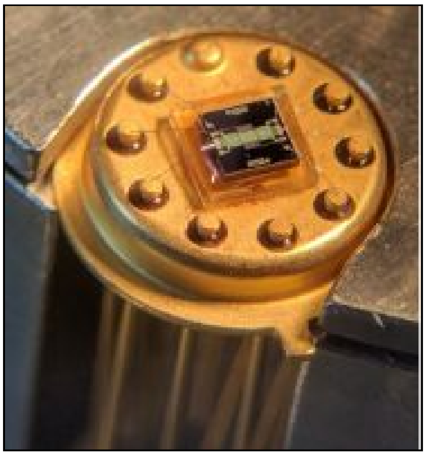
WO3-based gaz sensor

Datasheet



Features and applications

Applications

Detection of various gases:
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Hydrogen sulfide (SO_2)
- Dihydrogen (H_2)
- Methane (CH_4)
- Alcohols (-OH)

Main features

High sensitivity and selectivity
Low power consumption
Low cost
Small and compact
Easy to use
Long lifetime

General overview

This gas sensor was developed at the AIME laboratory of INSA Toulouse. The goal of the sensor is to detect outdoor or indoor air quality. The sensor consists of a polysilicon heater barrel on a silicon-based structure and a metal-oxide chemiresistor. Tungsten trioxide nanoparticles (WO3) are integrated on carved aluminum combs, providing the sensibility. An additional temperature sensitive resistors is included for calibration.

This sensor module is optimized for the detection of traces of atmospheric gases, including for instance nitrogen dioxide, carbon monoxide and dihydrogen.

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1. DEVICE OVERVIEW

1.1. Pin description

FIGURE 1-1: PIN MAPPING

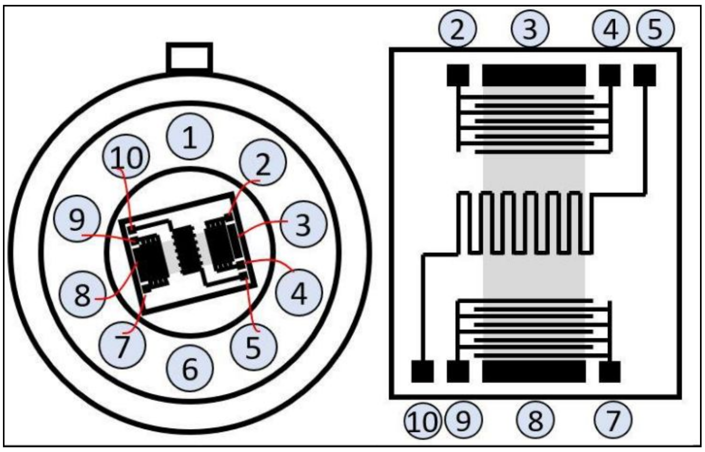


TABLE 1-2: PIN USAGE

Pin Number	Usage
1/6	Not connected
2/4	Gas sensor (WO3 nanoparticles)
3/8	Polysilicon heater
7/9	Gas sensor (WO3 nanoparticles)
5/10	Temperature sensor (Aluminium resistor)

2. SPECIFICATIONS

2.1. General

TABLE 2-1: GENERAL SPECIFICATIONS

Specification	Description
Type	Semiconductor
Materials	- Tungsten trioxide nanoparticles - Aluminium - Silicon - N-doped poly-silicon
Packaging	10-Lead TO-5 metal
Typical measure precision	Resistive measure
Power supply requirement	Active sensor
Nature of output signals	Analog signal
Nature of measurands	Resistive measurement
Head diameter	< 10 mm
Head height	< 5 mm
Package height	< 25 mm
Pin diameter	< 1 mm
Mounting	Through hole fixed
Detectable gases	- Nitrogen dioxide (NO2) - Carbon monoxide (CO) - Hydrogen sulfide (SO2) - Dihydrogen (H2) - Methane (CH4) - Alcohols (-OH)
Time response	Ethanol < 35s Ammonia < 20s
Aluminium resistance	80 Ω

TABLE 2-2: STANDARD USE CONDITIONS

	Unit	Typical Value
Temperature	**°C**	**25 +/- 5**
Relative Humidity	**%**	**60 +/- 5**

TABLE 2-3: USE DOMAINS

	Nominal domain	**Non deterioration domain**
Aluminium	[0 V ; 5 V]	[5 V ; 10 V]
Polysilicium	[0 V ; 7.5 V]	[7.5 V ; 15 V]
Gas sensor	Up to 523 K	Up to 623 K

2.2. Electrical characteristics

FIGURE 2-1: I(V) characteristics of the sensor at 15V

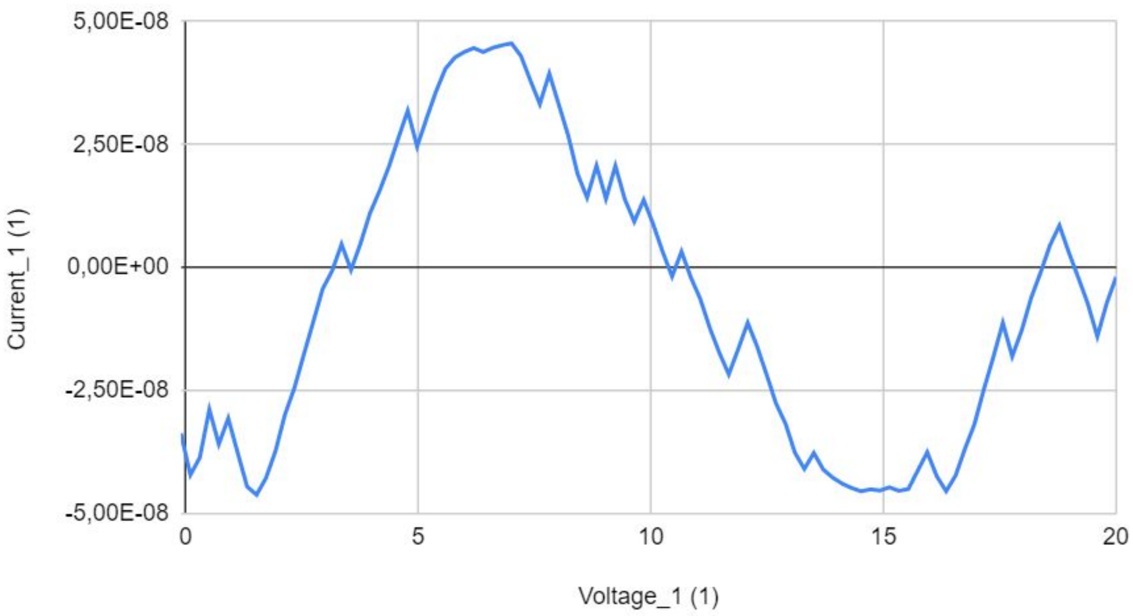


FIGURE 2-2: I(V) characteristics of the aluminium at 10V

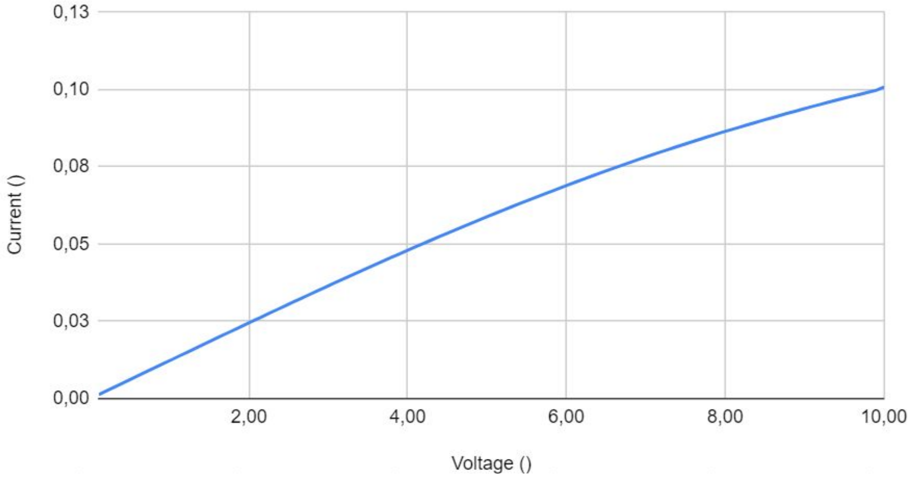


FIGURE 2-3: I(V) characteristics of the combs at 15V

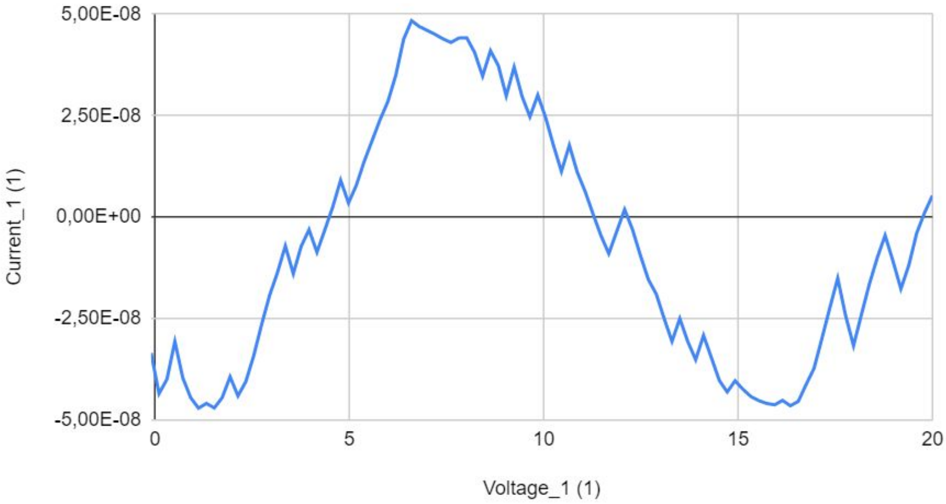
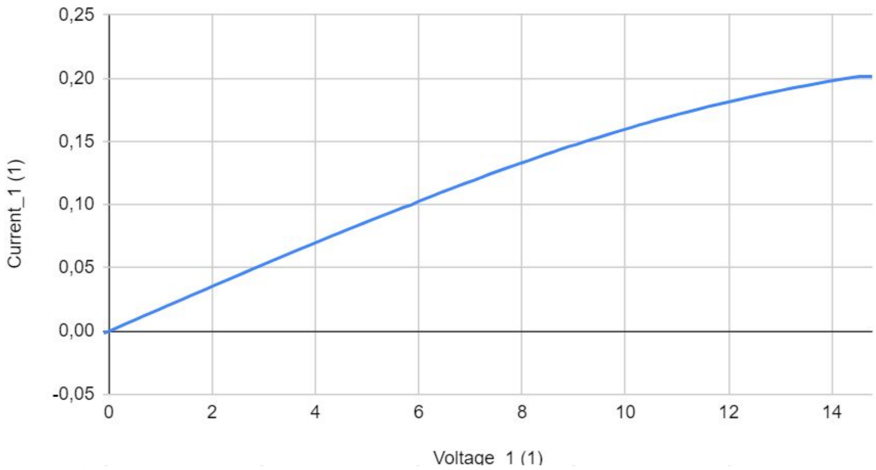


FIGURE 2-4: I(V) characteristics of the polysilicon at 15V



2.3. Sensor resistance variations to gaz exposure

Following, the test procedure presented in table 2-4, we obtained the following results.

Time	120	120	120	120	120	120	120	120	120
Gaz	Dry air	NH3	Dry air	NH3	Dry air	ethanol	dry air	ethanol	dry air

FIGURE 2-5: Variation of the sensor resistance at 500K

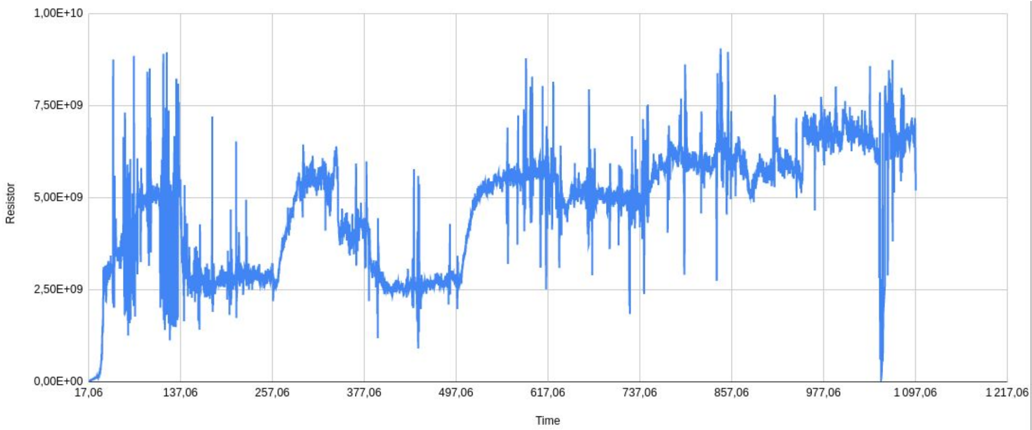


FIGURE 2-6: Variation of the sensor resistance at 600K

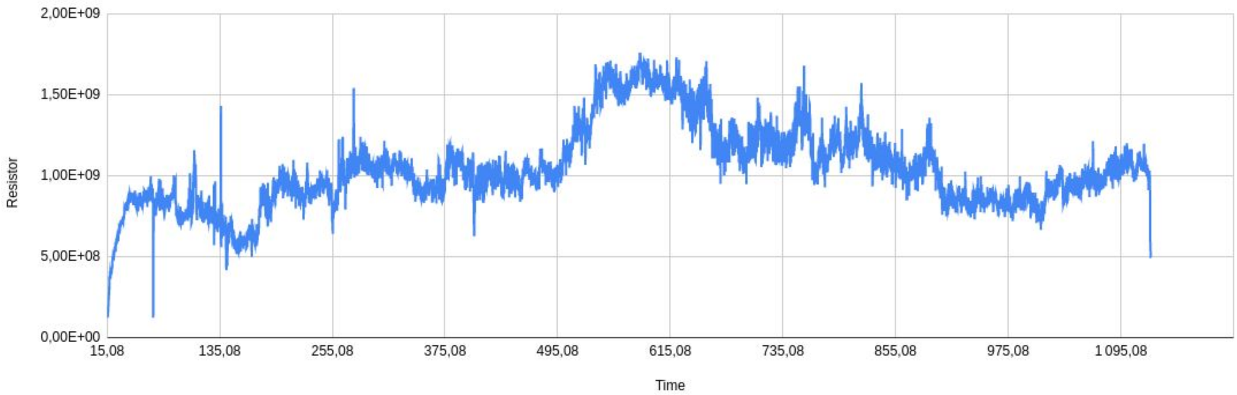
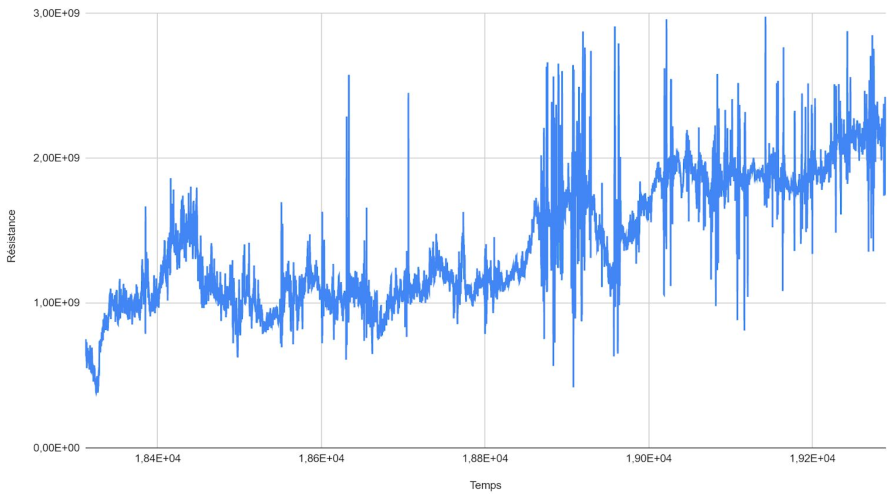


FIGURE 2-7: Variation of the sensor resistance at 610K

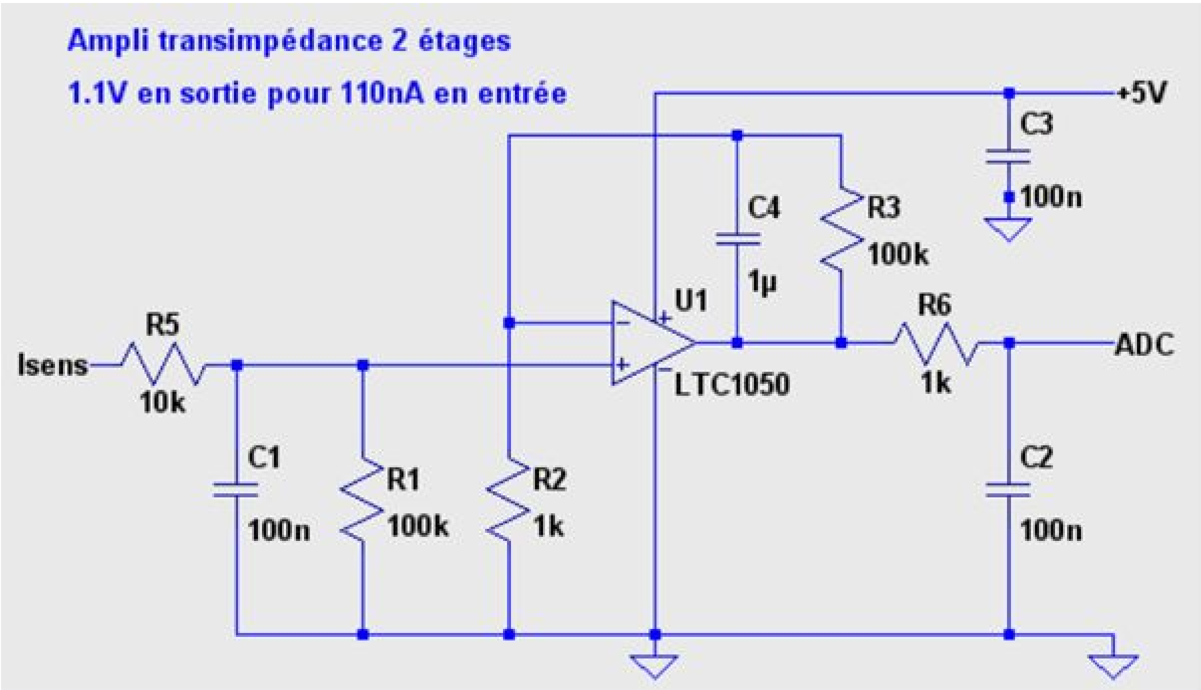


3. APPLICATION CIRCUIT

3.1. Typical application circuit

The output current of the sensor is about 100 nA. It is very difficult to measure such small currents with a basic microcontroller ADC, the signal must be amplified. Moreover, because of the very high impedance of the sensor, we need to adapt the impedance in the amplification stage to obtain an accurate measurement. A typical application circuit is shown below where Isens is one of the two outputs of the sensor (pin 7/9). With such an amplified signal, additional filtering is required.

FIGURE 3-1: RECOMMENDED SCHEMATIC



3.2. Typical values of the analog filters

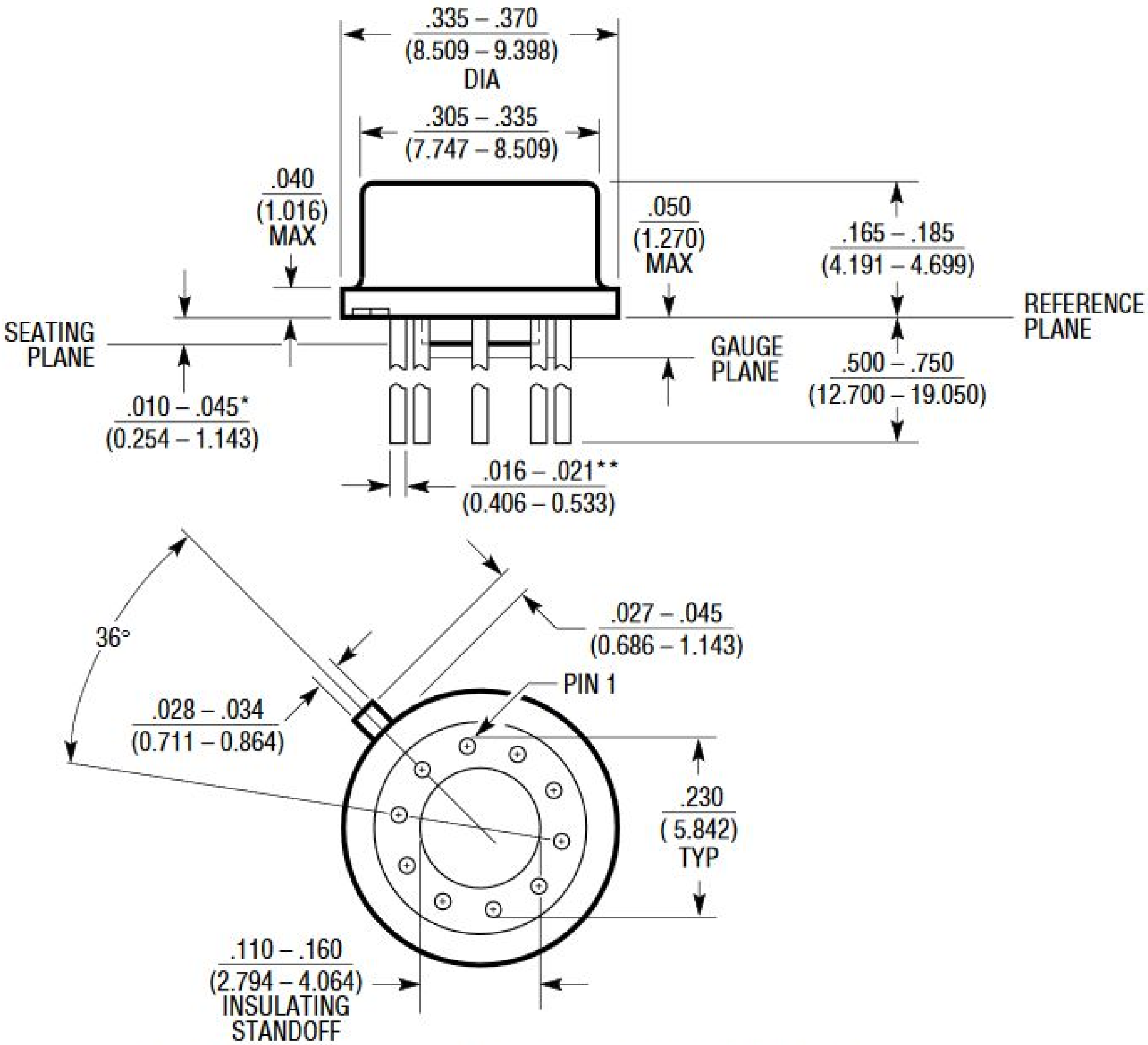
Analog low pass filtering is included to improve sensor's performance. In the above figure you will find the recommended values used to build a 3 stages active low pass filter which cutoff frequencies are respectively 1 kHz, 7.5 kHz and 15 kHz. In the following table you can read the typical values of this circuit.

TABLE 3-1: TYPICAL VALUES

Variable	Typical Value
Sensor	
R_{sensor}	≈ 1G Ohm
I_{sens}	≈ 100 nA
Sensor Bandwidth	1 Hz
ADC	
f_{ADC}	[50 kHz - 200 kHz]
ADC Resolution	5 mV
f_{mesure}	15 kHZ
f_{max} (shannon's criteria)	7.5 kHz
Circuit	
V_{R1}	10 mV
Amplifier circuit gain	500
Output Voltage	5 V
Opamp	
V_{offset}	10 mV
Input current	1 nA

4. PACKAGING INFORMATIONS

4.1. 10-lead TO-5 package



*LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND THE SEATING PLANE

**FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $\frac{.016 - .024}{(0.406 - 0.610)}$ H10(TO-5) 0204