

# Low-Tech Graphite Sensor

## Features

- Low power usage (3.3V-5V)
- Low cost and low tech
- Plug-in-play
- Ergonomic and easily repairable

## Applications

- Test findings of *Pencil Drawn Strain Gauges and Chemiresistors on Paper*<sup>1</sup>
- Pedagogical tool for students to design and implement their own PCB design

## General Description

This innovative sensor, conceptualized and made by students from the Applied Physics Department of INSA Toulouse, is a tool inspired by the publication *Pencil Drawn Strain Gauges and Chemiresistors on Paper*<sup>1</sup>. This research paper provides a simple, cost-efficient, and highly pedagogical tool for students to master their skills in Physics, Electronics, and Sensor Design. The sensor presented in the publication is a simple piece of paper with a layer of graphite on top of it, deposited with a pencil.

Due to the deposited graphite on the piece of paper, the electrons are able to move freely from particle to particle due to quantum tunnelling. This effect is extremely sensitive to the slightest movement of the paper. We observe that compressing or stretching the graphite will change the resistivity of the sensor.

<sup>1</sup>LIN, Cheng-Wei, ZHAO, Zhibo, KIM, Jaemyung et HUANG, Jiaying, 2014. Pencil Drawn Strain Gauges and Chemiresistors on Paper. Scientific Reports. 22 janvier 2014. Vol.4, n°1, pp.3812. DOI 10.1038/srep03812.

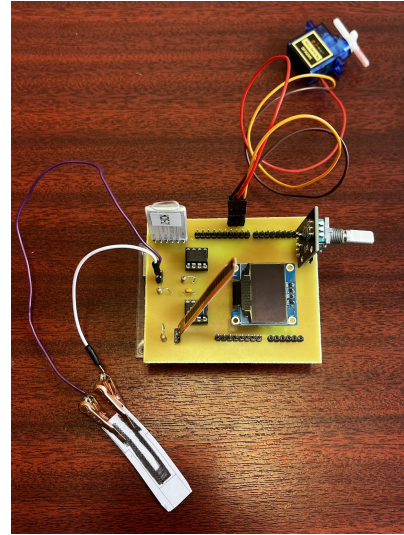


Figure 1: Graphite Sensor connected to the PCB

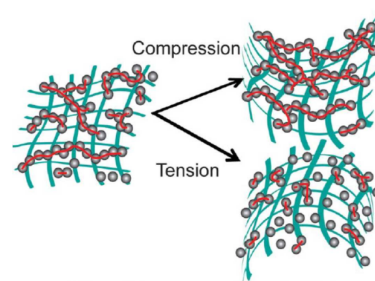


Figure 2: Compression and tension in a granular system

## Electrical Diagram

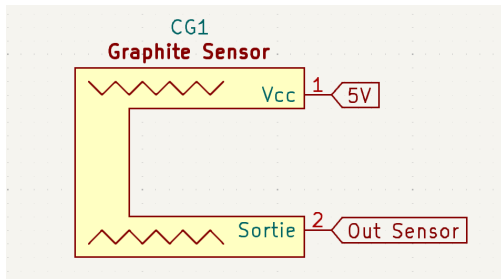


Figure 3: Schematic of the Graphite Sensor

Table 1: Specifications of the Electrical Diagram

Parameter	Pin	Symbol
Supply Voltage	$V_{CC}$	1
Out Sensor	$V_{out}$	2

## Electrical Specifications

All specifications are in  $-40^{\circ}C \leq T_A \leq 85^{\circ}C$  unless otherwise noted.

Table 2: Example Data Sheet Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Page width	$p_w$	20.9	21.0	21.1	cm	Standard A4 paper
Page height	$p_h$	29.6	29.7	29.8	cm	
Insulation voltage	$E_{max}^1$		1		kV	

<sup>1</sup> Based on characterization data, not tested in production.

## Absolute Maximum Ratings

Table 3: Absolute Maximum Ratings of the Graphite Sensor

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	$V_{CC}$	-	5.0	-	V
Temperature	T	10.0	-	30.0	$^{\circ}C$
Humidity	-	30	-	60	%
Paper Thickness	-	0.15	-	0.30	mm
Pencil Tone <sup>1</sup>	-	4B	-	2H	-

<sup>1</sup> Corresponds to the US grading system.

**Note:** Stresses above those listed under Absolute Maximum Ratings can cause permanent damage to the device. This is a stress rating only. Functional operation of the device is not implied in any conditions above those indicated in the Electrical Specifications section.