INSA TOULOUSE

MELISO

LOW-TECH GRAPHITE STRAIN SENSOR

Data Sheet **GSS-LT2025**

General Features

- Angle Displacement Measurement
- Low energy consumption
- Small sized (10 cm²)
- Lightweight (< 10 g)
- 5 V power supply
- Easy to use, repair and replace
- Low cost
- Low footprint

Description

This is a thin resistive low-tech strain sensor that produces an output based on the degree that the sensor is bent. Its manufacture is based on the scientific article *Pencil Drawn Strain Gauges and Chemiresistors on Paper*[1] and it is made up of a piece of paper (0.16 mm thick) where layers of graphite are deposited using pencils (type 2B, 3H, H or H/2).

The number of connected graphite particles attached to the paper varies depending on the type of deformation applied to the sensor. This change in the granular system translates itself in a variation in resistance and conductance. It is thanks to this property that we can use it as a strain sensor.

A transimpedance amplifier is required to amplify the signal, analyze the resulting signal, and measure the deformation. An example of a possible electronic circuit is given on page 2.

Dimensional Diagram

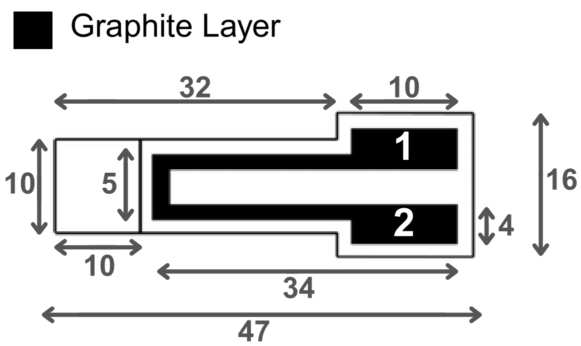

Figure 1 : Top view - Dimensions (mm)

PIN NUMBER	SYMBOL	PARAMETER
1	Vcc	Input supply voltage
2	Vout	Output voltage

Figure 2 : Pin Details

[1] Lin, C.-W., Zhao, Z., Kim, J. & Huang, J. Pencil Drawn Strain Gauges and Chemiresistors on Paper. Sci. Rep. 4, 3812; DOI:10.1038/srep03812 (2014).

Schematics

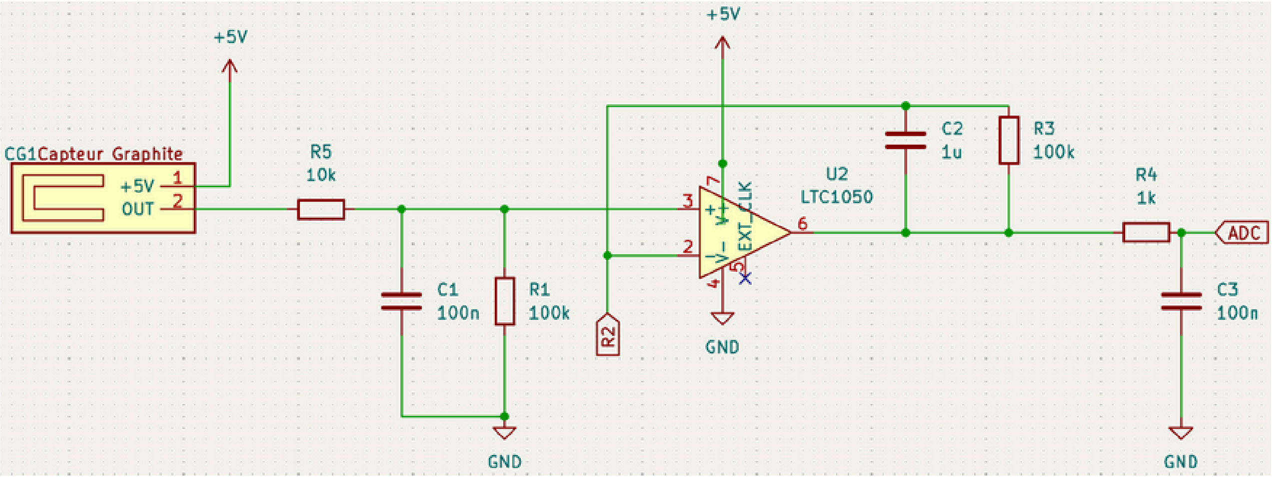

Figure 3 : Transimpedance amplifier circuit to use the sensor

The strain sensor is connected to a transimpedence amplifier circuit that contains a filters, allowing to obtain a good signal. The signal delivered by the sensor without this circuit is too weak. It has an average current of 100nA, so a very precise microcontroller would be required to detect variations on the signal. This is why we amplify it. The low-pass and high pass filters are necessary to cancel the noise caused by the amplification, the 50Hz frequencies that surround our environment (due to the electrical grid), and other unwanted frequencies.

The ensuing signal can be transmitted, for example, to the ADC of an Arduino board. This is where the variable resistance R2 can be tuned to adjust the circuit's amplification for each pencil grade. This is necessary in order to obtain a measured voltage value within the spectrum of measurable values.

Once instrumented, we obtain a measurement in volts, which corresponds to a digital value. To convert it into a usable value, we use the following expression:

$$V = V_{ADC} \times \frac{5}{1024}$$

The value of the strain sensor resistance Rss can be determined using the the following formula:

$$Rss = \left(R1 \times \left(1 + \frac{R3}{R2}\right) \times \frac{Vcc}{V} - R1 - R5\right) \times calibre$$

With

$$calibre = 1\Omega$$

Absolute Maximum Ratings

Input Supply Voltage (Vcc) 5V
Operating Ambient Temperature Range .... 0°C to 40°C
Paper thickness .... 0,15mm to 0,3mm
Pencil grades .... 6B to HB

Electrical Characteristics

SYMBOL	6B	5B	4B	3B	2B	B	HB
PARAMETER	Resistance						
VALUE	1	3	4	12	20	32	20
UNITS	MΩ						

Typical Performance Characteristics

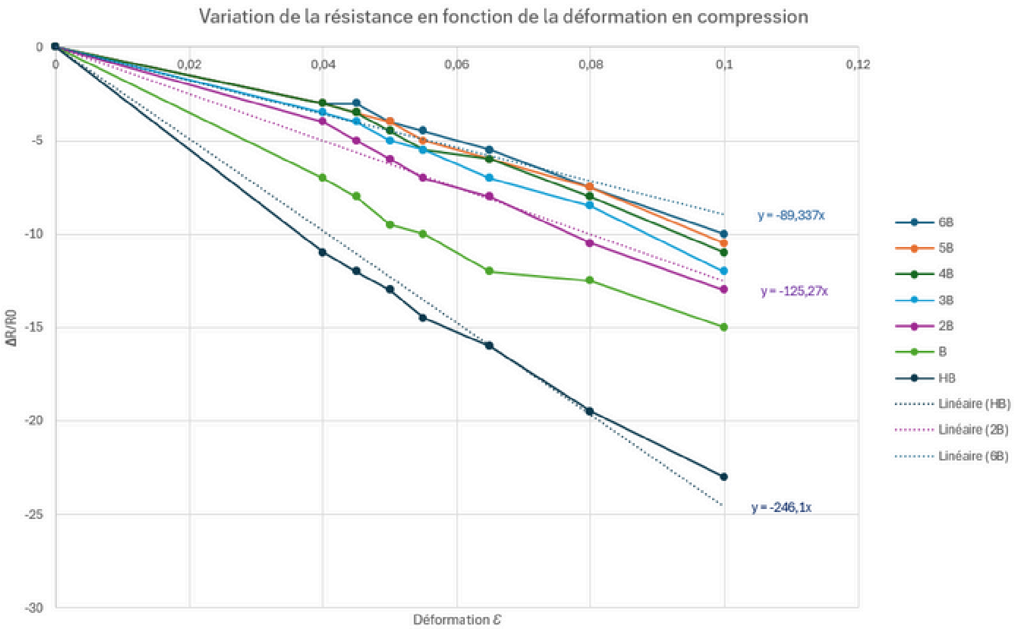

Figure 4 : Relative resistance graphs based on deformation in compression

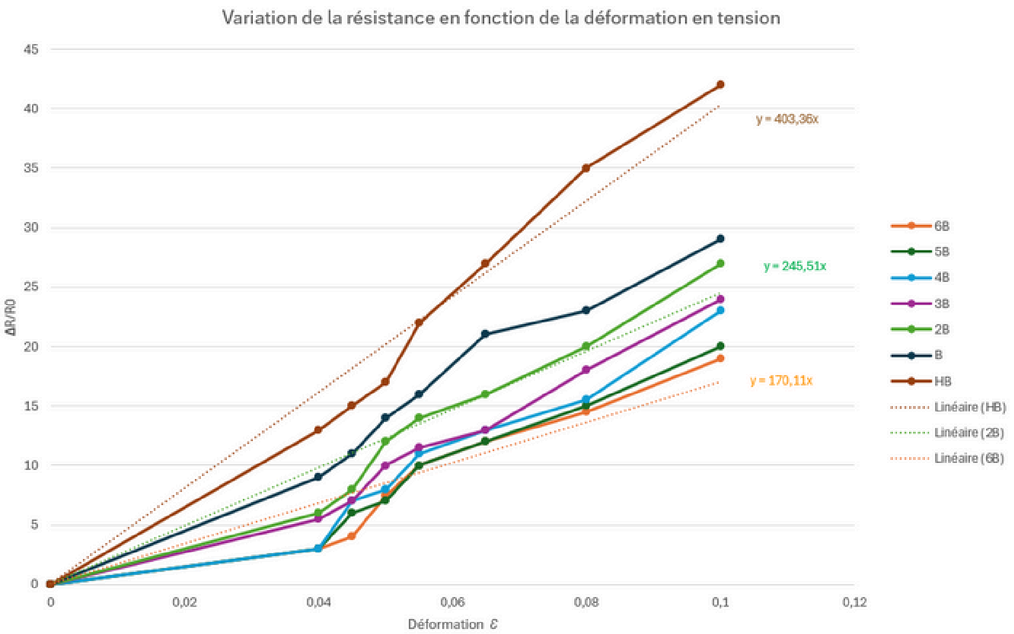

Figure 5 : Relative resistance graphs based on deformation in flexion