Datasheet for Graphite Sensor BG0524-LTG

Main Features

- Low-tech sensor
- Convenient to use
- Environment-friendly
- Replaceable and repairable

General Description

This strain sensor is made by INSA Toulouse students from the Génie Physique department. Its operation is based on a 2014 paper by Lin et al.[1]

A deposit of graphite on paper forms a granular system, composed of grains of varying sizes spaced at a certain distance, called the inter-grain distance. This property means that its conductance depends exponentially on the inter-grain distance, which can be modulated by folding the paper. Therefore the stress applied to the material can be directly determined by measuring the resistance at the sensor's terminals.

A transimpedance amplifier is necessary to measure the resistance precisely. An example of instrumentation for the sensor is listed below.

[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)

Sensor dimensions

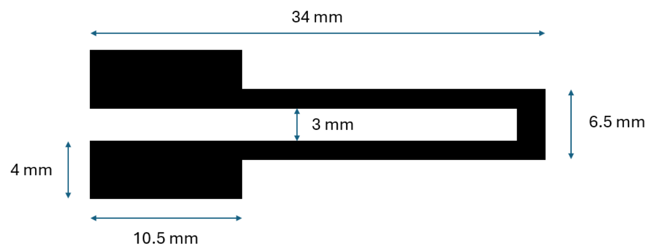

Figure 1: Dimensions in millimetres.

Thickness $t = 200\ \mu$m
Graphite surface $S_g = 146.5$ mm^2

Sensor pinout

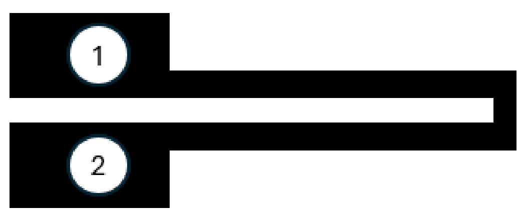

Figure 2: Sensor pinout

Pin 1 : V_{CC}
Pin 2 : V_{out}

Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings of Graphite Sensor

Parameter	Rating
V_{CC}	$5V$
Lifetime	5 to 20 uses (depending on applied stress)
Temperature	0°C to 40 °C
Pencil tone	4B to 4H (4H stress range is limited)

Electrical Specifications

All specifications are at ambient temperature ($T = 300K$).

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}	4.0	5.0	6.0	V
4H resistance	R	30	60	120	MΩ
HB resistance	R	6	7	8	MΩ
4B resistance	R	0.9	1.1	1.3	MΩ

Note: Resistance varies greatly depending on the amount of graphite deposited on the paper. A better indicator for measure would be the relative variation of resistance with respect to when the paper is flat.

Typical performance characteristics

In compression, a harder pencil lead will allow for more precision over the deformation value, but too much deformation will render the sensor useless.

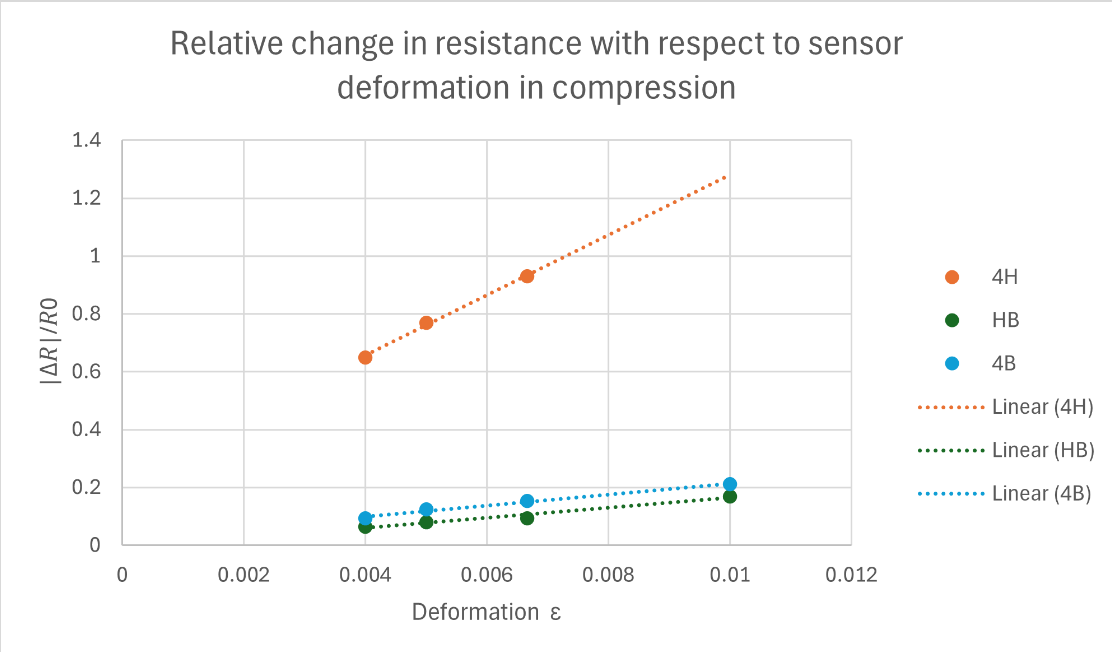

Figure 3: Performance characteristics for compression

In relaxation, a harder lead will too allow for more precision over the deformation value but too much deformation drive to a noised output signal, rendering the measure difficult.

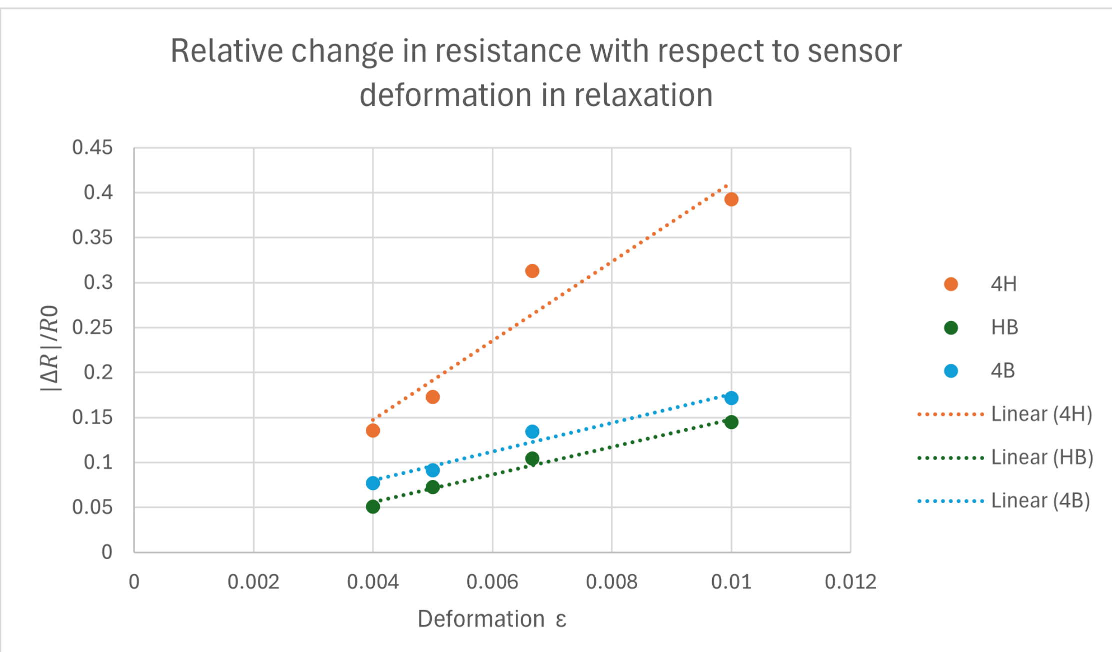

Figure 4: Performance characteristics for relaxation

Application example

The analog electronics for amplifying and filtering the graphite sensor signal consist of a transimpedance amplifier and three filters:

- An input passive filter to prevent distortion in the input stage
- An active filter based on the amplifier for maximum efficiency
- An output passive filter to eliminate noise introduced during processing.

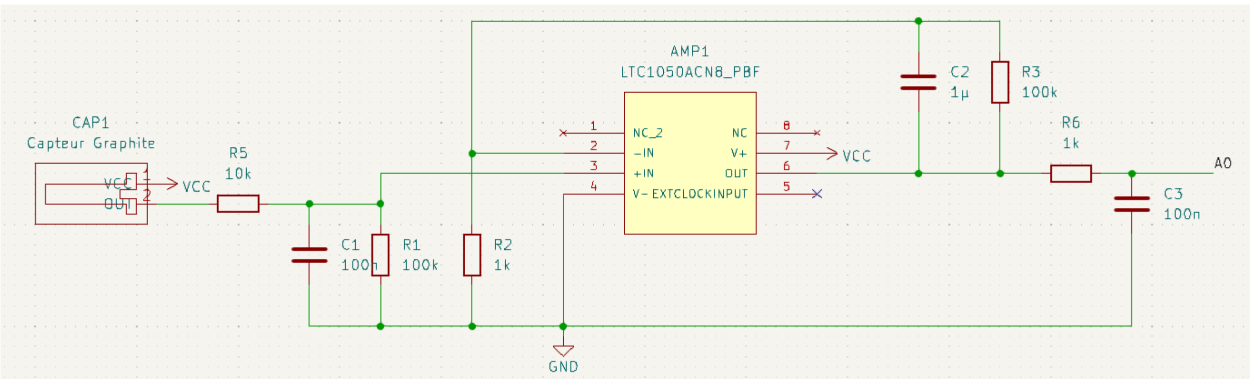

Figure 5: Example schematic of transimpedance amplifier for instrumenting the graphite sensor

Sensor resistance is computed according to this formula :

$$R_{sensor} = R_1 \cdot (1 + \frac{R_3}{R_2}) \cdot \frac{V_{CC}}{Vout} - R_1 - R_5$$

R_2 can be replaced by a variable resistance for a better control on output voltage.