FIGARO

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Technical Information for Figaro Lead-Free Oxygen Sensor TGS4260

TGS4260 is a potentiostatic electrolysis-type oxygen sensor which has a wide measuring range and operating temperature range. It is easy to incorporate this sensor in size oriented applications such as portable oxygen detectors and multi-gas detectors.

Page

IMPORTANT NOTE: OPERATING CONDITIONS IN WHICH FIGARO SENSORS ARE USED WILL VARY WITH EACH CUSTOMER'S SPECIFIC APPLICATIONS. FIGARO STRONGLY RECOMMENDS CONSULTING OUR TECHNICAL STAFF BEFORE DEPLOYING FIGARO SENSORS IN YOUR APPLICATION AND, IN PARTICULAR, WHEN CUSTOMER'S TARGET GASES ARE NOT LISTED HEREIN. FIGARO CANNOT ASSUME ANY RESPONSIBILITY FOR ANY USE OF ITS SENSORS IN A PRODUCT OR APPLICATION FOR WHICH SENSOR HAS NOT BEEN SPECIFICALLY TESTED BY FIGARO.

1. Basic Information and Specifications

1-1 *Features*

* Lead-free
* In 20mm industrial standard package
* Linear output
* Quick response to Oxygen
* High repeatability/selectivity to O_2
* Long life
* High impact resistance

1-2 *Applications*

* Oxygen monitors
* Stationary O_2 detectors
* Portable O_2 detectors
* Multi-gas detectors

1-3 *Structure and Dimensions*

Figure 1 shows the structure and dimensions of the sensor.

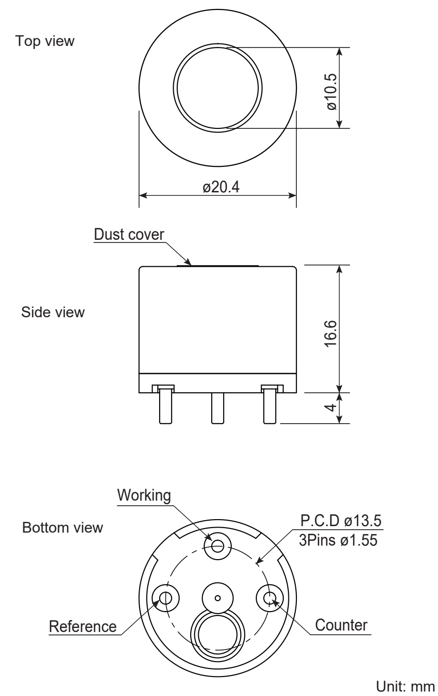

Fig. 1 - Sensor dimensions

1-4 *Operating Conditions and Specifications*

The specifications shown in the table 1 are based on the standard test conditions, using Figaro's recommended measuring circuit.

Model Number	TGS4260
Detection Gas	Oxygen
Detection Range	0 ~ 25 vol.%
Maximum Overload	30 vol.%
Output Signal	-80 ~ -130 µA in Air
Repeatability	± 2% (*1)
Resolution	0.1 vol.%
Response Time (t_{90})	< 10 sec (*2)
Long Term Output Drift	< 5% over operating life (*3)
Expected Life Time	> 5 years (*3)
Operating Temperature	-20 ~ 50˚C(continuous) -40 ~ -20˚C, 50 ~ 60˚C(short term)
Operating Humidity	15% RH ~ 85% RH(continuous) 5 ~ 15%RH, 85 ~ 95%RH(short term) no condensation
Operating Pressure Range	100kPa ± 20kPa
Recommended Load Resistor	20 Ω
Bias Voltage	-600mV ± 10mV
Position Sensitivity	None
Recommended Storage Temp.	5˚C ~ 35˚C
Weight	6.0g (approx.)
Warm-Up Time	3hour. or more (*4)

Table 1 - Specifications of TGS4260

*1: When tested under constant operating conditions
*2: When tested within the range from -20˚C to 60˚C
*3: Under standard test conditions of 20˚C, 50%RH and 1013 hPa
*4: No sudden changes of ambient temperature or humidity

All sensor characteristics shown in this document represent typical characteristics. The only characteristics warranted are those shown in the Specification table above.

1-5 *Basic Measuring Circuit*

Figure 2 shows the basic measuring circuit for use with TGS4260.

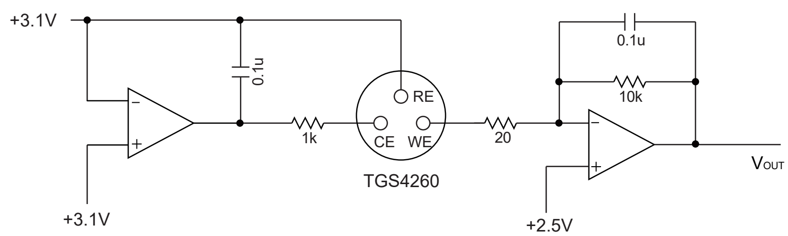

Fig. 2 - Basic measuring circuit

1-6 *Operation Principle*

TGS4260 is a potentiostatic electrolysis-type oxygen sensor. Figure 3 shows the structure of TGS4260 oxygen sensor. The working electrode (WE), the counter electrode (CE), and the reference electrode (RE) respectively comprise a gas permeable membrane and a noble metal catalyst, all of which are in contact with the liquid electrolyte and contained in a resin housing. The electrolytic current generated between WE and CE is measured while an external power supply (potentiostatic circuit) controls the potential of the WE with respect to the RE potential. When TGS4260 sensor is placed where oxygen is present, by maintaining the potential of the WE at a predetermined negative value with respect to the RE potential, reduction of oxygen occurs on the WE, and oxidation of water occurs on the CE at the same time. During these electrochemical reactions, ionic conduction occurs in the electrolyte and electronic conduction occurs in the external circuit. Output voltage proportional to oxygen concentrations can be measured by converting the generated electrolytic current which is proportional to oxygen concentration.

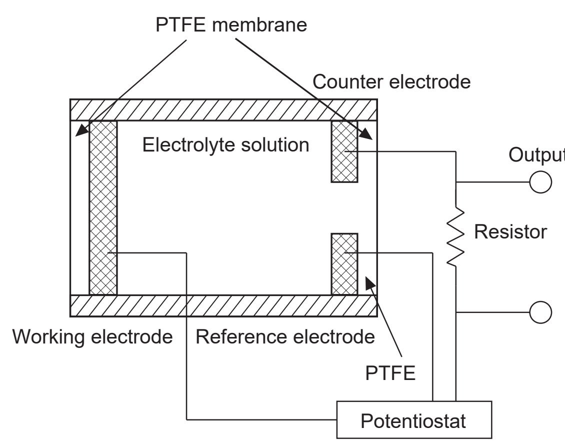

Fig. 3 - Schematic diagram of operating principle

[The reaction formula]
At working electrode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$
At counter electrode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

2. Basic Sensor Characteristics

2-1 *Sensor Characteristics*

Figure 4 shows the typical sensor response and linearity of TGS4260 to O_2 measured under standard test conditions using the recommended measuring circuit. TGS4260 has excellent linearity to O_2 in the range of 0~25 vol.% O_2.

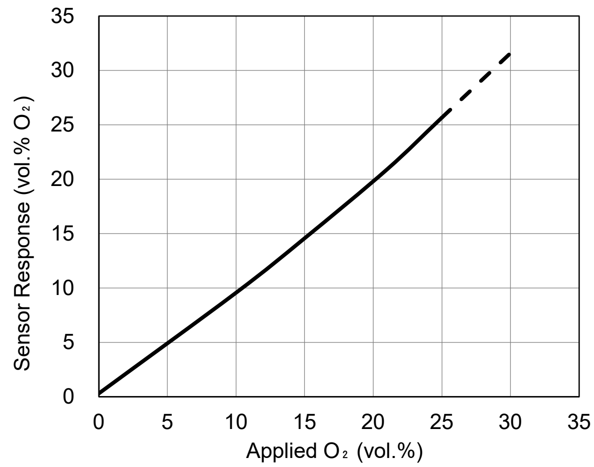

Fig. 4 - Typical sensor characteristics of TGS4260

2-2 *Response Time*

Figure 5 demonstrates the typical response pattern of the sensor output measured under standard test conditions using recommended measuring circuit when the sensor is placed into 100 vol.% N_2 (i.e. 0 vol.% O_2) and then returned to normal air of 20.9 vol.% O_2. Typical response time to 90% of the saturated response level (t90) is approximately 10 seconds.

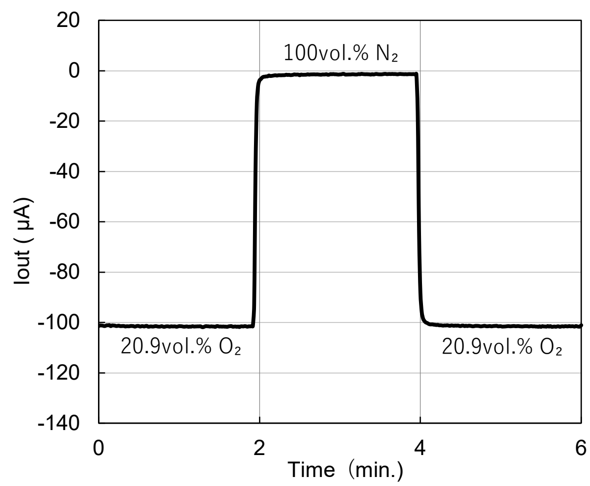

Fig. 5 – Typical Response pattern of TGS4260

2-3 *Repeatability*

Figure 6 demonstrates excellent repeatability of the sensor output measured using the recommended measuring circuit under standard test conditions when the sensor is repeatedly placed into 100 vol.% N_2 for 2 minutes and then returned to normal air of 20.9 vol.%O_2 for 2 minutes.

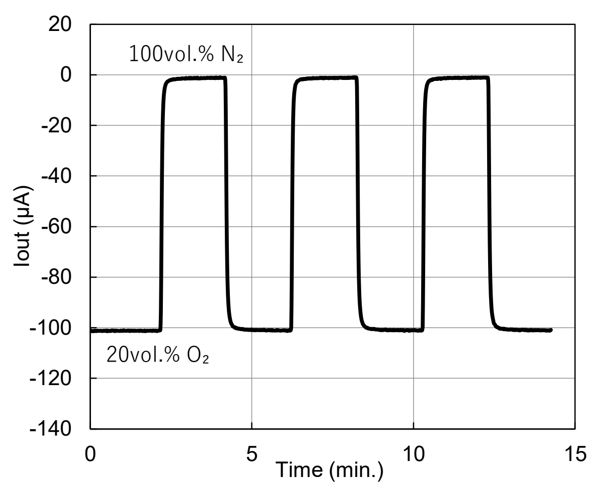

Fig. 6 - Repeatability of TGS4260

2-4 *Cross Sensitivity*

Figure 7 shows the typical response of TGS4260 to interference gases under standard test conditions. As shown in this table, the sensor has little sensitivity to almost all gases other than O_2 and has excellent selectivity to O_2.

Gas	Concentration	Display readings in vol.% O_2
Oxygen	20.9%	20.9%
Hydrogen	5,000ppm	20.1-20.2% O_2
Carbon Monoxide	500ppm	20.8-20.9% O_2
Carbon Dioxide	10,000ppm	20.8-20.9% O_2
Hydrogen Sulfide	15ppm	20.8-20.9% O_2
Sulphur Dioxide	30ppm	20.9%
Nitric Oxide	100ppm	20.7-20.8% O_2
Nitrogen Dioxide	100ppm	20.9-21.0% O_2
Ozone	1ppm	20.8-20.9% O_2
Acetone	1,000ppm	20.8-20.9% O_2
Ethanol	1,000ppm	20.8-20.9% O_2

Fig. 7 - Cross sensitivity of TGS4260 (@20˚C)

2-5 *Temperature Dependency*

Figure 8 represents typical temperature dependency of the sensor output and the response time measured under various temperature conditions in ambient air conditions of 20.9 vol.% O_2. The Y-axis on the left shows the ratio of output current in 20.9 vol.% O_2 at various temperatures to the output current in 20.9 vol.% O_2 at 20˚C. The Y-axis on the right shows T90 response time at various temperatures. The output current gradually decreases as ambient temperature decreases, and slightly increases as ambient temperature increases. The temperature dependency of TGS4260 can be compensated by utilizing a NTC thermistor. The response is very fast and has little temperature dependence in the wide range of temperature.

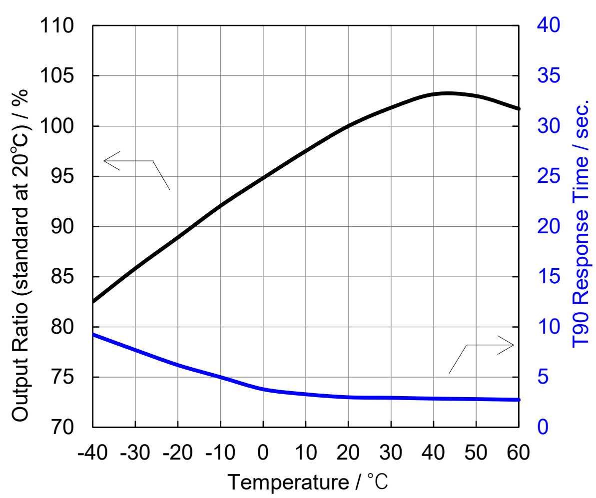

Fig. 8 - Temperature dependency

3. Reliability

3-1 *Long Term Stability*

Figure 9 displays long term stability data showing the sensor output signals in 20.9 vol.% O_2 measured using the recommended measuring circuit with the load resistor being 1 kohm.
The Y-axis shows pseudo display readings in vol.% O_2 that are calculated by assuming the initial output current (Io) in 20.9 vol.% oxygen measured on the first day of the test as 20.9 vol.% O_2. This chart demonstrates very stable characteristics for more than 2 years.

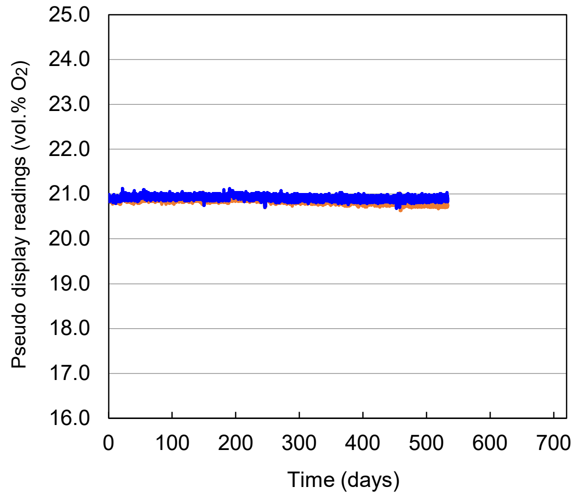

Fig. 9 - Long term stability of calculated display readings of TGS4260

3-2 *Drop impact test*

Resistance against mechanical shock on the sensor was verified by the drop test. The sensor was covered with a resin housing for protection and mounted inside a portable oxygen detector. The oxygen detector was permitted to drop from a height of 2 m onto a concrete plate placed on a floor 30 times. Fig. 10 shows the response pattern of the display readings measured under the standard test conditions when the detector was placed into 100 vol. % N_2 (i.e., 0 vol. % O_2) and then returned to normal air of 20.9 vol. % O_2 before and after the drop impact test. This demonstrates that there is no significant influence from this drop impact test on the sensor performance.

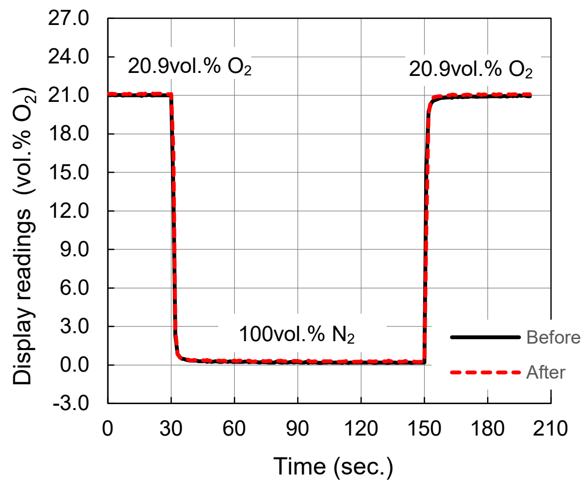

Fig. 10 - Durability to drop impact

4 Cautions

4-1 *Safety Precautions*

- Carefully read product information and other technical information provided by Figaro before using our products, and confirm specifications and operating conditions.
- When designing an application circuit, please make sure that an accidental short circuit or open circuit of other electronic components would not cause the sensor to be subjected to excessive voltage, current, or temperatures exceeding the rated values.
- When designing application products, please make sure that a gas sensor malfunction would not
  1) cause adverse effects on other components,
  2) directly or indirectly impair the safety of application products that use gas sensors (e.g., emit smoke, cause fire, or other unstable states of application products).
- Consider adding safety measures for fail-safe where necessary, such as a protection circuit.

4-2 *Conditions for use and storage*

1) Rated temperature and humidity conditions
Using or storing the sensor in an environment outside the rated temperature and humidity range may cause physical damage and/or affect the sensor characteristics.

2) Storage conditions
Store the sensor in clean ambient air of normal temperature and humidity; recommended temperature from 5˚C to 35˚C. When storing for a long time, store the sensor in a moisture-proof bag such as an aluminum coated bag. Store the sensor in a place away from direct sunlight. Prolonged exposure to sunlight may cause deterioration of the sensor housing material.

3) Condensation
If water condenses inside the sensor housing, sensor characteristics may drift.

4) Oxygen concentration
Continuous sensor operation in a zero oxygen content atmosphere may affect the sensor characteristics and is not recommended. If the sensor is exposed to higher than the specified oxygen concentration, sensor characteristics may drift, and/or the linearity may be affected.

5) High concentration of gases
Sensor performance may be affected if exposed to a high concentration of gases for a long period of time during the operating or storage period.

6) Organic vapors
If the sensor is exposed to organic vapors generated from alcohol, ketones, ethers, volatile oil etc. for a short period with high concentration or for a prolonged period, sensor performance may be affected. Ketone or ether type organic vapors may cause deterioration of the sensor housing material.

7) Dusts and oil mist
Sensor performance may be affected if exposed where dust, fine particles, or oil mist is present.

8) Low humidity conditions
Using or storing the sensor in a low humidity environment of 15%RH or less for a long period of time will cause an increase in the electrolyte concentration inside the sensor, which may lead to the deterioration of the sensor housing material.

4-3 *Handling*

1) Applied voltage
Do not apply voltage exceeding the rated voltage to the sensor. If voltage is applied to the sensor, the sensor may be damaged.

2) Shorting clip
Sensors are shipped open-circuited. Under no circumstances should the working pin, and the reference pin and the counter pin be short-circuited. If any sensor pins are short-circuited, sensor performance may be affected.

3) Mechanical shock and vibration
Avoid mechanical shock. Change in sensor characteristics or electrolyte leakage may occur if the sensor is subjected to a strong shock or vibration. Do not use the sensor if subjected to a drop or other mechanical shock.

4) No soaking
Avoid contact with water. Sensor characteristics may be affected due to soaking or splashing the sensor with water.

5) No disassembly or deformation
Under no circumstances should the sensor be disassembled, nor should the sensor structure be deformed. Electrolyte leakage may occur as a result. Such action would void the sensor warranty.

6) Gas inlet
Do not block the gas inlet of sensor. The sensor would not work properly with a clogged inlet.

7) Non-woven filter
Do not remove the non-woven filter on the sensor top, and do make it dirty. Do not insert foreign objects through the non-woven filter. This may damage the sensor, leading to leakage of electrolyte.

4-4 *Mounting process*

1) Soldering
The sensor pins should not be soldered directly to a PC board. The internal structure may be damaged by the heat of soldering, causing electrolyte leakage. Pin sockets should be used for sensor connection. (e.g. Mac8: PD-152)

2) Electrical connector grease
Do not use electrical connector grease when installing the sensor into circuit. This may lead to deterioration of the sensor housing material.

3) Resin coating
When a resin coating is applied on a printed circuit board for improving its resistance to moisture, the chemical solvent contained in the coating material may affect sensor characteristics. Sample testing should be conducted to see if this process would adversely affect sensor characteristics.

4) Electro static discharge
Exercise necessary precaution against ESD during mounting of the sensors on finished instruments.

5) Resonance
Excessive vibration may cause damage of the sensor structure or breakage of the sensor components at the resonance frequency. Usage of compressed air drivers or ultrasonic welders on assembly lines may cause such vibration to the sensor. Before using such equipment, preliminary tests should be conducted to verify that there will be no influence on sensor characteristics.

4-5 *Application design*

1) Foreign conductive objects
If foreign conductive objects get into the sensor, short-circuit may occur inside the sensor. When such conditions are expected to be encountered, installation of an external air filter is recommended.

2) Calibration and adjustment
Periodic calibration and adjustment are required to maintain proper sensor performance. Perform calibration and adjustment at an appropriate interval according to the detection accuracy required.

3) Fitness for purpose
Before usage of the sensor, customers should verify and ensure that the sensor will work properly under the conditions where they intend to use it and that the sensor is fit for the purpose for which customers wish to use it.