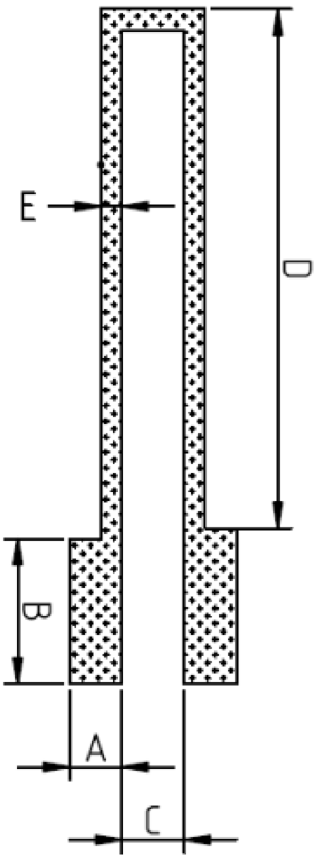
Course : Sensor

Teacher : J.Grisolia

Speciality : Applied physics

Graphite Strain Sensor



DE BARROS Alan

LEHEMBRE Lauriane

General features

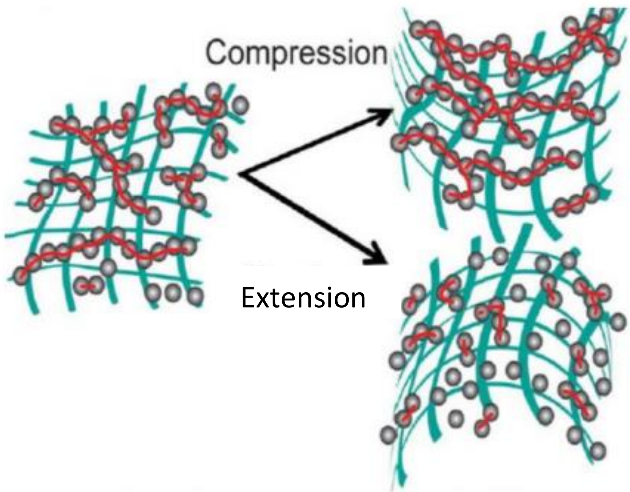
- Low-tech
- Low cost
- Open-source
- Transportable
- Easy to use
- Easy to fabricate
- Environment friendly
- Measures a deformation
- Use of graphite (HB)

General description

The sensor is a piece of paper on which graphite has been deposited (HB), it's dimensions have been optimized for the analysis of resistance variations.

The graphite particles will allow the current to pass, or not, according to their distance: the more the paper will be in compression, the closer the particles will be and the more the current will be able to pass easily by quantum tunneling of electrons (inversely for extension).

By measuring the angle at which the sensor is bent, it is possible to determine the value of the resistance. To do this, we use an HB pencil - it can however be used with other types of pencils, but the sensitivity will be different.



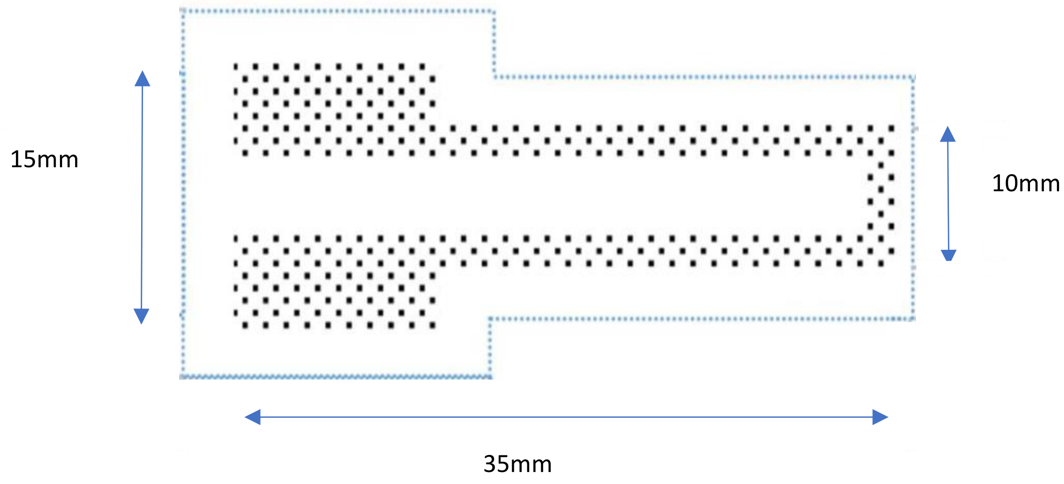
Representation of the particles on the paper matrix for different curvatures

In summary, a deformation of the sensor will induce a variation of the resistance (relative to the straight position resistance). We can therefore measure this resistive variation to determine the deformation undergone by the sensor.

Specifications

Type	Graphite strain sensor
Materials	Paper (thickness: 0.16mm) Graphite (carbon)
Type of sensor	Passive
Usable types of graphite	3H, 2H, H, HB, B, 2B, 3B
Measurand	Resistance
Power supply	Vin = 4,31V
Response time	Few hundred milliseconds to be stable

Dimensions



Electrical characteristics (For a diameter of 3,5cm)

	Compression				Extension			
	Min	Type	Max	Unit	Min	Type	Max	Unit
Sensor voltage	0	-	5	V	0	-	5	V
2B pencil resistance	40,1	42	43,4	MΩ	89,8	91	92	MΩ

Sensor calibration

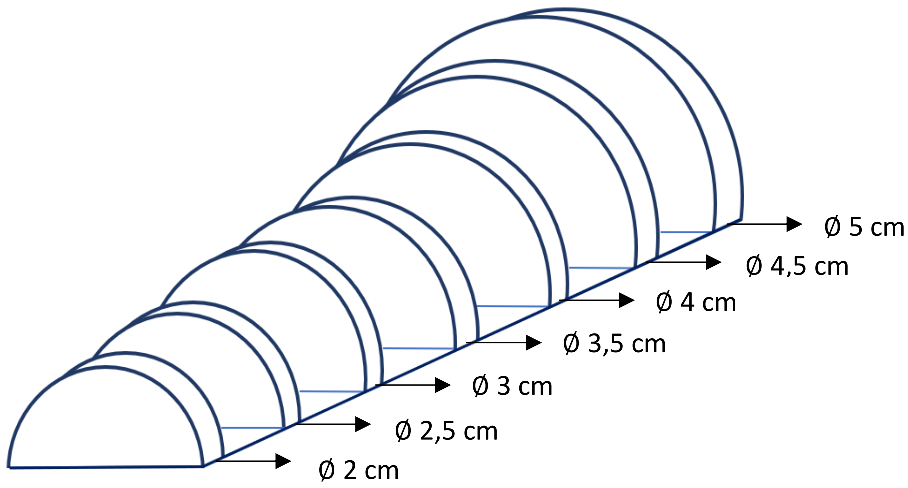
<u>Deformation characterization</u>

To calculate the relative variation of resistance with respect to the deformation of the sensor and thus characterize it, we use the following formula:

$$\varepsilon = \frac{e}{2R}$$

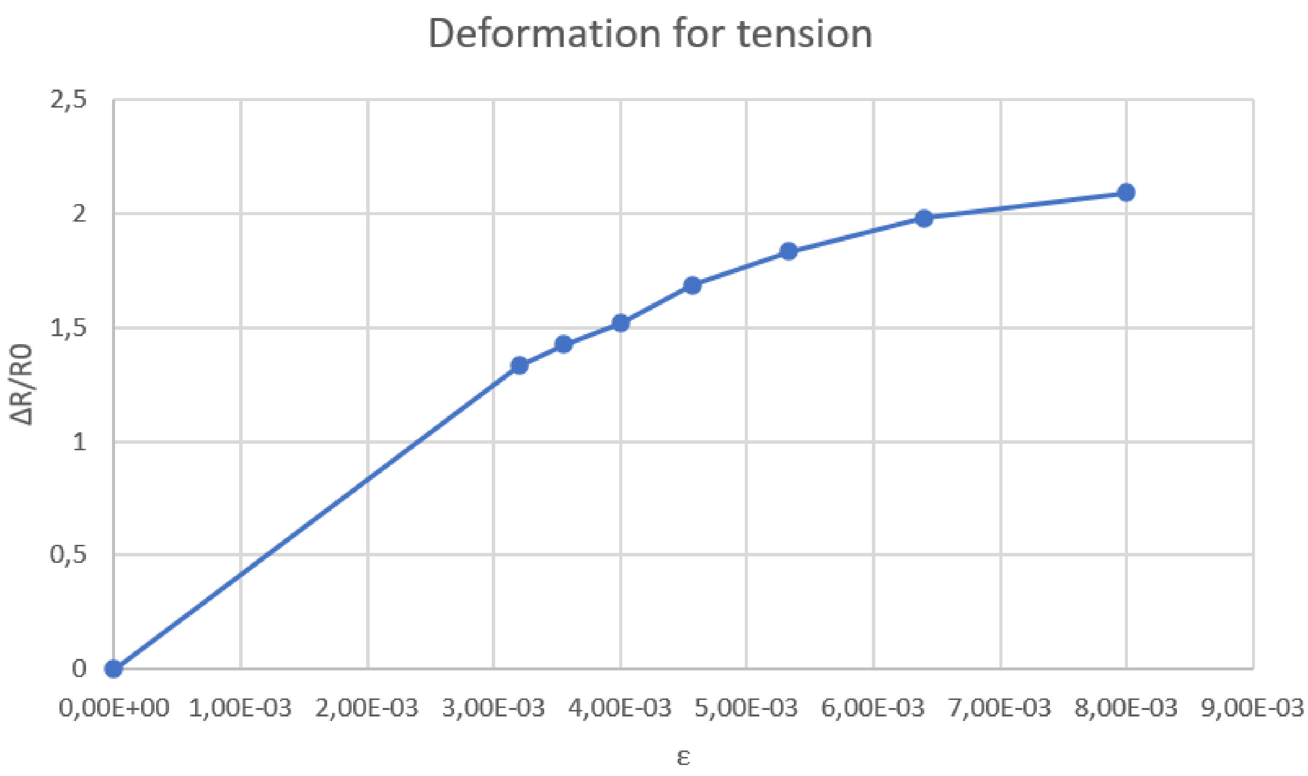
With **e** the thickness of the sheet, **ε** the deformation, and **R** the radius of curvature. (e = 0,16mm)

To calculate the deformation induced by the curvature of our test bench, we used different radii:

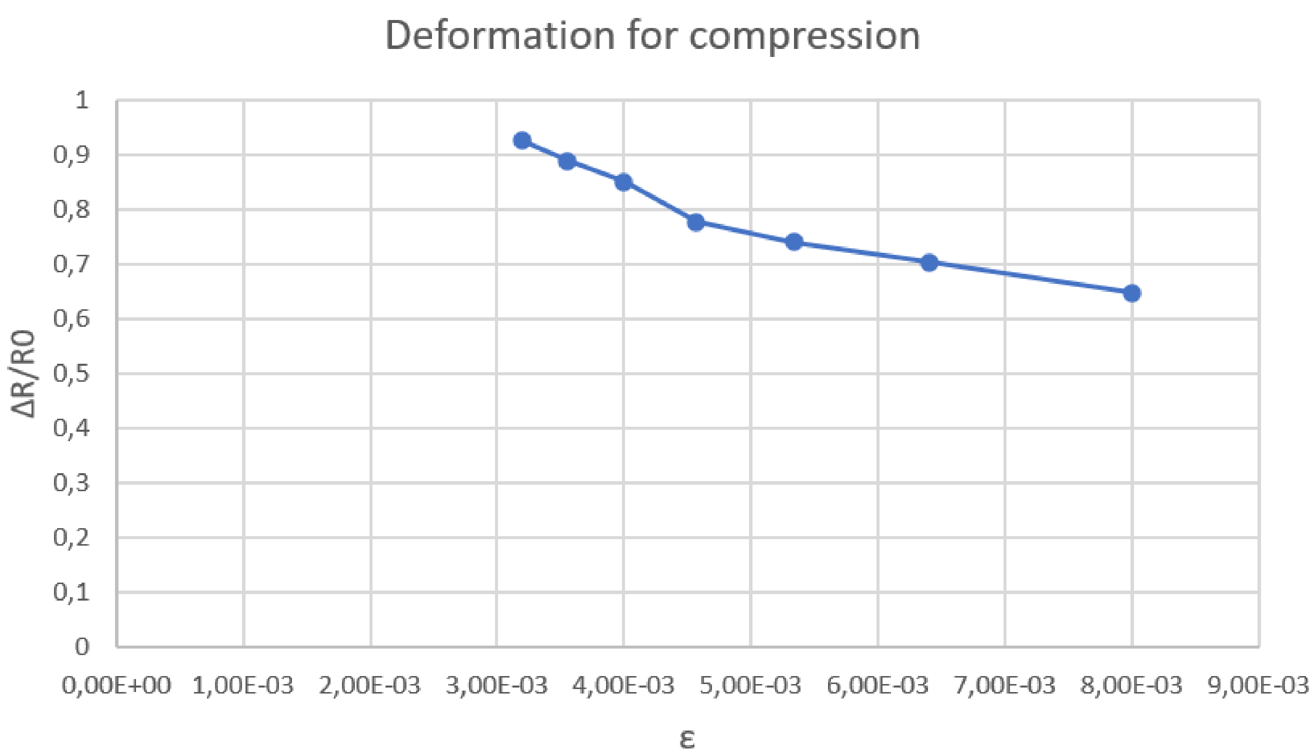


$\Delta R/R_0$ is calculated for a R_0 = 54 MΩ.

- Tension:

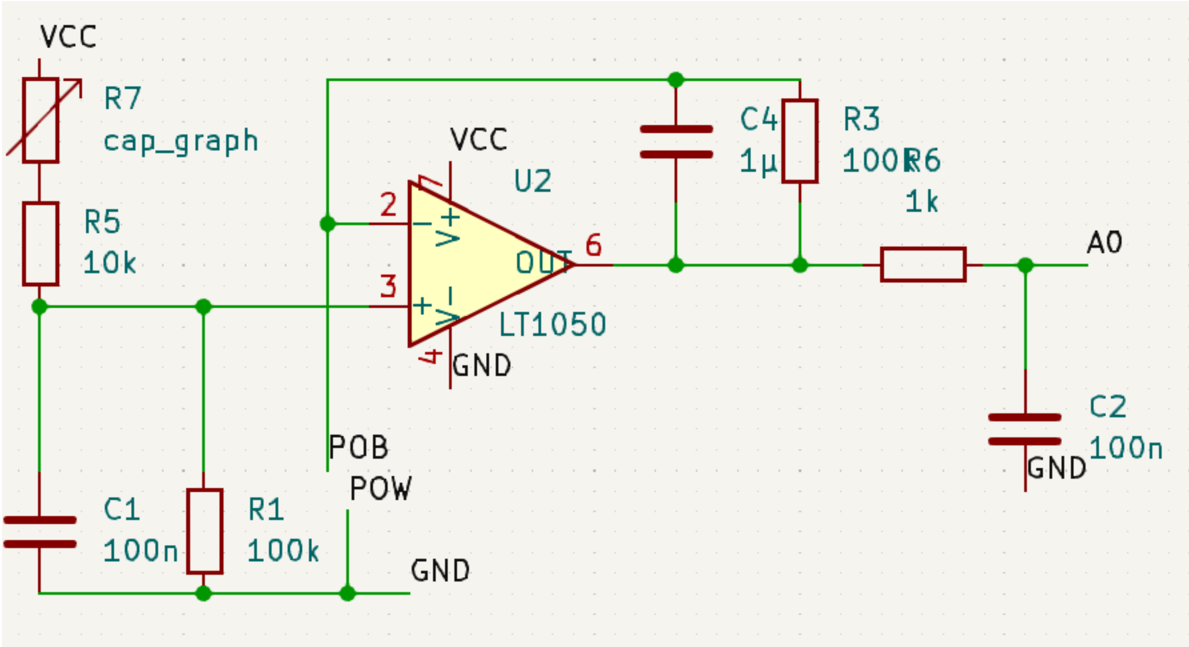


- Compression:



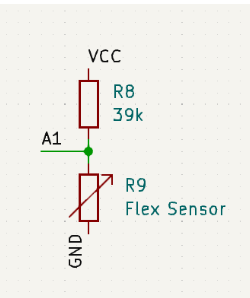
KiCAD specifications

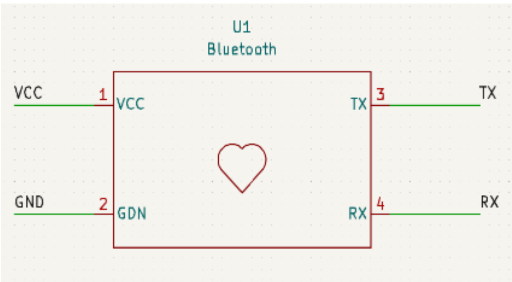
<u>Schematic of the signal amplification circuit :</u>

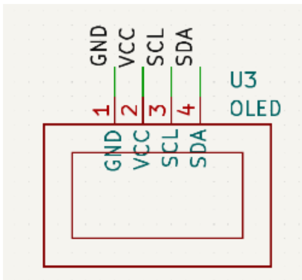


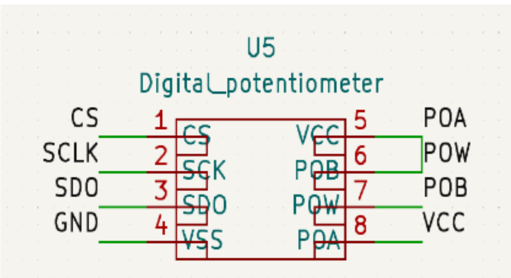
The resistance R2 represented by the POB-POW spacing allows the calibration of the amplifier with the use of an MCP41050 SPI Digital Potentiometer.

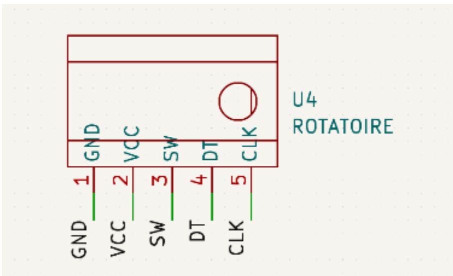
<u>Additional modules and their connexions:</u>



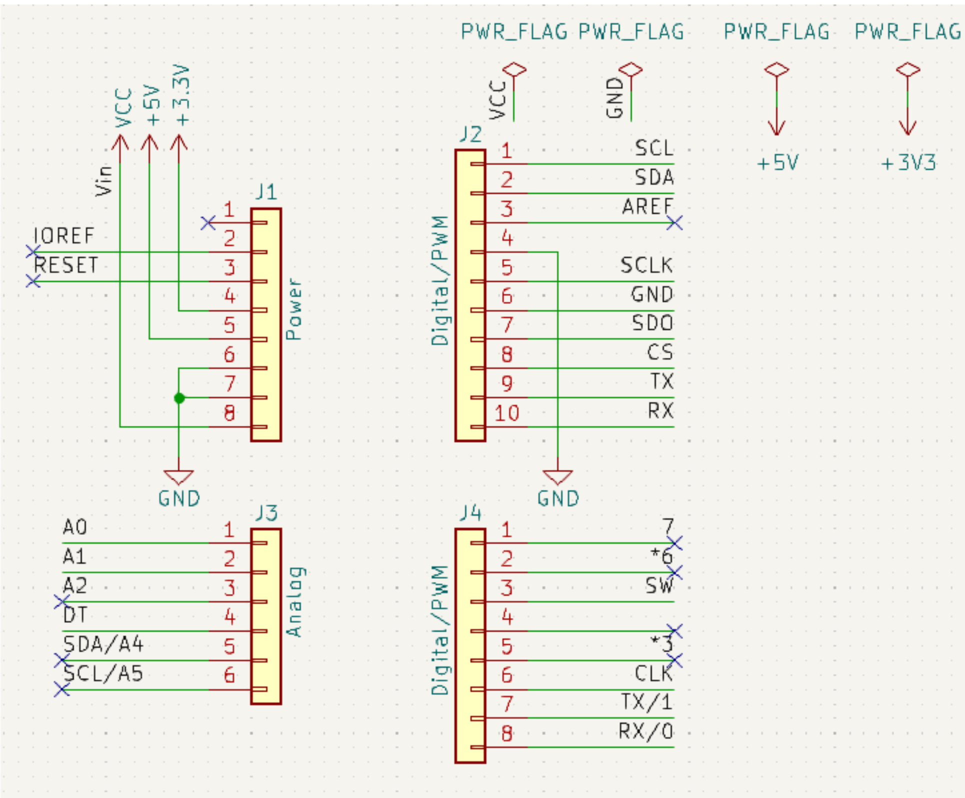








Pin setup for Arduino connection



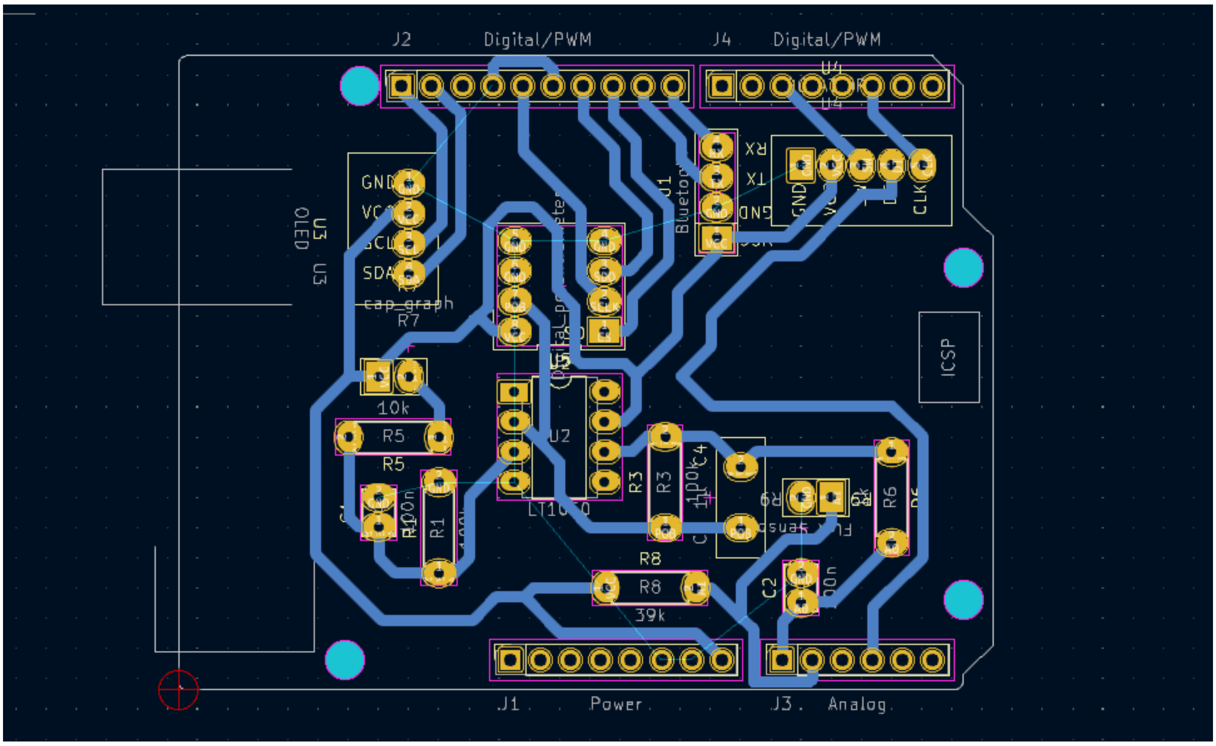
<u>Components needed:</u>

- Arduino Uno
- Bluetooth module HC05
- LTC1050 Amplifier
- I2C OLED screen Joy-it SBC-OLED01
- Rotatory encoder with push button (Joy-it KY-040)
- Spectrasymbol 005 21 Flex Sensor
- MCP41050 SPI Digital potentiometer

To filter noise, the sensor is connected via a low-pass filter tuned appropriately.

To amplify the signal, it is also connected to a trans-impedance amplifier.

KiCAD PCB schematic:



Footprints of the components :