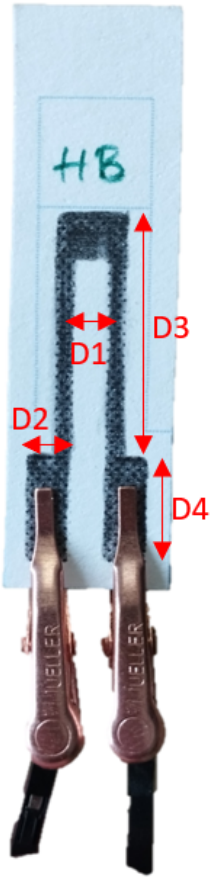
Low-tech Graphite based Strain Sensor

Main features

- ➔ Low-tech
- ➔ Low-cost
- ➔ Usable for different Resistance ranges

STRAIN GAUGE DIMENSIONS



DESCRIPTION

Low-tech graphite strain sensor using the properties of electron conduction in films of nanoparticles linked by organic molecules.

The sensor consists of a thin Graphite film deposited with a pencil on a sheet of paper. This can be assimilated to graphite nanoparticles (C atoms) linked by organic molecules.

The lower the distance L between two nanoparticles, the greater the conductance. Therefore, such films can be used as strain sensor because an applied strain will move away or bring closer the nanoparticles (changing the value of L) and thus modify the conductance and the resistance of the sensor.

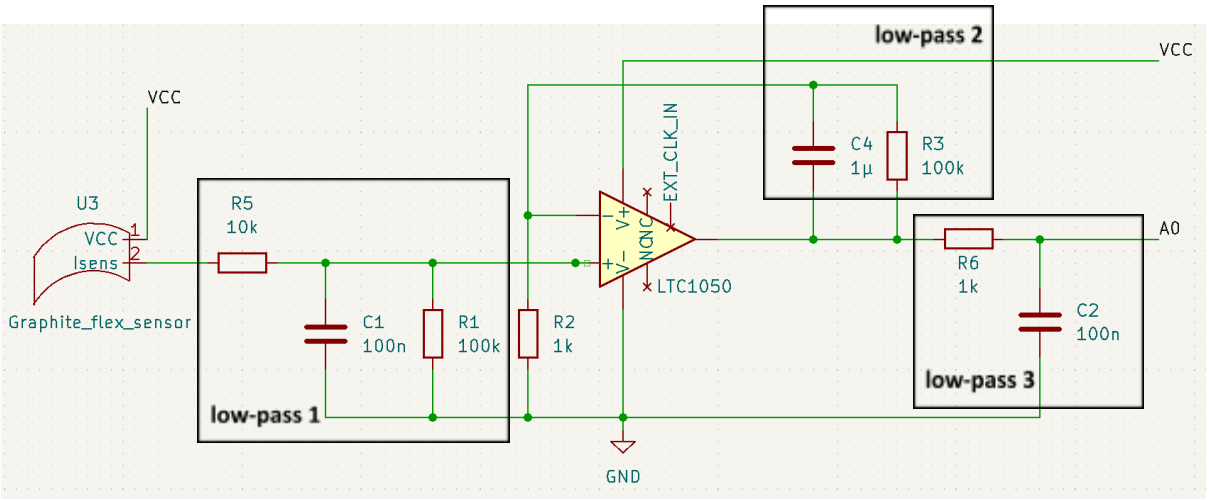
This conductance also varies with C density of the pencil graphite. We can therefore use the sensor in different resistance ranges, according to the hardness (C density) of the pencil.

The gauge is connected with crocodile Copper clips.

dim.	D1	D2	D3	D4
val. (mm)	5	5	25	10

Signal conditioner

The sensor uses a transimpedance amplifier to deliver an output voltage proportional to the gauge resistance. The amplifying system is built on a PCB shield which can be plugged on an Arduino UNO. Below is shown the schematic of the conditioner.



TECHNICAL SPECIFICATIONS	Unit	Value
Power Supply (VCC)	V	5
Output signal	V	0 to 5
Cutoff low-pass filter 1	Hz	16
Cutoff low-pass filter 2	Hz	1.6
Cutoff low-pass filter 3	kHz	16
Transimpedance static Gain	dB	116

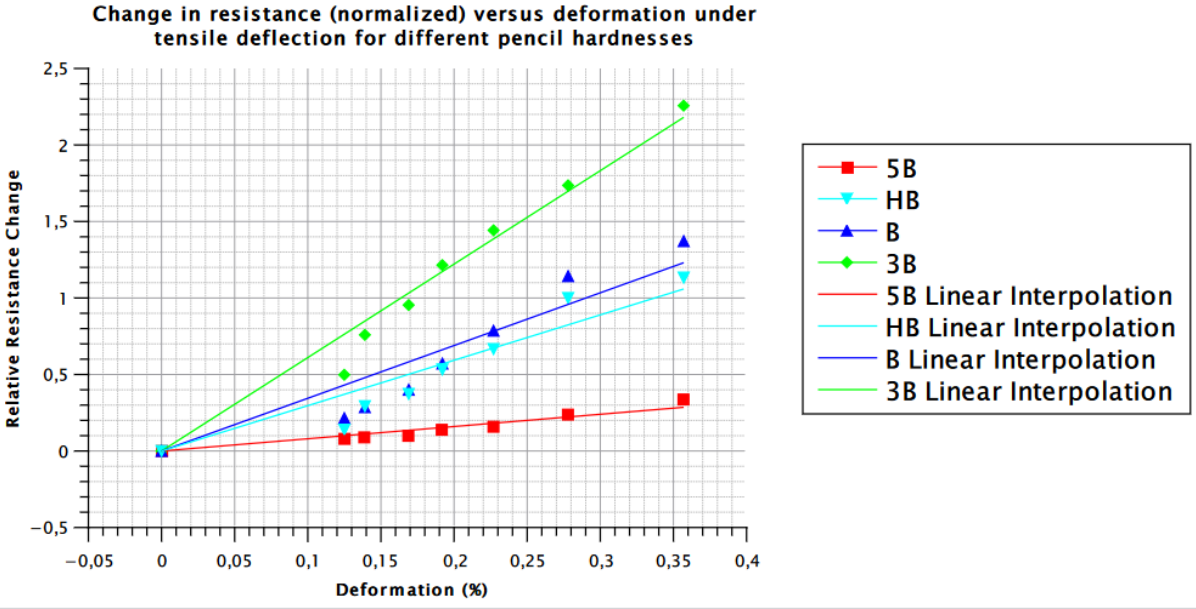
Electrical characteristics and response

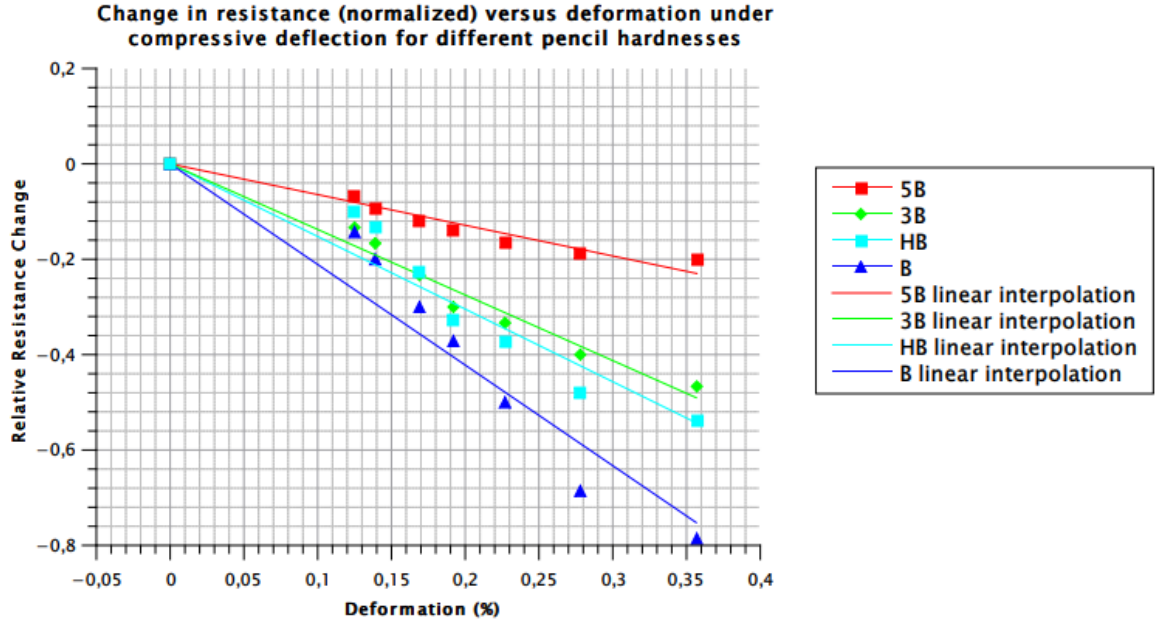
STANDARD USE CONDITIONS	Unit	Typ. value
Temperature	°C	25 ± 10
Humidity	%	60
Pressure	bar	1

RESISTANCE (by Hardness)	Unit	Value		
		Min	Typ.	Max
5B	MΩ	12	15	20
3B	MΩ	16	30	100
B	MΩ	18	70	165
HB	MΩ	70	150	320

Warning : *The resistance values depend on Carbon nanoparticles density and thus on the amount of graphite which has been deposited on the paper. In the chart above, the values have been measured with an amount of graphite such that the resistance remains in the 10-400 MΩ range.*

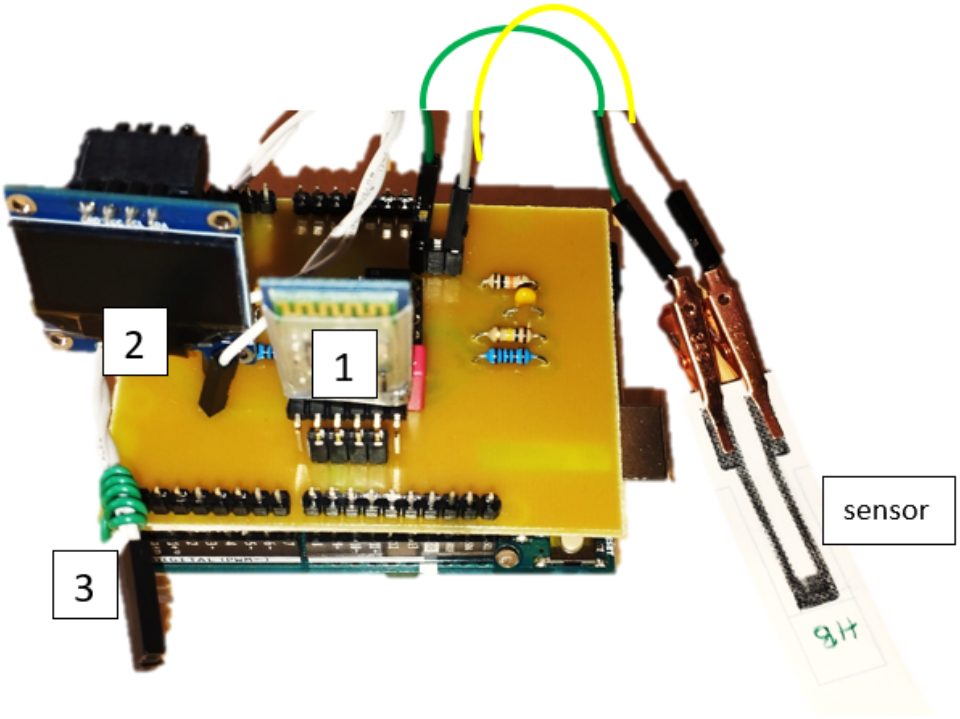
Below are plotted the electrical response (change in resistance) for the 4 different hardnesses. The graphs show a difference in sensitivity for each hardness. They also show a different sensitivity for compression and tension.





Additional modules

The PCB Shield which comes with the sensor includes several additional modules, allowing the user to broadcast and store the measurements in different ways.



CONNECTIONS ON THE SHIELD	
Module or component	**Pin name/Connection on Arduino**
Sensor (Strain Gauge + Conditionner)	1 (VCC) / VCC 2 (OUT) / A0
1 - HC-05 Bluetooth module Communicate the output sensor value via BT connection. Can be used to plot the resistance value on an app.	1 (VCC) / VCC 2 (GND) / GND 3 (TX) / 11 4 (RX) / 10
2 - SSD 1306 I2C OLED Screen Display the gauge resistance value directly on the shield. Indicates if the resistance is too low and saturates the circuit.	1 (GND) / GND 2 (VCC) / VCC 3 (SCL) / A6 4 (SDA) / A5
3 - Additional trigger Can be used in two ways : ⇒ Voltage divider to use a variable resistance as a trigger ⇒ Simple voltage line to add a switch as a trigger	1 (VCC) / VCC 2 (OUT) / A1