AiME Micro-Nano Pôle CNFM de Toulouse	**Low-power high-efficiency tungstate nanoparticles gas sensor**	**AIME GASWO3A-2018** **Datasheet**

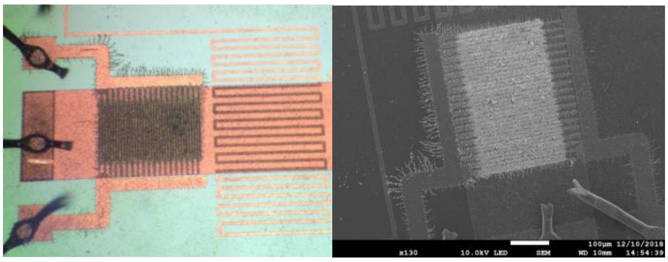
Description

The *AIME GASWO3A* sensor is a highly sensitive tungstate (WO_3) nanoparticles gas sensor, designed for detection of oxidable-gases in the air. It can detect gas such as (but not limited to) Ethanol and Ammonium.

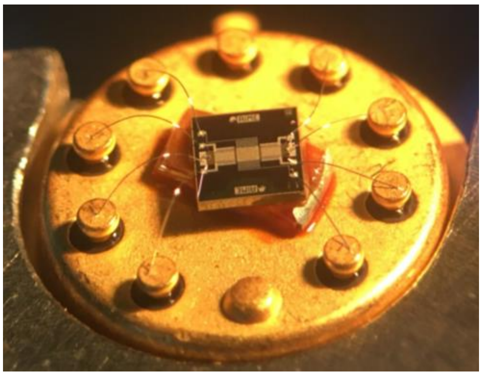
It is based on a metallic-oxide of tungsten trioxide nanoparticles set in aluminum interdigitated combs on a N-doped silicon substrate. Sensor contains two sensitive aluminum combs, one of which does not have a nanoparticles deposit and can be used for calibration purposes.

Reactivity of the metallic-oxide is factor of the temperature of the sensing area. Sensor temperature can be set using a N-doped polysilicon internal resistor, and controlled with an aluminum resistor.

Overview



The sensor's silicon substrate with internal resistors, and nanoparticles sensitive area.



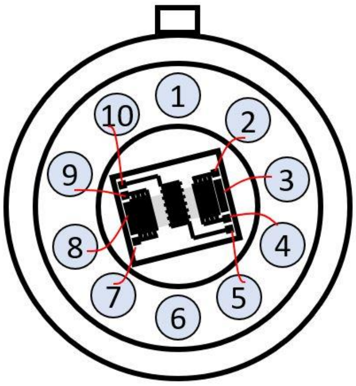
Silicon substrate mounted on the package with its Al bonding. Wires were attached by ultrasonic welding. Sensor is set and thermally isolated from package with resin.

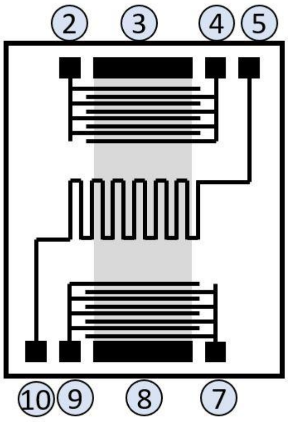
Features

- High sensitivity to a wide range of gases
- State-of-the-art nanoparticles technology
- Conditioner is not integrated in the package: power efficiency can be optimized to the application
- Long lifetime
- Short to instant response-time
- Environmentally safe(ish)
- Low cost at high volume

Packaging

Sensor is mounted on a 10-pin TO-5 package. It protected by a drilled enclosing cap that lets gas pass-through. Sensor and its bonding's are sensitive and should be handled with care.





Pin number	Description
2, 4	Sensitive gas layer (WO_3nanoparticles integrated on aluminium interdigitated combs)
3, 8	Heater polysilicon resistor
5, 10	Aluminum based temperature sensor
7, 9	Sensitive gas layer (WithoutWO_3nanoparticles for calibration)
1, 6	Not used

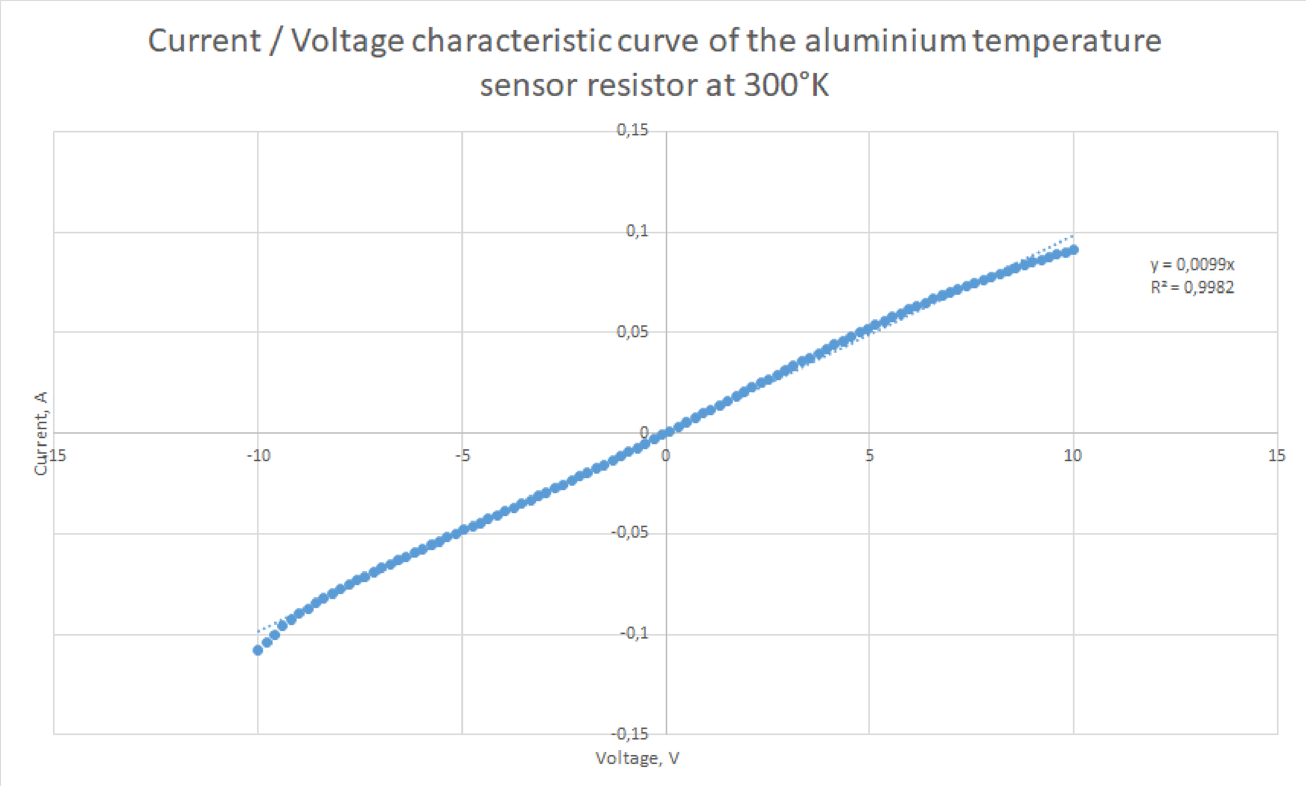
Electrical characteristics

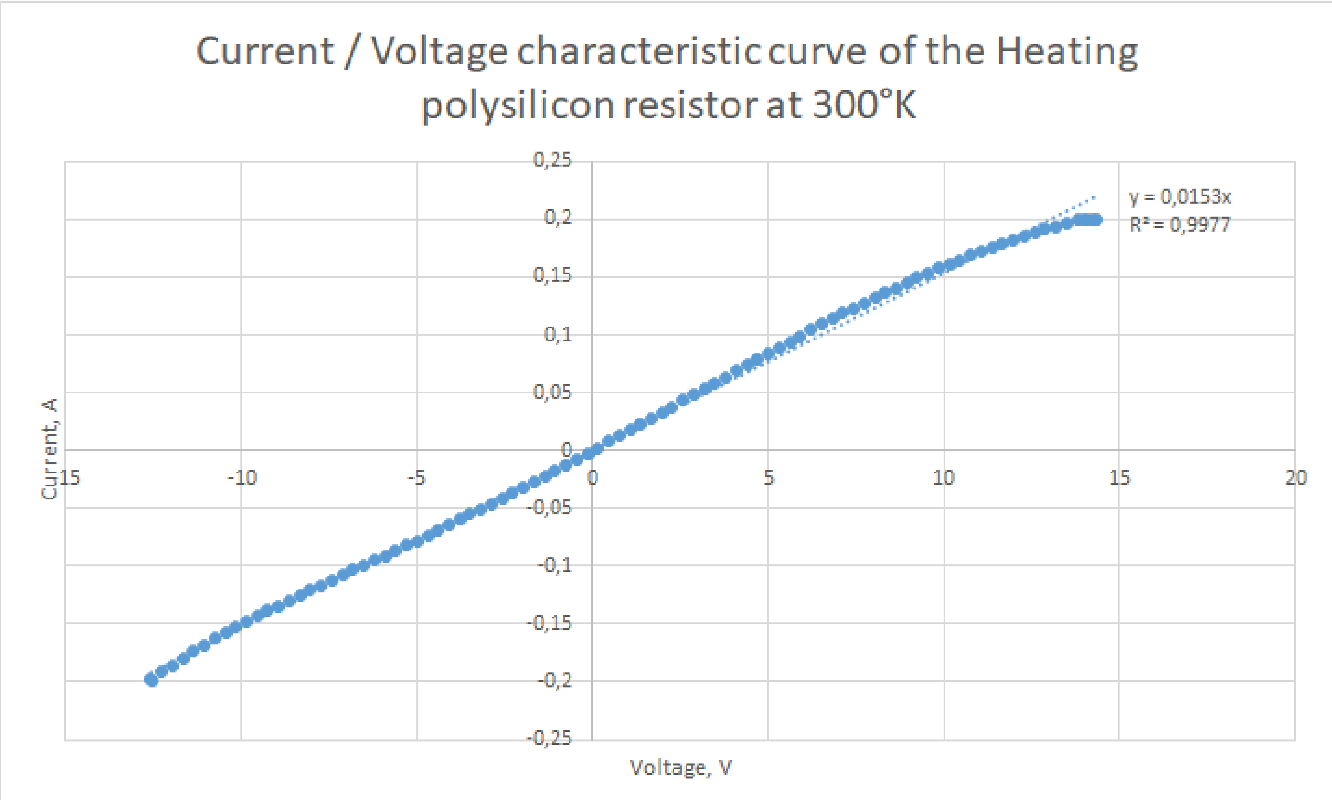
	Unit	Value		
		Min.	Typ.	Max.
Power supply, sensitive layer	V	5	8.7	20
Power supply, aluminum-based temperature sensor	V	5	8.7	15
Power supply, heater polysilicon resistor	V	5	8.7	15
Power consumption	W	0.4	2	-
Rpoly at 300°K	Ω	62	65	70
Ralu at 300°K	Ω	76	88	90
Ralu at 400°K	Ω	-	120	-
Ralu at 500°K	Ω	-	163	-
Ralu at 600°k	Ω	-	200	-
Gaz sensor resistance	MΩ	0.1	1	100

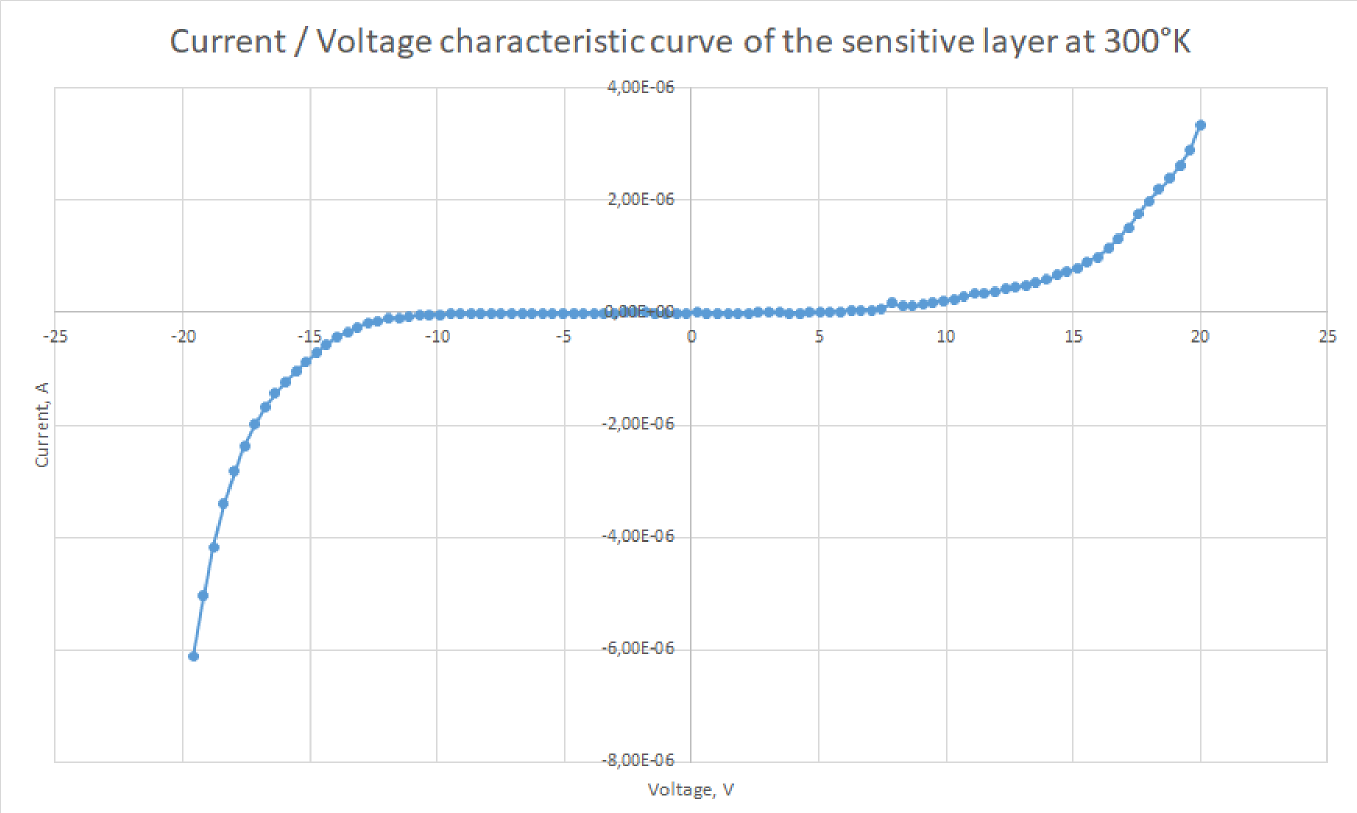
Testing conditions

	Unit	Value
Temperature	°C	20±5
Gaz concentration	ppm	1000
Humidity	%	60±5

Current / Voltage characteristics of each layer at 300°K


Current / Voltage characteristic curve of the aluminium temperature sensor resistor at 300°K
0,15
0,1
0,05
0
-0,05
-0,1
-0,15
-15
-10
-5
0
5
10
15
Current, A
Voltage, V
y = 0,0099x
R² = 0,9982


Current / Voltage characteristic curve of the Heating polysilicon resistor at 300°K
0,25
0,2
0,15
0,1
0,05
0
-0,05
-0,1
-0,15
-0,2
-0,25
-15
-10
-5
0
5
10
15
20
Current, A
Voltage, V
y = 0,0153x
R² = 0,9977

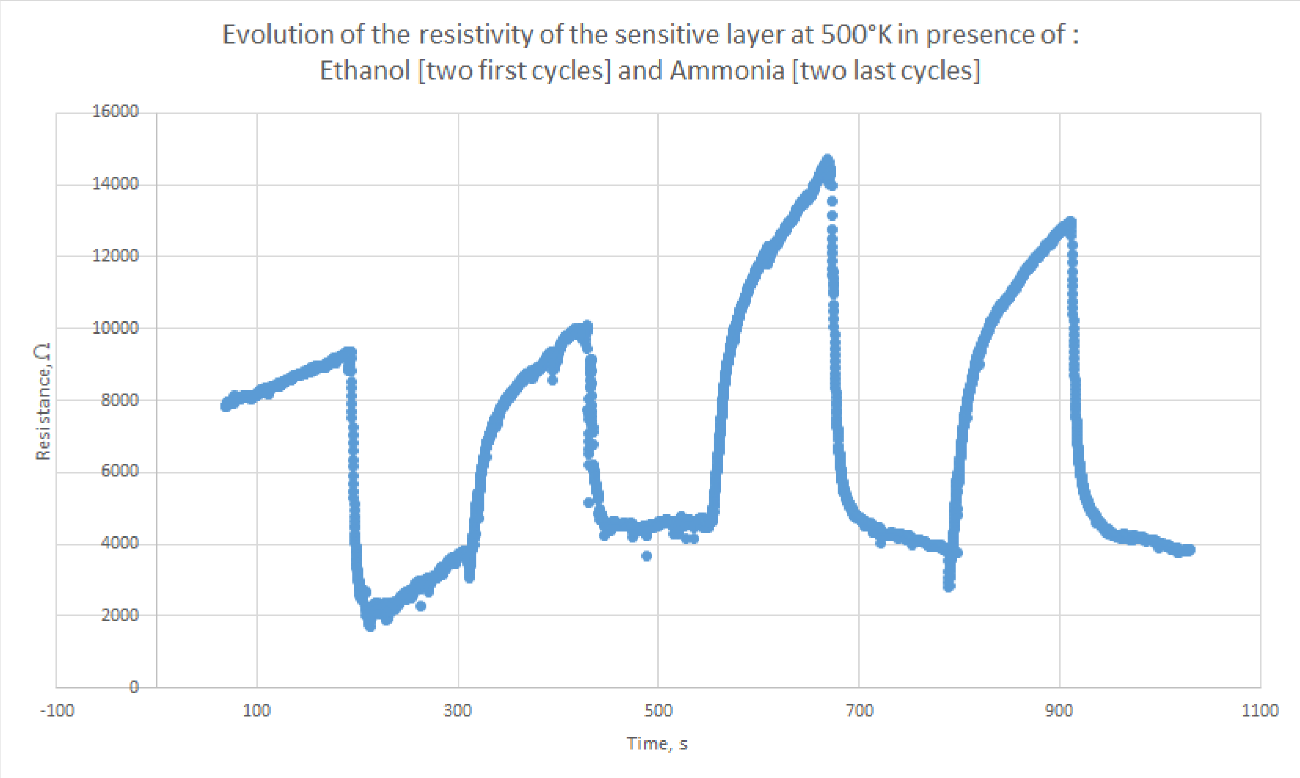


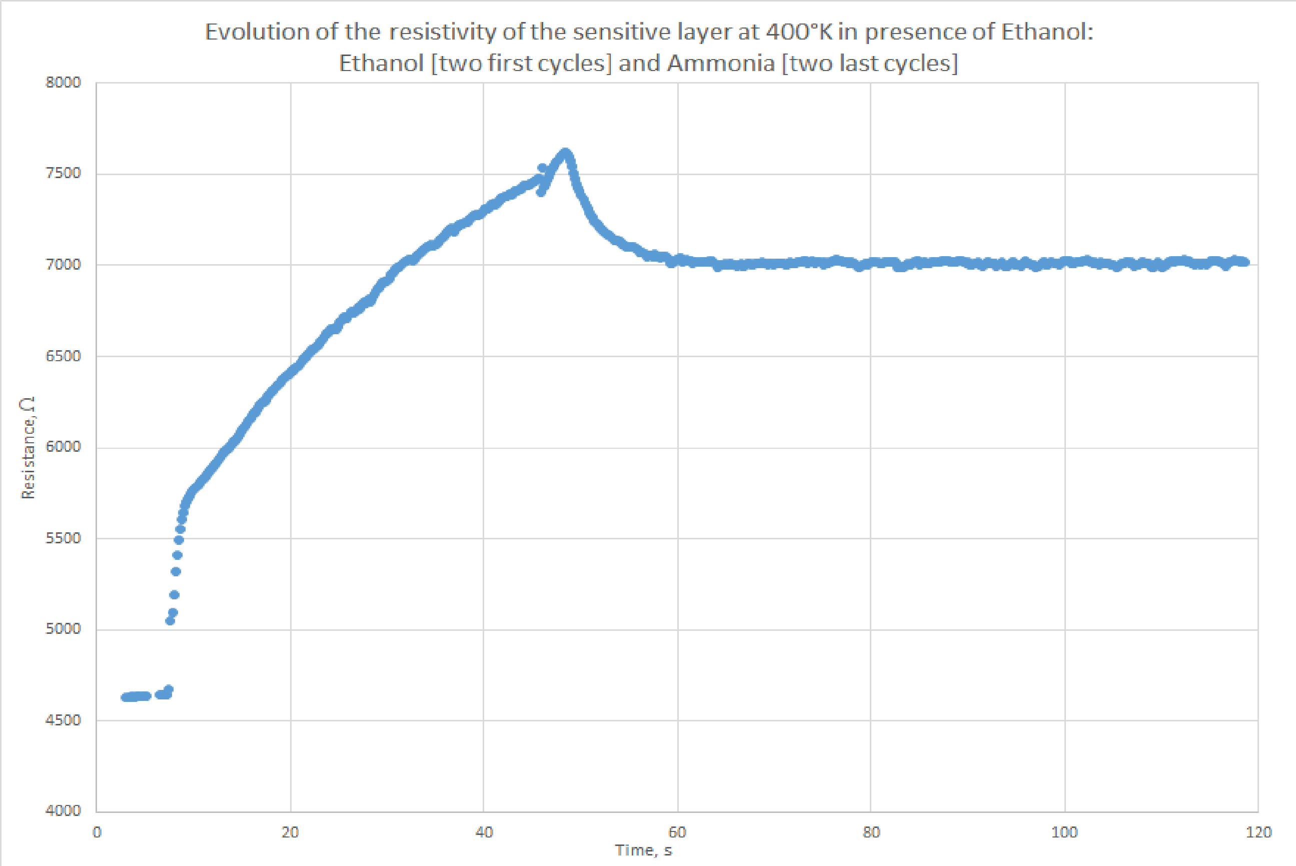
Time response of the gas sensor in presence of ethanol and ammonia

The response of the WO_3gas sensor was tested, at AIME, in presence of ethanol and ammonia for 2 temperatures: at 500°K and 400°K. Before proceeding to the experiment, the WO_3gas sensor was preconditioned, that means heated to densify the sensitive layer. This preconditioned is a mandatory step between the production of the gas sensor and its use. On the experiments, the deep polysilicon layer is used to heat, the aluminum resistive layer to sense the current temperature of the sensor and the sensitive layer to detect the presence of the gas. It is important to access the temperature of the sensor (with the aluminum layer) at the same time that the resistance variation of the sensitive layer to make the difference between a resistance variation of the sensitive layer due to a temperature variation of the sensor or due to the presence of a gas.

For the first characterization at 500°K, all the layers were polarized at 8.7V. For this test, we realized the two first cycles with ethanol gas flow and dry air flow and the two last with ammonia gas flow and dry air flow. The time response of the sensor is really good (less than 1s) and the regeneration time between cycles is really low (less than 2s). It is possible to differentiate the ethanol detection from the ammonia detection with the maximum resistance of the sensitive layer (between 13KΩ and 15KΩ for the ammonia and between 9KΩ and 10KΩ for the ethanol.

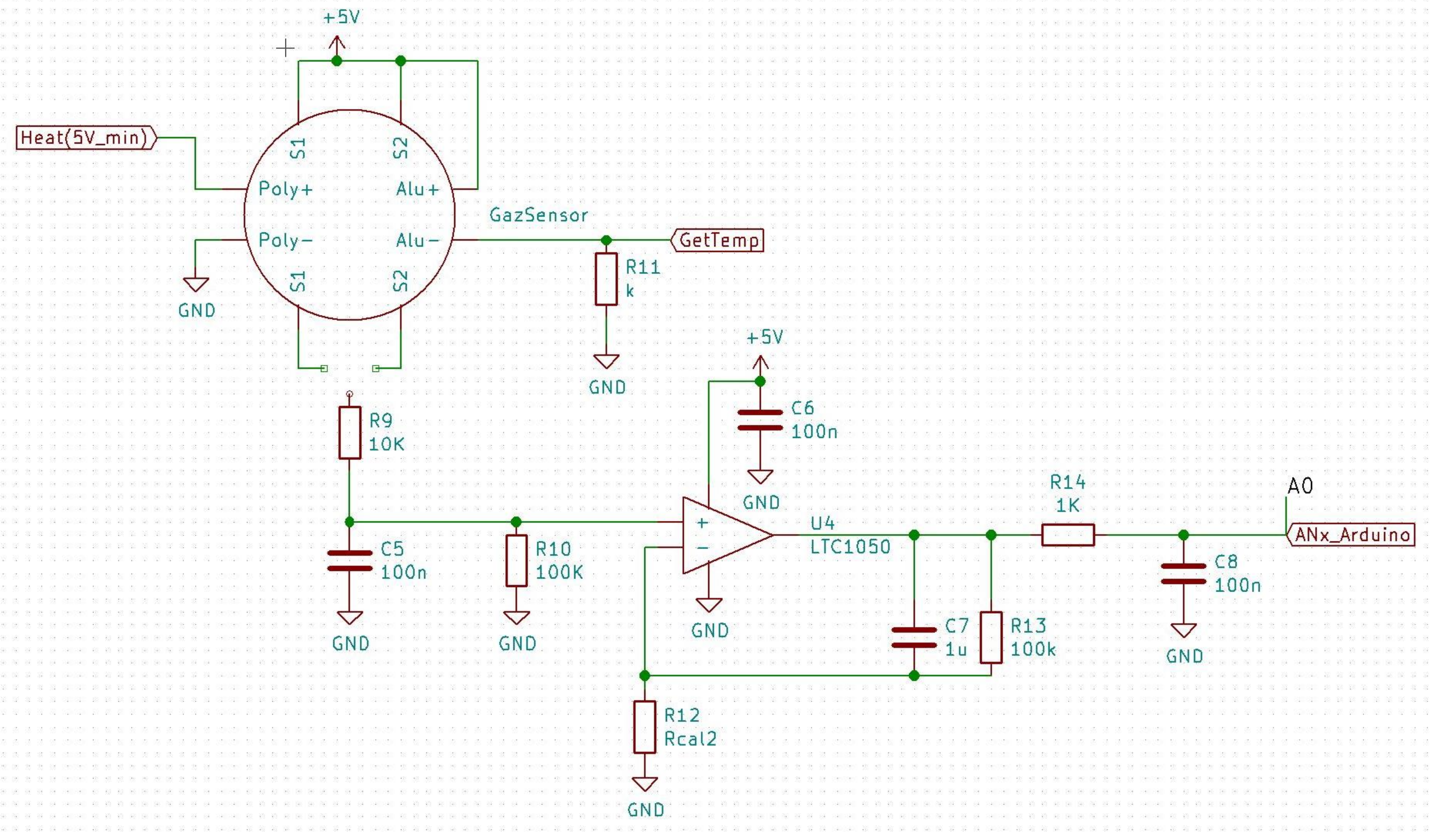
For the second characterization all the layers were polarized at 5V to see its response if the sensor is use with an arduino or raspberry for example. This limitation imposed the 400°K of the experiment. The time response of the sensor is almost 20s, but it still detects the gas presence. With this operating temperature the regeneration of the sensor is impossible. It then can only detect the gas presence once and must be replace after.





Applications

The following circuit allows to use the WO_3gas sensor with an Arduino for example. The user can choose to use a 5V voltage for the polysilicon heater resistor or higher. The user can access the temperature of the sensor and the response of the sensitive layer. The response of the sensitive layer is amplified by an LTC1050 operational amplifier and then filtered by a low pass RC filter. The voltage response is proportional to the input current that mean by the resistance variation of the sensitive layer.



Use conditions

The GASWO3A is adapted for monitoring various gases such as, but not limited to, pollutants in atmosphere, or toxicity due to misuse of electrical devices or home appliances. It is not suitable for fire detection and users should rely on standard fire protection equipment for that purpose. It is a highly versatile component that can be efficiently used in conjunction with advanced digital signal processing. If your application does not require such capabilities, we offer a wide range of sensors adapted to every application. Please refer to **www.aime-toulouse.fr** for more information.

Ordering information

Part number	Package	Rating	Operating temperature
GASWO3A-I	10-pin TO-5	Military	0 to 60°C
GASWO3A-H	10-pin TO-5	Industrial	-30 to 70°C