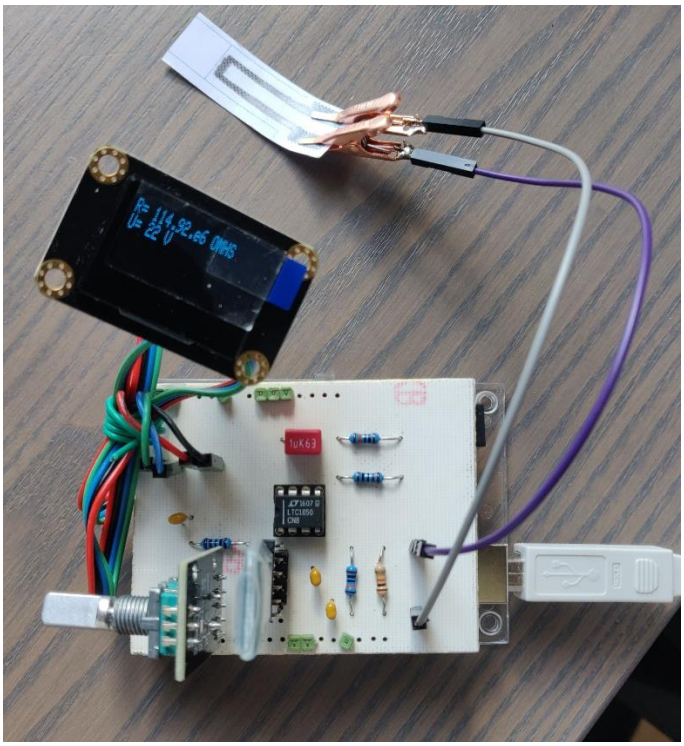
Project realized by Santiago Sanchez and Marc Vidal **Year 20/21**

Resistance sensor based on graphite strain gauge



Main features

- Bluetooth connected to any android smartphone
- Small size
- Low power consumption
- Low cost
- Easy-to-use
- Interchangeable sensor paper
- Premade drawing pattern
- Does not generate potentially negative environmental impact during and after fabrication

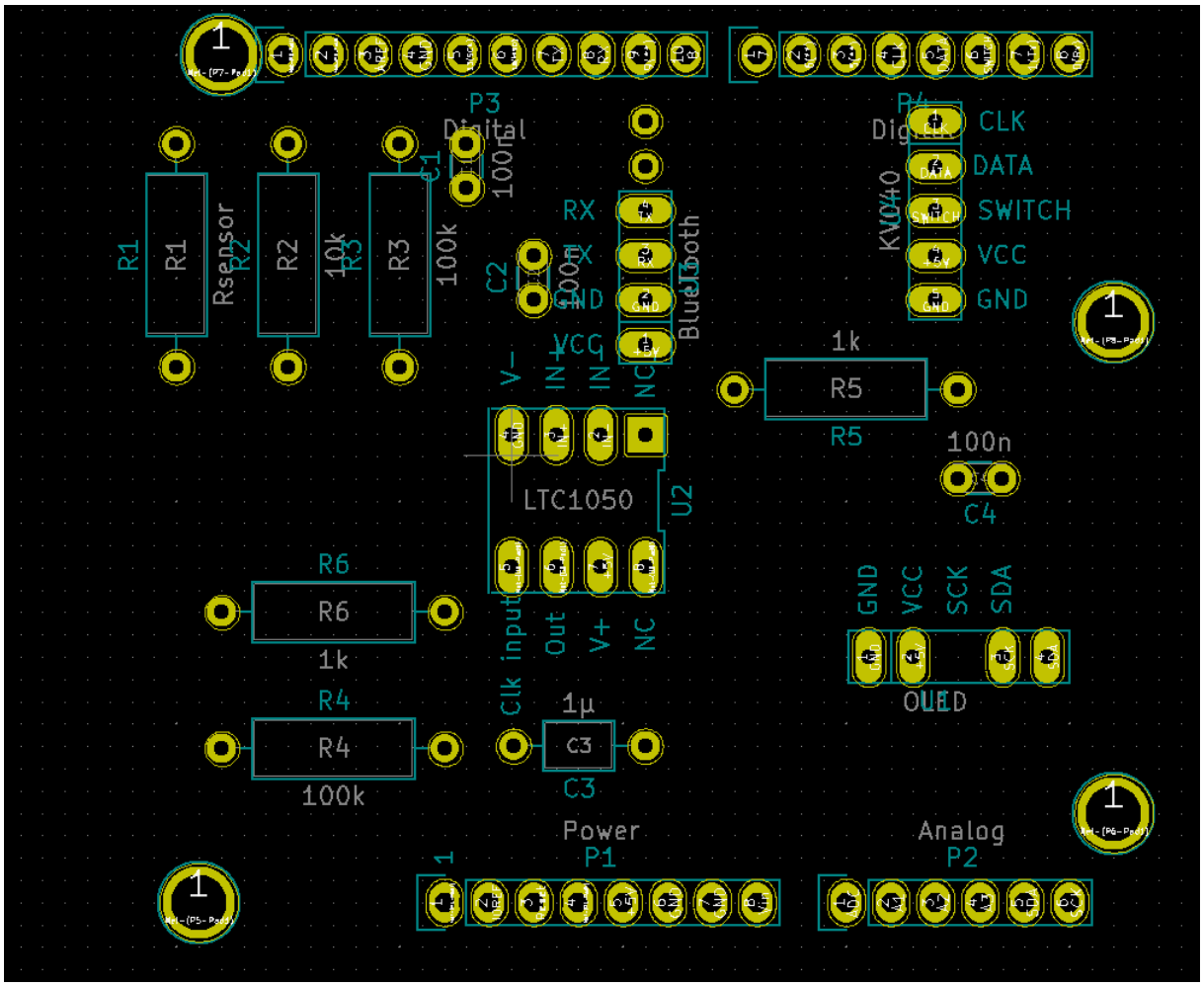
General description

This resistance sensor based on graphite was developed as a part of an INSA Toulouse *applied physics- sensors* major project. The sensing element is made of a sheet of paper with a premade drawing pattern filled with graphite form a type B pencil. When the sensor is under mechanical stress the linear atomic links from the graphite pattern exhibits reversible resistance changes. Compression or depression of the graphite particle network show variations on the sensor's resistance. Behind the sensor lies an ARDUINO UNO powered shield with a transimpedance amplifier (LTC1050), a Bluetooth module, OLED screen and a

rotational encoder to respectively, amplify, transport and communicate the measured resistance. This sensor has high sensibility and selectivity which can be adjusted through the app on any android smartphone.

Pin description

Pin number	Function
10/11/GND/	Bluetooth module (RX, TX, power)
	LTC-1050 Operational Amplifier
A5/A6/+5V	OLED screen (SDA, SCK, VCC, GND)
4/5/6/7	Rotatory encoder (CLK, DATA, SWITCH, VC, GND)



Specifications

Type	Strain gauge resistance sensor
Sensing principle	Electron transport
Materials	• Graphite • Paper sheet
Power supply requirement	Active sensor
Nature of output signal	Analog
Nature of measurands	Resistance
Shield length	68 mm
Shield width	59 mm
Sensor length	47 mm
Sensor width	18 mm
Graphite sensor pattern length	39 mm
Graphite sensor pattern width	11 mm
Pin diameter	<0.6 mm
Mounting	Soldering
Detectable strains	• Compressive deflection • Tensile deflection
Typical detection range	0-5 V
Typical response time	500ms
Typical recuperation time	150ms
Service resistance range	1e7-1e10 Ω
Typical applications	Noncritical angle measurements

Warning

This sensor must not be in contact with water because of injury risk in case of malfunctioning.
The graphite pattern wears off after a few uses so make sure that the one you are testing is not constantly at 0.

Calibration may be needed with a rotational encoder to have the most accurate results.

Unit	**Typical Value**

Temperature	°C	20±5
Humidity	%	60±5
Air Quality	%N2/O2	80/20

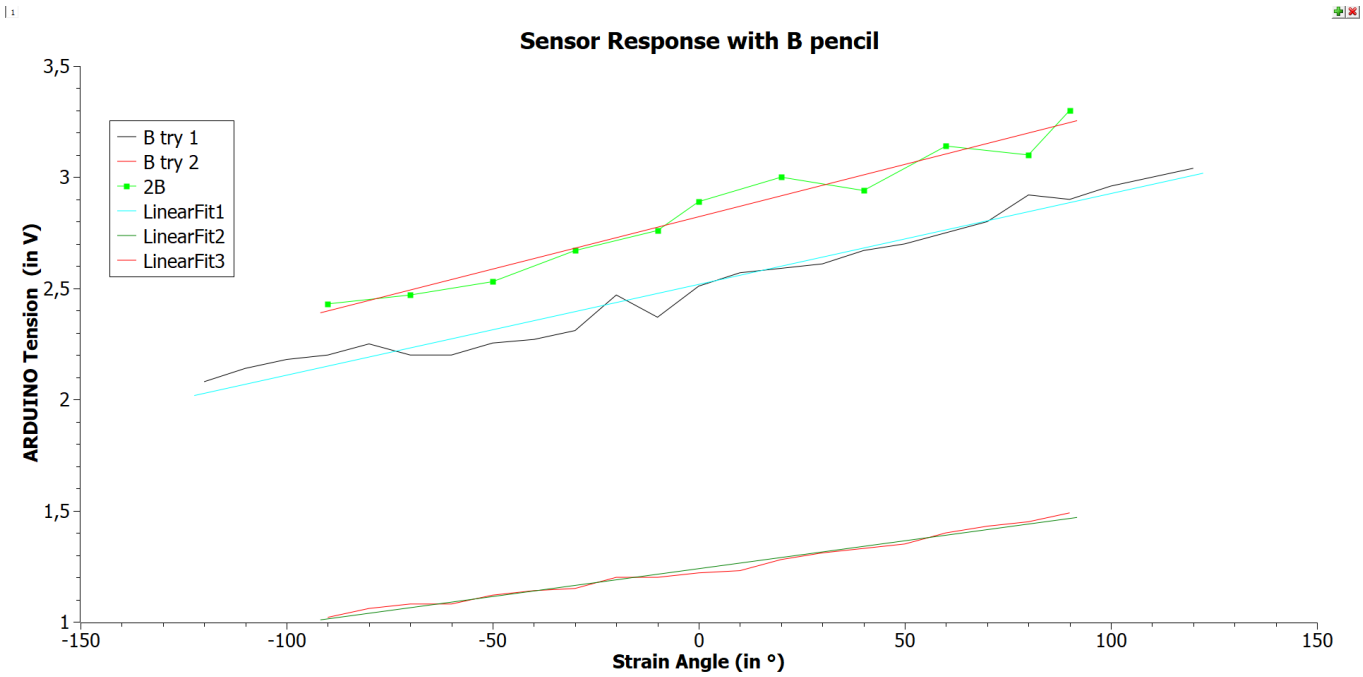
Standard use condition

Electrical characteristics

	Unit	**Min value**	**Typical value**	**Maximum value**
Graphite sensor resistance	°MΩ	1	37	1000

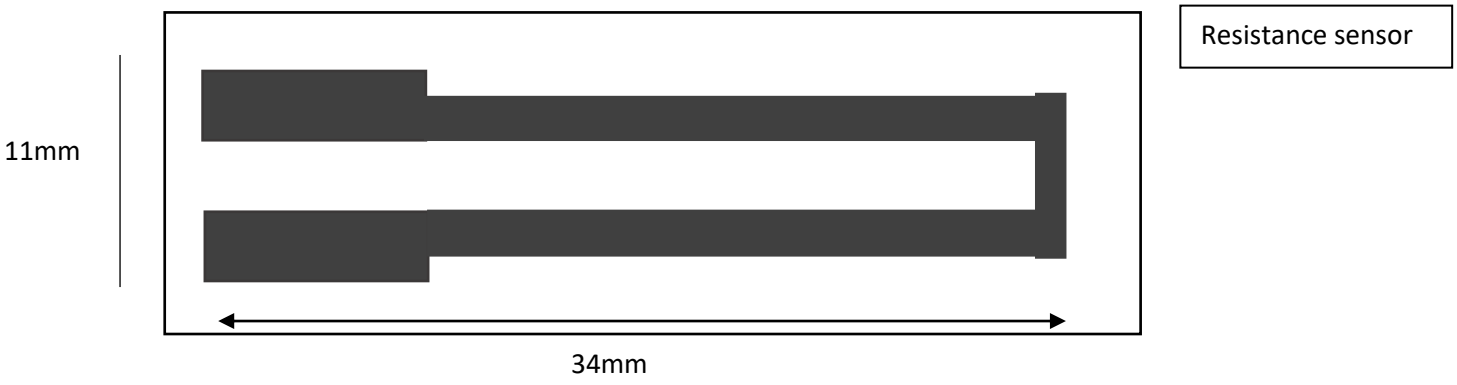
Resistance sensor characteristics

Current sensor as a function of the stain angle

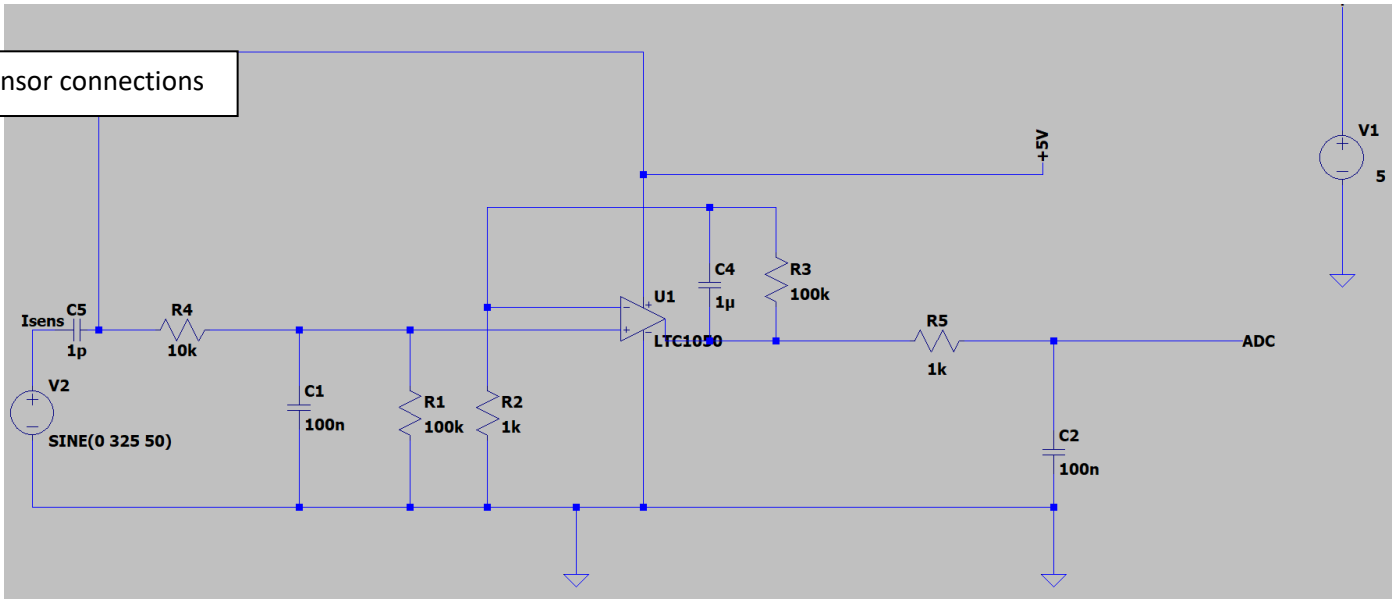


	B try 1	B try 2	2B
Linear fit coefficient	4.08e-3	2.51e-3	4.71e-3
Resistance range	16.36MΩ– 23.78MΩ	33.47MΩ – 48.93MΩ	15.06MΩ – 20.48MΩ

Dimensions



Typical applications



Above is the typical application for the resistance strain sensor in an analogic circuit. The sensor is connected in parallel with the operational amplifier which will convert and amplify a current proportional to the resistance of the graphite strain sensor (here Rsensor) to a voltage signal which will be read by the Arduino. In the diagram above “ADC “is the reference for the Arduino input.