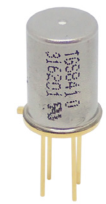
FIGARO
an ISO9001 company

## Technical Information for Methane Gas Sensors

**The Figaro 8410 is a new MEMS type semiconductor methane sensor. Combining advanced Micro Electro Mechanical Systems technology (MEMS) with Figaro's extensive experience in metal oxide type gas sensing sensors, Figaro has developed a new methane sensor with extremely low power consumption. The TGS8410 displays high selectivity and sensitivity to methane.**





***See also Technical Brochure 'Technical Information on Usage of TGS Sensors for Toxic and Explosive Gas Leak Detectors'.***

**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 A SENSOR HAS NOT BEEN SPECIFICALLY TESTED BY FIGARO.

**TGS8410 is a UL recognized component in accordance with the requirements of UL2075.** *Please note that component recognition testing has confirmed long term stability in 60ppm of methane; other characteristics shown in this brochure have not been confirmed by UL as part of component recognition.*

## 1. Basic Information and Specifications

1-1 *Features*

* Low power consumption
* High sensitivity and selectivity to methane
* Long life

1-2 *Applications*

* Portable/pocket type methane gas detectors
* Battery operable/wireless gas detectors
* Leak detection for natural gas vehicles
* Leak detection for gas pipelines

1-3 *Structure*

Figure 1 shows the structure of TGS8410. The MEMS chip contains a sensor element with heater. The sensor's (+) electrode is connected to pin No.3 and the (-) electrode is connected to pin No.2. The sensing material is heated by a heater connected to pins No.1 and No.4.

The sensor base is made of Ni-plated steel. The cap is stainless steel. The upper opening in the cap is covered with a double layer of 100 mesh stainless steel gauze (SUS316). The TGS8410 utilizes a proprietary filter material inside the cap for reducing the influence of interference gases.

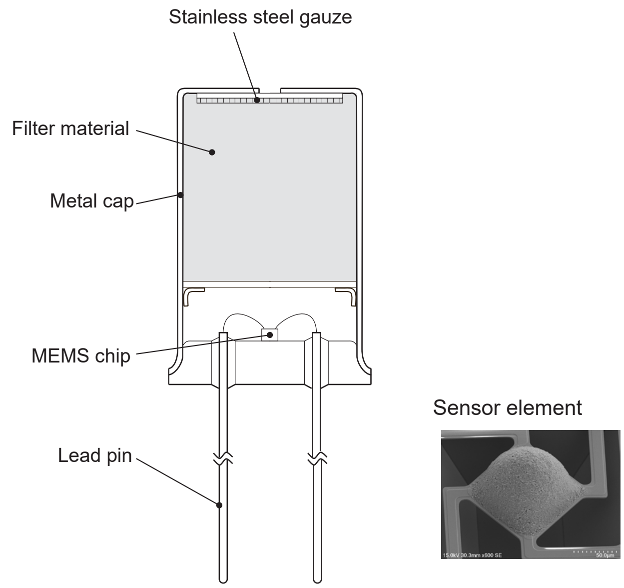



Fig. 1 - Sensor structure

1-4 *Basic measuring circuit*

Figure 2 shows the basic measuring circuit and timing chart.

The sensing element is heated by an integrated heater connected to pin Nos. 1 and 4. The sensor requires application of a 30-second heater voltage cycle comprised of a 1.9V pulse (VH) being applied to the heater for 0.1 seconds, followed by 0V for the remaining 29.9 seconds. Circuit voltage (VC) is applied across the sensing element which has a resistance (Rs) between the sensor's two electrodes (pin Nos. 2 and 3) and a load resistor (RL) connected in series. A 2.0V circuit voltage pulse is applied for the final 0.002 seconds of each VH pulse, followed by 0V for the remaining period.

The sensor's signal should be measured during the 0.002 second VC pulse (see timing chart). The numbers shown around the sensor symbol in the circuit diagram correspond with the pin numbers shown in the structure drawing.

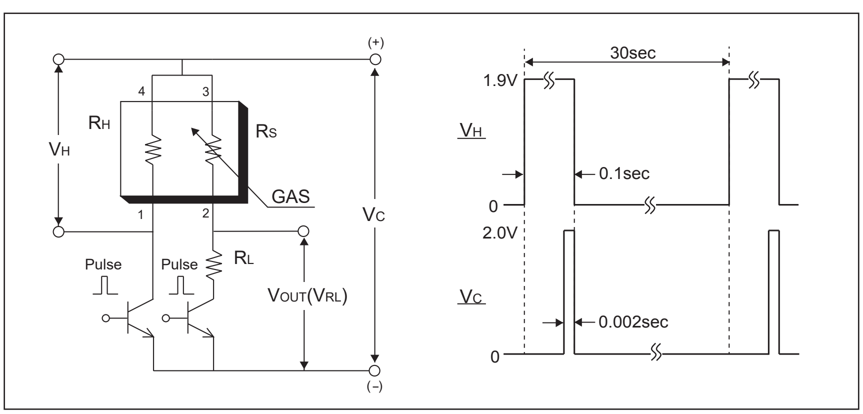



Fig. 2 - Basic measuring circuit and timing chart

Sensor resistance (Rs) is calculated with a measuredvalue of VOUT(VRL) by using the following formula:

$$Rs = \left( \frac{Vc}{V_{RL}} - 1 \right) \times R_L$$

Formula to determine Rs

## 1-5 *Circuit & operating conditions*

The ratings shown below should be maintained at all times to insure stable sensor performance:

| Item | Specification |
|---|---|
| Circuit voltage ($V_C$) | 2.0V±2% DC pulse |
| Heater voltage ($V_H$) | VHH=1.9V±3% DC for 0.1sec<br>VHL=0.0V for 29.9sec. |
| Inrush heater current | ≤40mA at VH=1.9V |
| Heater resistance | approx 60Ω at room temp. |
| Load resistance ($R_L$) | variable (2kΩ min.) |
| Operating temperature | -10 ~ +50˚C |
| Storage temperature | -20 ~ +60˚C |
| Typical detection range | 1~25% LEL |

## 1-6 *Specifications* NOTE 1

| Item | Specification |
|---|---|
| Sensor resistance (3000ppm methane) | 3 ~ 160kΩ |
| Sensor resistance ratio (ß) | 0.48 ~ 0.68 |
| ß = Rs(3000ppm methane)/Rs(1000ppm methane) | |
| Heater current ($R_H$) | 12.7 ~ 15mA at VH=1.90V |
| Heater power consumption ($P_H$) | 0.087mW (ave.) |

**NOTE 1:** Sensitivity characteristics are obtained under the following standard test conditions:
(Standard test conditions)
Temperature and humidity: 20 ± 2˚C, 65 ± 5% RH
Preheating period: 3 days or longer under standard circuit conditions.

NOTE 2: TGS8410 is an ESD-sensitive device. Figaro recommends using ESD protection equipment for handling the sensor.

NOTE 3: Please regulate heater voltage as specified in the above table. Sensor performance may differ from that shown in this brochure if specified heater voltage is not maintained.

***All sensor characteristics shown in this brochure represent typical characteristics. Actual characteristics vary from sensor to sensor and from production lot to production lot. The only characteristics warranted are those shown in the Specification table above.***

## 1-7 *Dimensions*

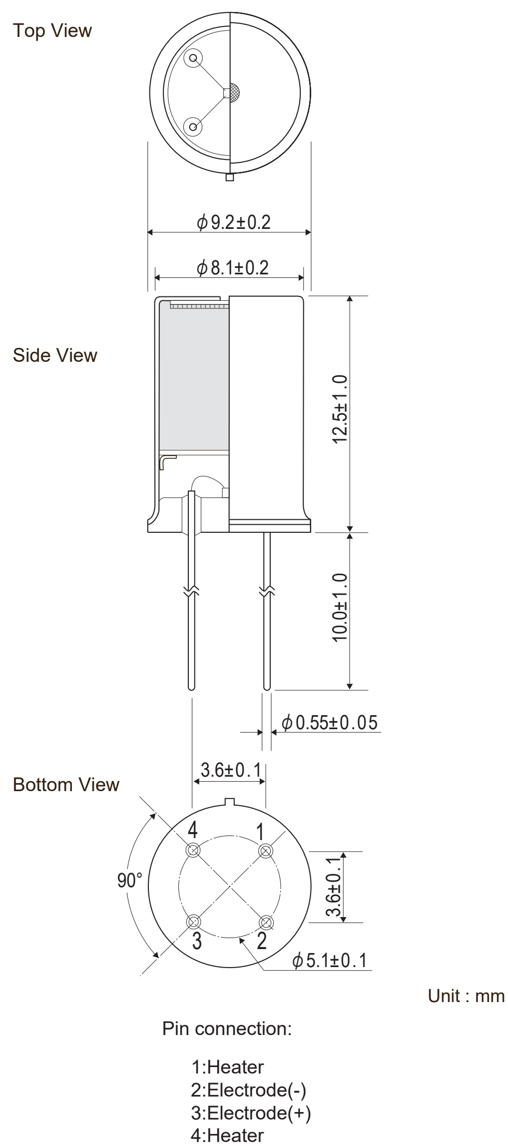



Fig. 3 - Sensor dimensions

*Mechanical Strength:*

The sensor shall have no abnormal findings in its structure and shall satisfy the above electrical specifications after the following performance tests:

Withdrawal Force - (pin from base) withstand force of over 49N

Vibration - frequency-10Hz, total amplitude-5mm, duration-one hour, direction-X Y Z

Drop - 3 times from 1m height onto a tile floor

## 2. Typical Sensitivity Characteristics

2-1 *Sensitivity to various gases*

Figure 4 shows the relative sensitivity of TGS8410 to various gases. The Y-axis shows the ratio of the sensor resistance in various gases (Rs) to the sensor resistance in 3000ppm of methane (Ro).

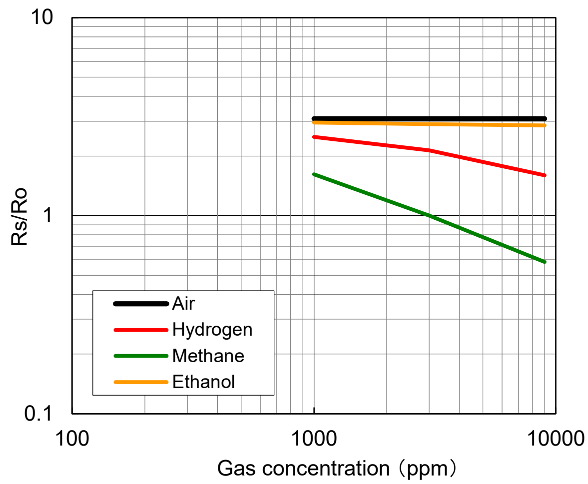



Fig. 4 - Sensitivity to various gases (Rs/Ro)

Using the basic measuring circuit illustrated in Figure 2, and with a matched RL value equivalent to the Rs value in 3000ppm of methane will provide sensor output voltage (VRL) change as shown in Figure 5.

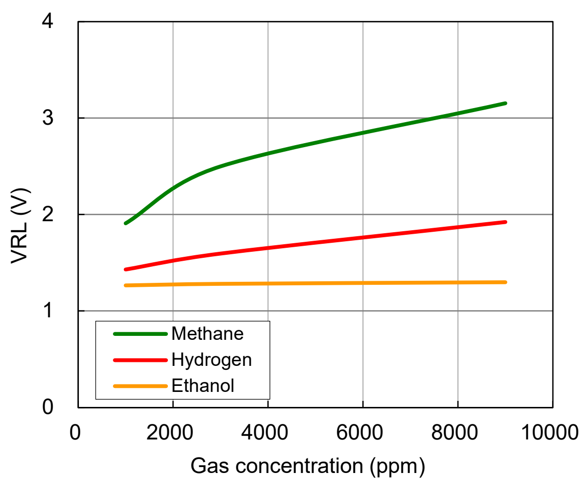



Fig. 5 - Sensitivity to various gases (VRL)

<u>**NOTE**</u>:
All sensor characteristics in this technical brochure represent typical sensor characteristics. Since the Rs or output voltage curve varies from sensor to sensor, calibration is required for each sensor (*for additional information on calibration, please refer to the Technical Advisory 'Technical Information on Usage of TGS Sensors for Toxic and Explosive Gas Leak Detectors'*).

2-2 *Gas response*

Figure 6 shows the change patterns of sensor resistance (Rs) when the sensor is inserted into and later removed from 12500ppm of methane. Measurement was taken every 30 seconds.

As this chart display, the sensor's response speed to the presence of gas is quick, and when removed from gas, the sensor will recover back to its original value in a short period of time.

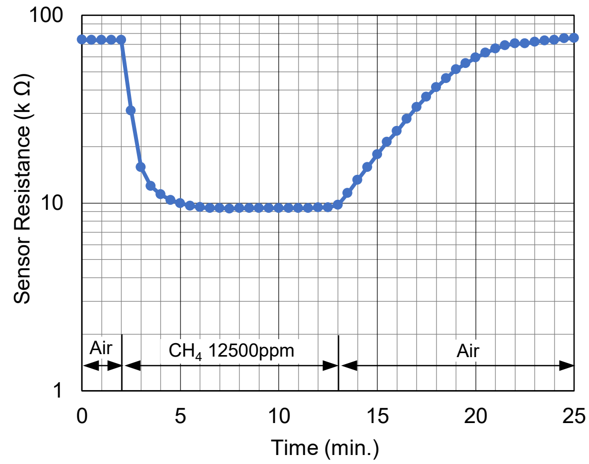



Fig. 6 - Gas response to methane

2-3 *Initial action*

Figure 7 shows the initial action of the sensor resistance (Rs) for a sensor which is stored unenergized in normal air for 30 days and then energized in clean air. The Y-axis represents sensor resistance in clean air at various times after.

Since this initial action may cause a detector to alarm unnecessarily during the first moments after powering on, it is recommended that an initial delay circuit be incorporated into the detector's design.

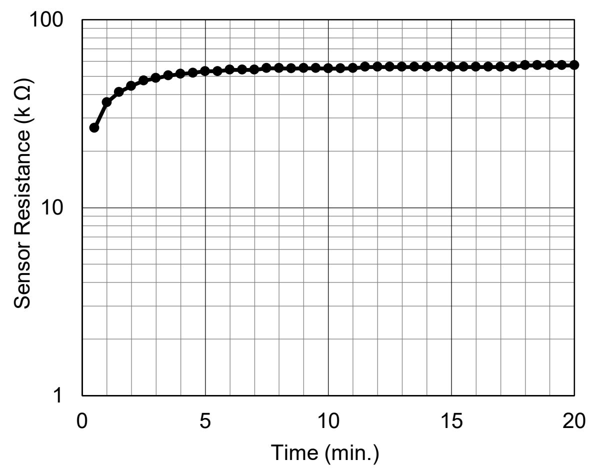



Fig. 7 - Initial action

2-4 *Long-term characteristics*

Figures 8 shows long-term stability data for TGS8410. Test sample was energized in normal air and under standard circuit conditions (see p.2).

Measurement for confirming sensor characteristics was conducted under standard test conditions (20˚C, 65%RH). The initial value was measured after 3 days of energizing in normal air at standard test conditions (see p.3).

The Y-axis shows the sensor resistance values in air and at each methane concentration.

The characteristics for methane sensing is very stable for more than 650 days.

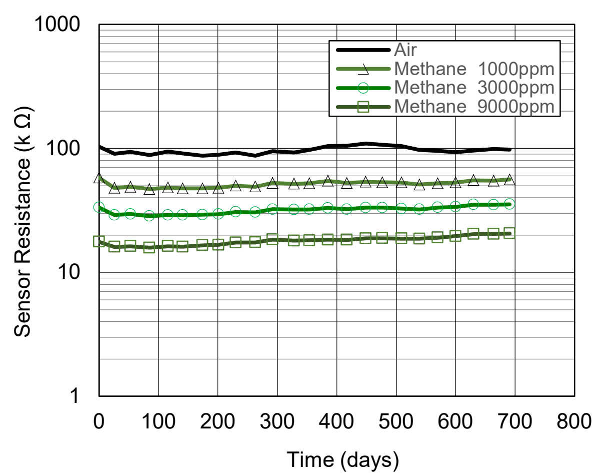



Fig. 8 - Long-term stability (continuous energizing)

## 3 Cautions on Usage of Figaro Gas Sensors

### 3-1 *Situations which must be avoided*

1) Exposure to silicone vapors
If silicone vapors adsorb onto the sensor's surface, the sensing material will be coated, irreversibly inhibiting sensitivity. Avoid exposure where silicone adhesives, hair grooming materials, or silicone rubber/putty may be present.

2) Highly corrosive environment
High density exposure to corrosive materials such as $H_2S$, SOx, $Cl_2$, HCl, etc. for extended periods may cause corrosion or breakage of the lead wires or heater material.

3) Contamination by alkaline metals
Sensor drift may occur when the sensor is contaminated by alkaline metals, especially salt water spray.

4) Contact with water
Sensor drift may occur due to soaking or splashing the sensor with water.

5) Freezing
If water freezes on the sensing surface, the sensing material would crack, altering characteristics.

6) Application of excessive voltage
If higher than specified voltage is applied to the sensor or the heater, lead wires and/or the heater may be damaged or sensor characteristics may drift, even if no physical damage or breakage occurs.

7) Operation in zero/low oxygen environment
TGS sensors require the presence of around 21% (ambient) oxygen in their operating environment in order to function properly and to exhibit characteristics described in Figaro's product literature. TGS sensors cannot properly operate in a zero or low oxygen content atmosphere.

8) Excessive exposure to alcohol
IF TGS8410 is exposed to high concentrations of alcohol (such as 10,000ppm or more) for a long period of time, the filter may become saturated. In this case, the sensor would show a lower resistance in alcohol than that indicated in Figure 4.

9) Polarization
These sensors have polarity. Incorrect Vc connection may cause significant deterioration of long term stability. Please connect Vc according to specifications.

10) Lighter gas exposure test
Consumers often check if detectors are actually sensing gas by exposing them to lighter gas (main component is iso-butane). Because the filter will block iso-butane from reaching the sensing element, this test **cannot** be used with TGS8410.

### 3-2 *Situations to be avoided whenever possible*

1) Water condensation
Light condensation under conditions of indoor usage should not pose a problem for sensor performance. However, if water condenses on the sensor's surface and remains for an extended period, sensor characteristics may drift.

2) Usage in high density of gas
Sensor performance may be affected if exposed to a high density of gas for a long period of time, regardless of the powering condition.

3) Storage for extended periods
When stored without powering for a long period, the sensor may show a reversible drift in resistance according to the environment in which it was stored. The sensor should be stored in a sealed bag containing clean air; do not use silica gel. *Note that as unpowered storage becomes longer, a longer preheating period is required to stabilize the sensor before usage.*

4) Long term exposure in adverse environment
Regardless of powering condition, if the sensor is exposed in extreme conditions such as very high humidity, extreme temperatures, or high contamination levels for a long period of time, sensor performance will be adversely affected.

5) Vibration
Excessive vibration may cause the sensor or lead wires to resonate and break. Usage of compressed air drivers/ ultrasonic welders on assembly lines may generate such vibration, so please check this matter.

6) Shock
Breakage of lead wires may occur if the sensor is subjected to a strong shock.

7) Soldering
Ideally, sensors should be soldered manually.

8) Influence by static electricity
TGS8410 is an ESD-sensitive device. Please observe the following precautions during handling:

- Handling of products should be performed in an environment where static electricity is not easily generated (for example, relative humidity 40% RH or more).
- Wear a grounded wrist band when working.
- Take measures against static electric discharge from containers and other materials that may come in contact with the sensor.

9) Pin handling
Do not bend or twist the pins or twist the sensor cap when mounting the sensor on a circuit board or removing the sensor from a circuit board after soldering. If excessive stress is applied to the glass seal at the pin exit on the sensor base due to improper handling, the glass seal may be broken or damaged, which may result in deterioration of the sensor performance because poisonous gases or interference gases may enter the sensor housing through the broken glass seal.

**NOTE**: To achieve the optimal level of accuracy in gas detectors, each TGS8410 sensor should be individually calibrated by matching it with a load resistor (RL) in an environment containing the target gas concentration for alarming (refer to Figure 2).



Before purchasing this product, please read the Warranty Statements shown in our webpage by scanning this QR code.

https://www.figaro.co.jp/en/pdf/Limited_Warranty_en.pdf

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