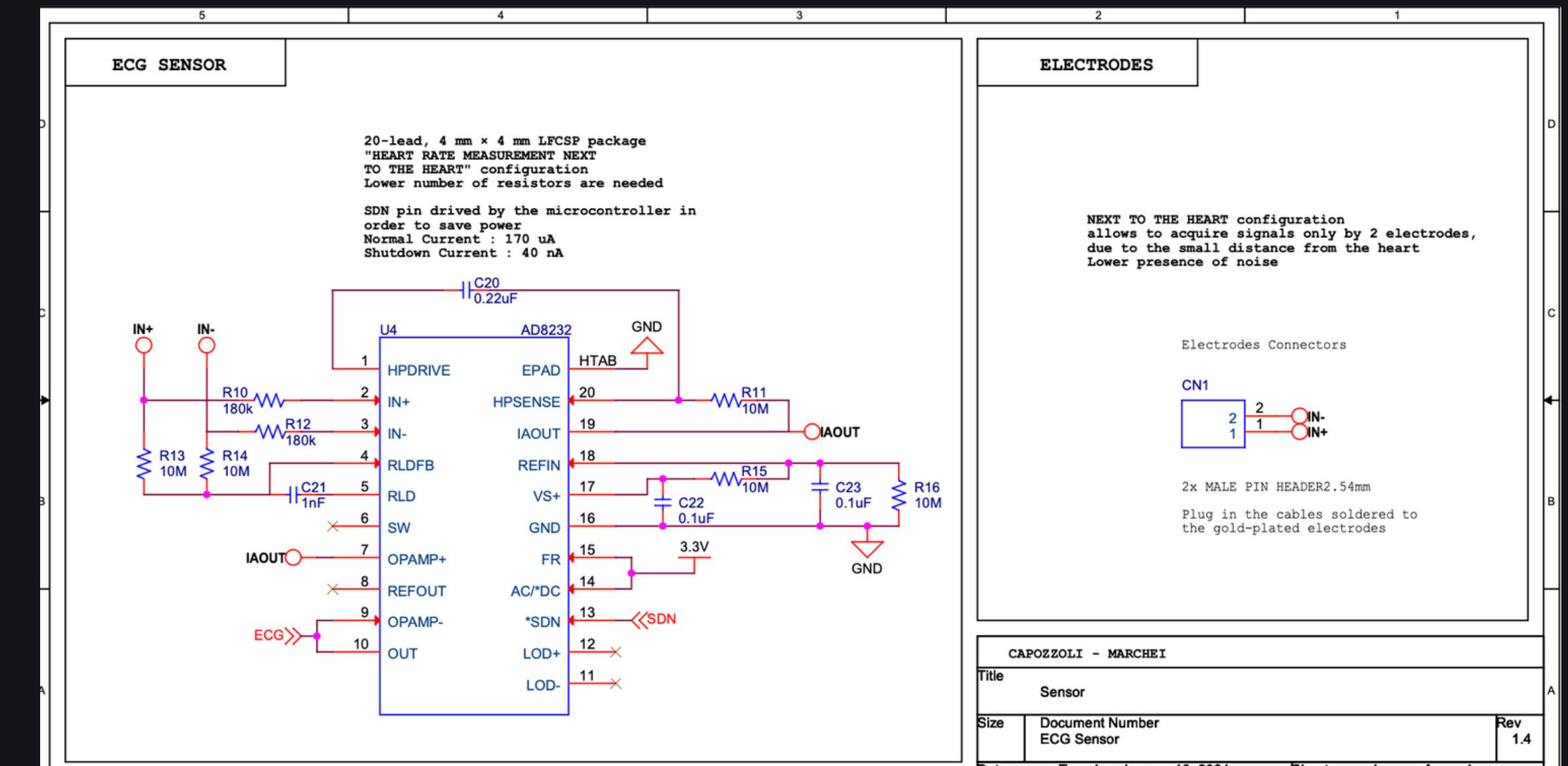
SCHEMATIC OVERVIEW



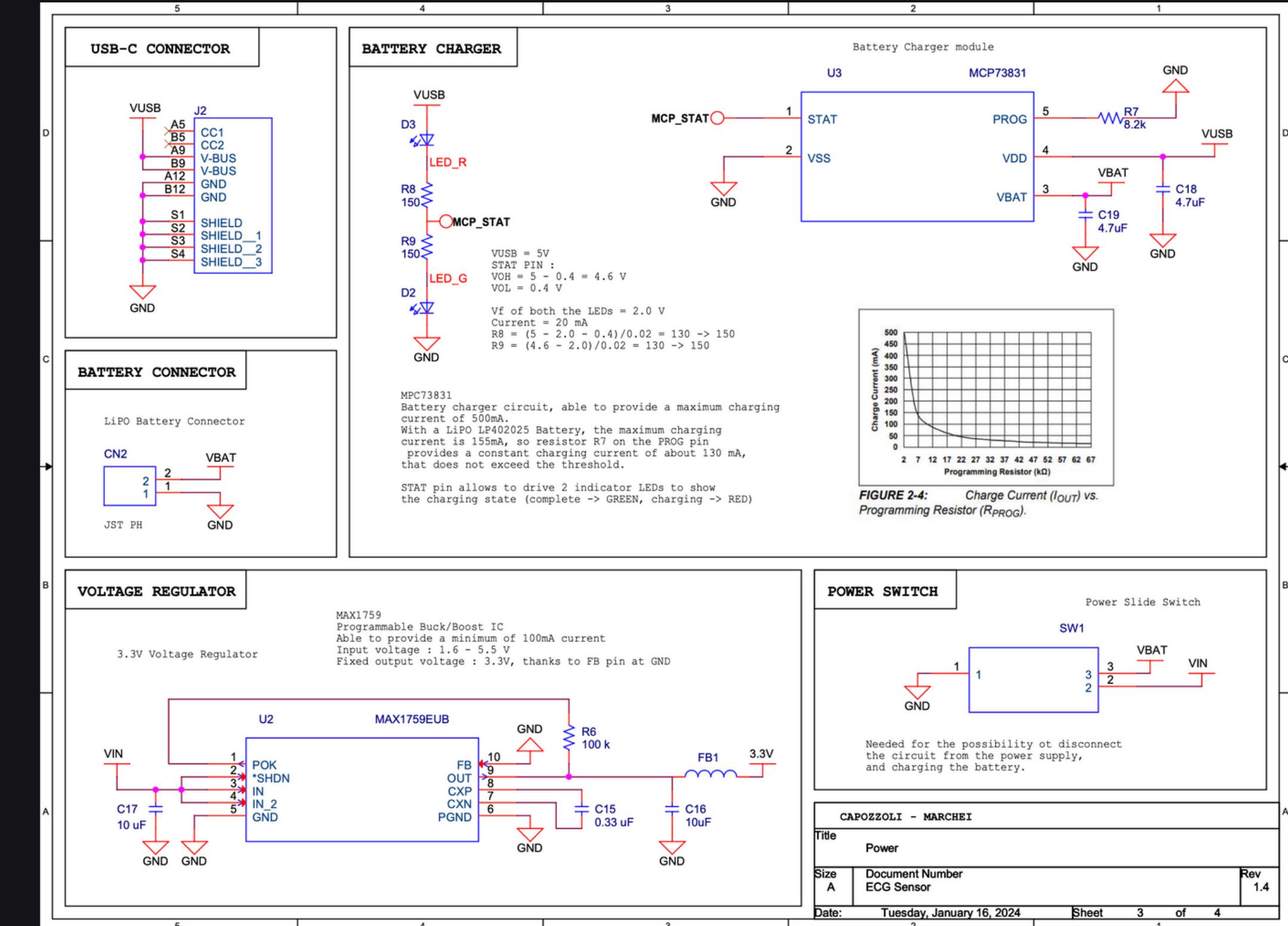
MICRO CONTROLLER



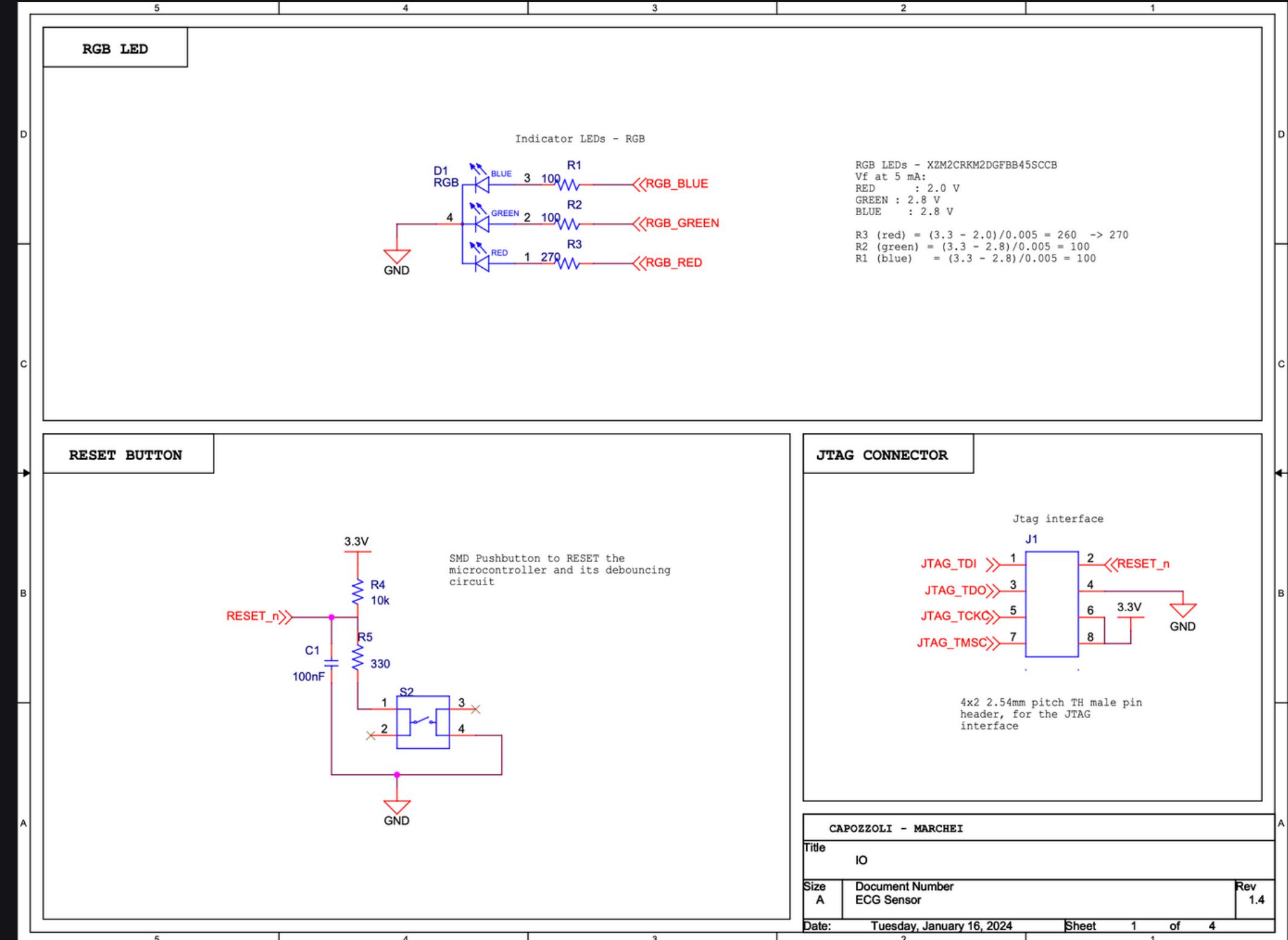
SENSOR



POWER



I/O PERIPH ERALS





PCB DESIGN



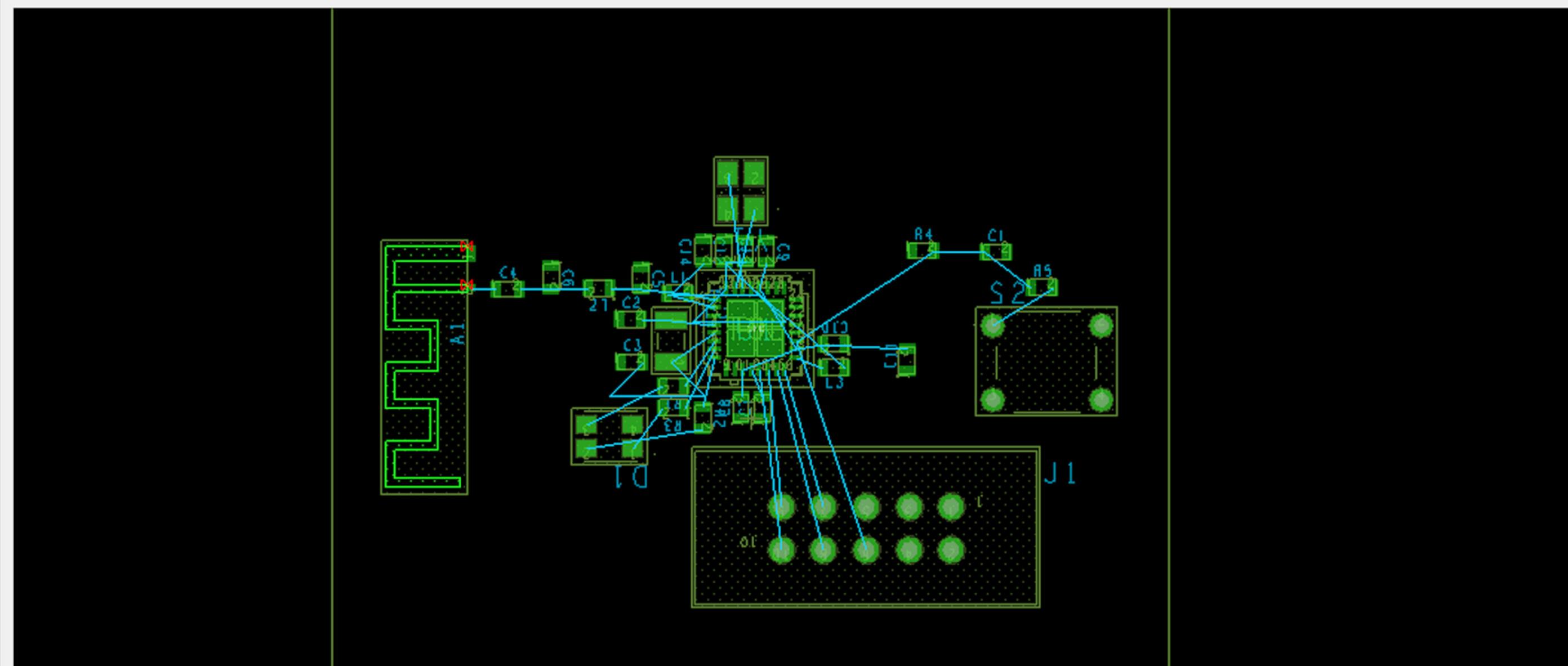


MAIN STEPS

- 01** For each component pads dimension and footprint were defined
- 02** Design of PCB positioning components to optimize the size, respecting design rules and distance constraints
- 03** Readability of components label was enhanced by managing font size and positioning
- 04** Final version of PCB and 3D model



File Import Setup Display Outline Add Edit Place Route Shape Check Analyze Tools Manufacture Export Help



Find Visibility

Find

Design Object Find Filter

- | | |
|---|--|
| All On | All Off |
| <input type="checkbox"/> Groups | <input checked="" type="checkbox"/> Shapes |
| <input type="checkbox"/> Comps | <input checked="" type="checkbox"/> Voids/Cavities |
| <input checked="" type="checkbox"/> Symbols | <input checked="" type="checkbox"/> Cline segs |
| <input type="checkbox"/> Functions | <input checked="" type="checkbox"/> Other segs |
| <input checked="" type="checkbox"/> Nets | <input checked="" type="checkbox"/> Figures |
| <input checked="" type="checkbox"/> Pins | <input checked="" type="checkbox"/> DRC errors |
| <input checked="" type="checkbox"/> Vias | <input checked="" type="checkbox"/> Text |
| <input checked="" type="checkbox"/> Clines | <input checked="" type="checkbox"/> Ratsnests |
| <input checked="" type="checkbox"/> Lines | <input checked="" type="checkbox"/> Rat Ts |

Find By Name

Symbol (or Pin) Name
> More...

Command:

```
last pick: 21.0500 -0.8000
E- Command not found: Del
E- Command not found: Del
Pick 1st corner of the new window.
Command >
```

Command View

Idle

Assembly_Top

-44.0000, 18.6000

P

A

General edit

Off

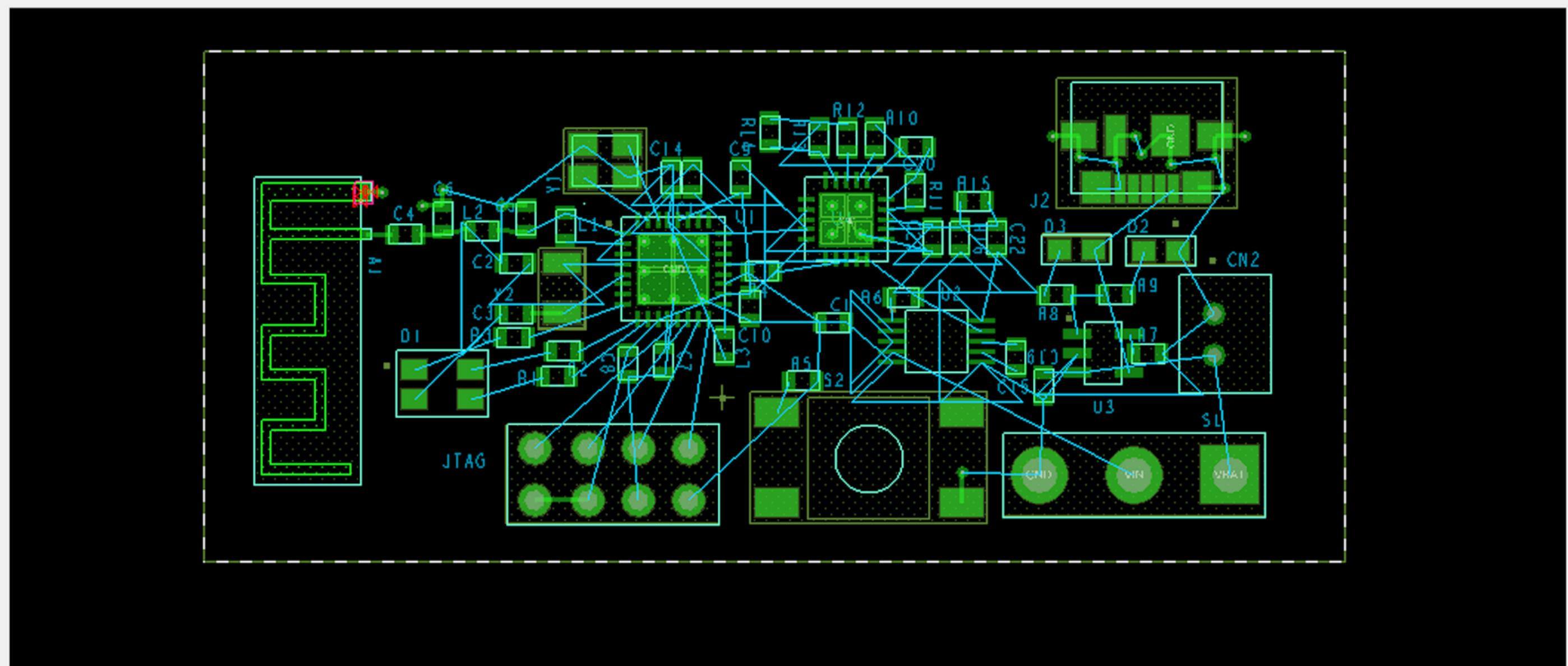
DRC

0



Cerca





Options Find Visibility
Options

Active Class and Subclass:

Board Geometry

Design_Outline



Command:

Enter shape outline.
last pick: 1.8500 4.9750
Pick new location for the element(s).
Pick 1st corner of the new window.
Command >

Command View

Idle

Design_Outline

-35.0000, -1.4000

P

A

General edit

Off

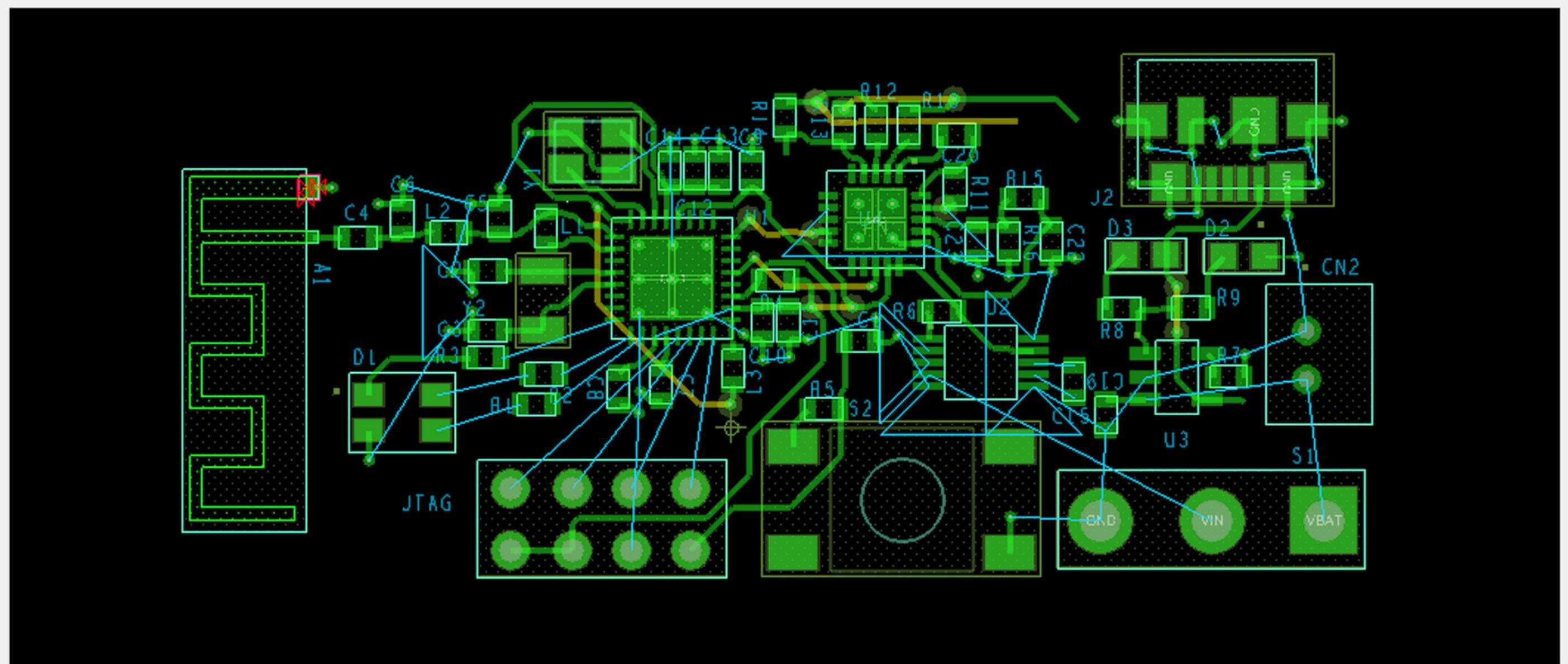
DRC

1



Cerca





Options Find Visibility
Options

Active Class and Subclass:

Etch

Top



Command View

Idle

Top

-30.2000, 2.8000

P

A

General edit

Off

DRC

0



Cerca

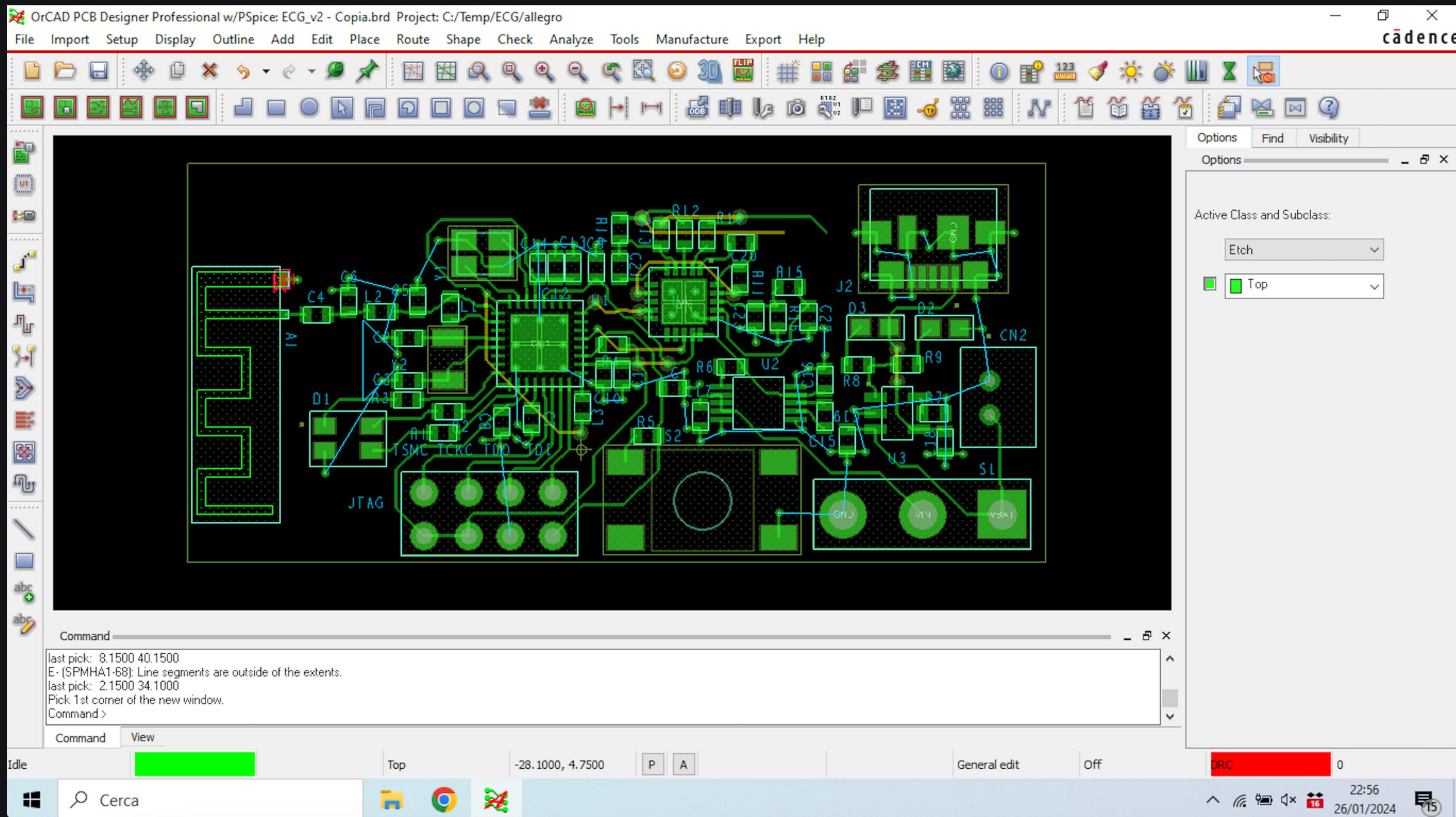


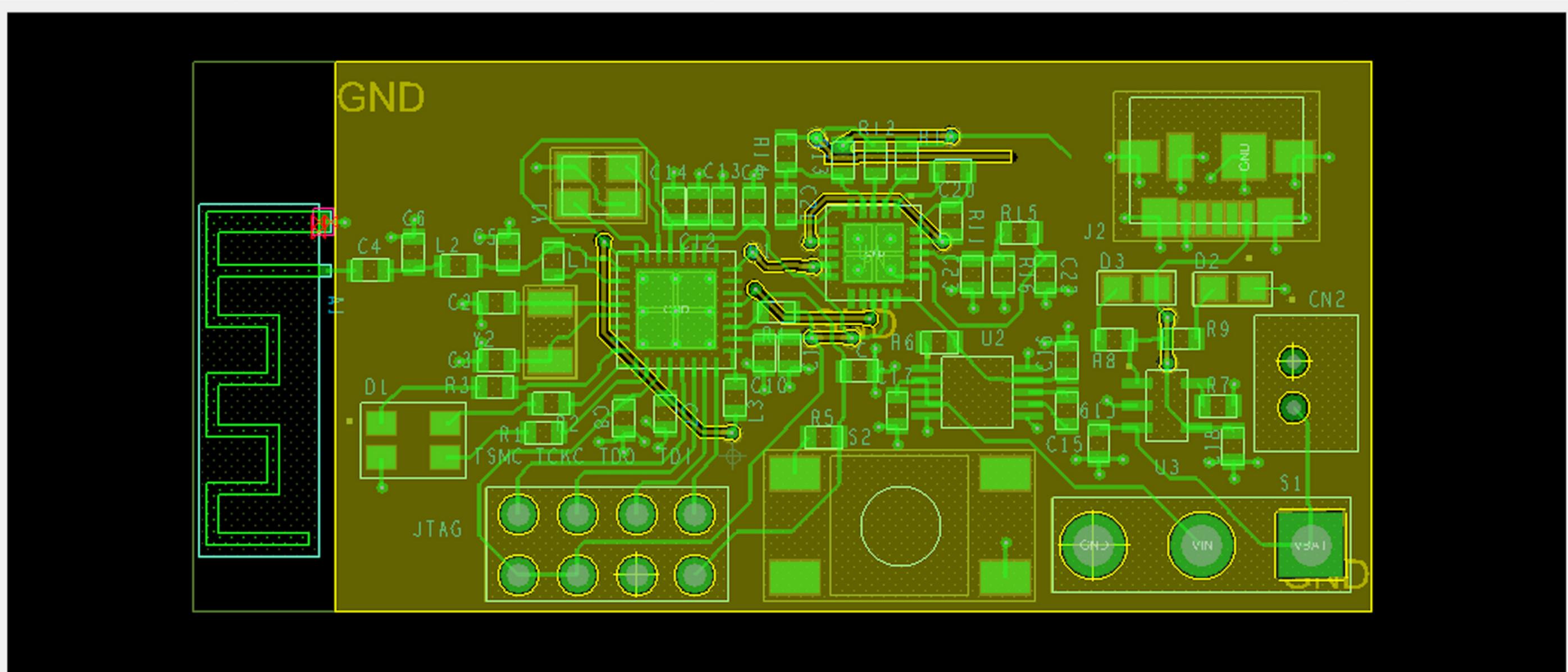
22:56

26/01/2024



15





Options Find Visibility

Options

Active Class and Subclass:

Etch

Top



Command View

Idle

Top

-31.3500, 5.5500

P

A

General edit

Off

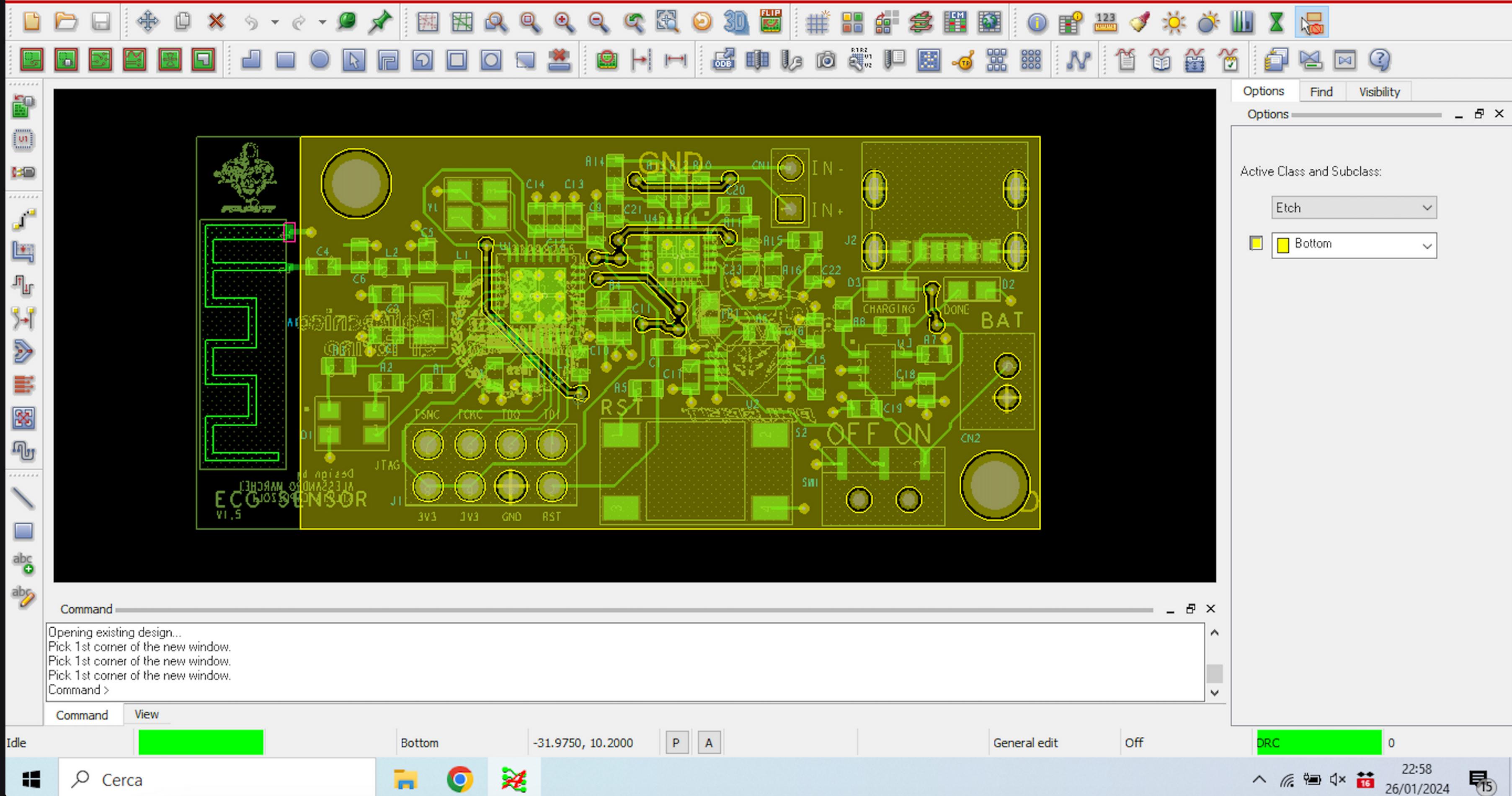
DRC

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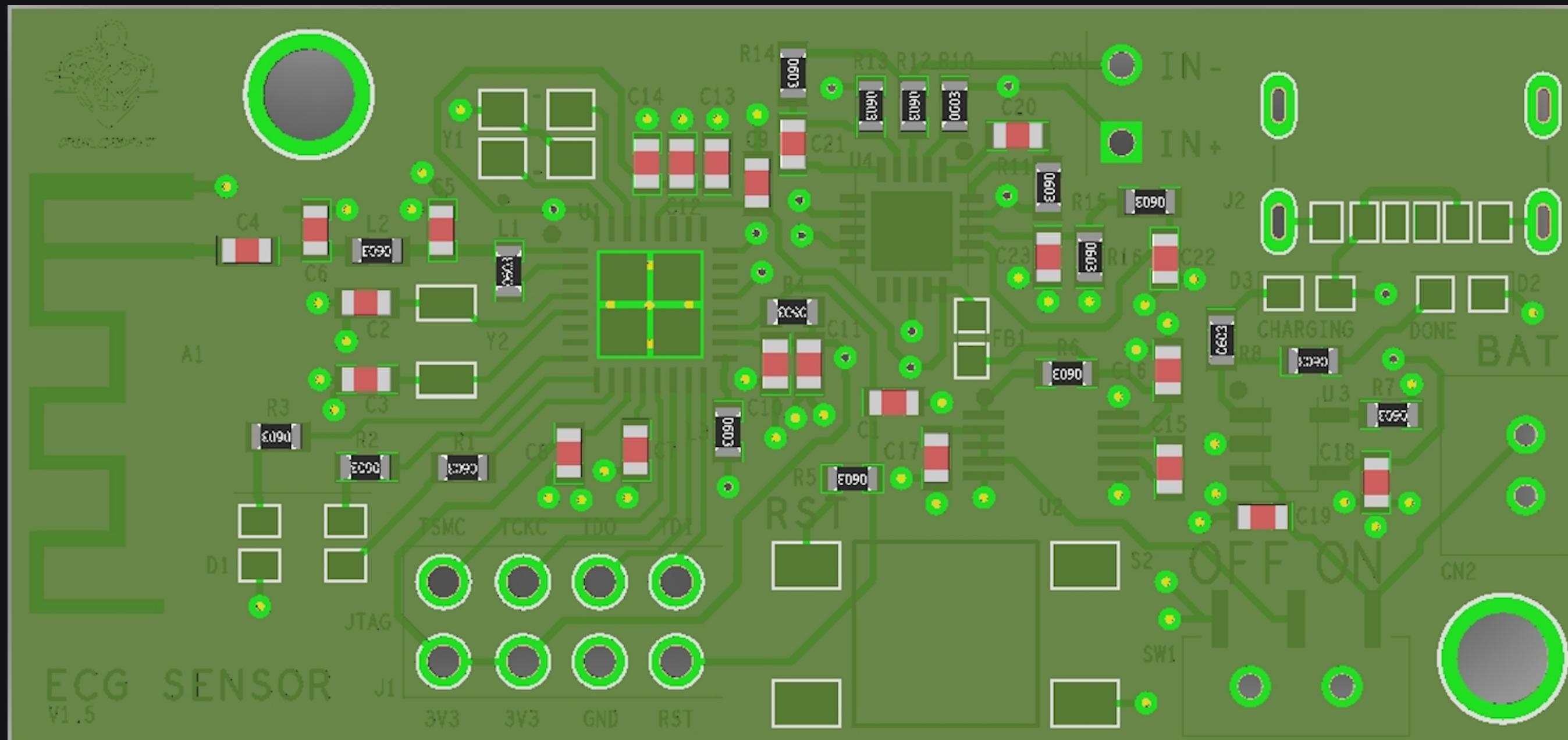


Cerca





TOP

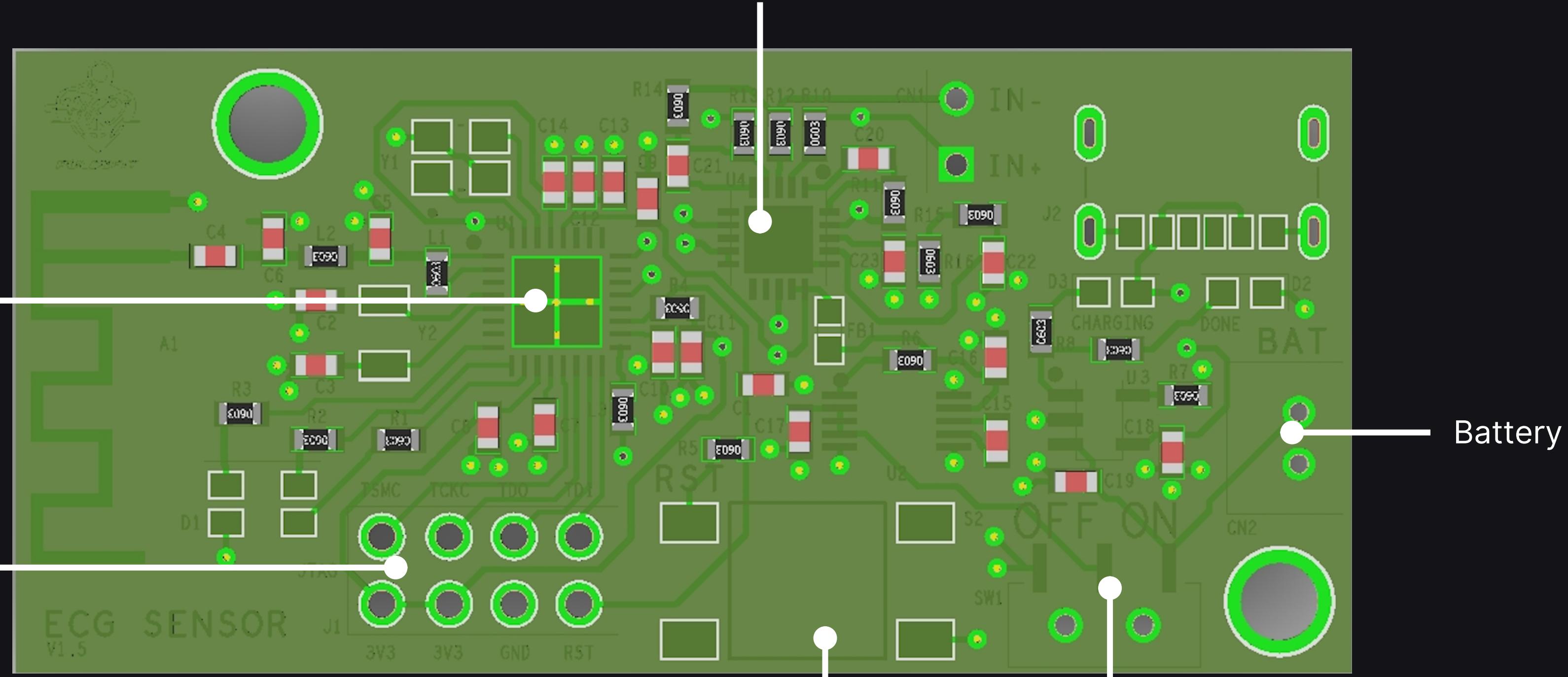


TOP

ECG Sensor AD8232

Microcontroller
CC2640

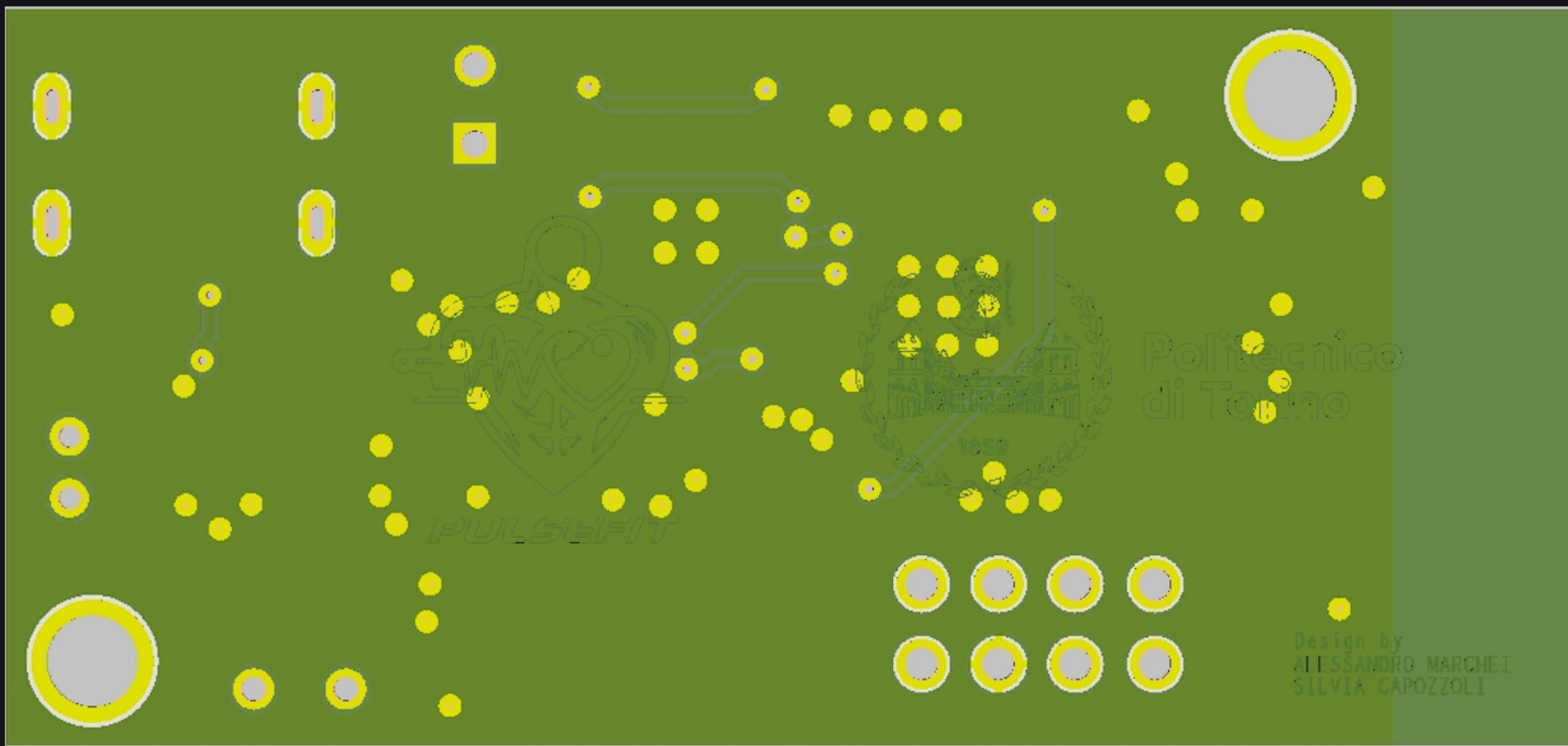
JTAG



Reset Push button

ON/OFF Switch

BOTTOM





3D RENDERING



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