# FIGARO GAS SENSORS
# 2000-Series

The FIGARO 2000 Series comprises a new type of thick film metal oxide semiconductor gas sensor fabricated using a novel screen printing technique. This technique enables narrow sensor to sensor variation within production lots.
Additionally, Figaro's material technology has expanded the range of sensing materials to metal oxides other than the tin dioxide.
Gases which are oxidizing or have specific odor properties can now be detected as well as flammable gasses. Also, by having multi-elements on one chip, FIGARO can provide intelligent sensors with multiple output signals.

## Product List

※For equivalents, please refer to Product Catalogue①

| Application | Target gas | Type S1 | Type S2 | Type M1 | Type D1 | Equivalents |
|---|---|---|---|---|---|---|
| Combustible gas detection | Butane<br>LP gas | | | | TGS2610 | |
| | Methane<br>Natural gas | | | | TGS2611 | TGS 842 |
| | Methane and<br>Carbon monoxide | | | | TGS2670* | |
| Solvent vapor detection | Alcohol<br>Organic solvents | | | | TGS2620 | TGS 822 |
| Toxic gas detection | Carbon monoxide | | | TGS 2442 | | TGS 203 |
| Odor detection | Volatile sulfide | | | TGS 2450* | | |
| Cooking control | Water vapor | TGS 2180 | | | | TGS 883 |
| Air quality control | General air contaminants | TGS 2100 | | TGS 2400* | TGS 2600 | TGS 800 |
| | VOC | | | | TGS 2602* | |
| Automobile ventilation control | Gasoline exhaust | TGS 2104 | TGS 2201 | | | TGS 822 |
| | Diesel exhaust | TGS 2106* | | | | |

*Under development

## Product Code for FIGARO 2000 series

**TGS** **2** **X** **X X**

| Technology | |
|---|---|
| 1 | |
| 2 | Printed semiconductor |
| 3 | |
| 4 | Solid state electrolyte |

| Element type | |
|---|---|
| 1 | S1 |
| 2 | S2 |
| 3 | |
| 4 | M1 |
| 5 | |
| 6 | D1 |
| 7 | |
| 8 | |
| 9 | |
| 0 | |

| Target gas / Application | |
|---|---|
| 10～19 | Combustible gasses |
| 20～29 | Organic solvent vapor |
| 30～39 | Halocarbon gasses |
| 40～49 | Toxic gasses |
| 50～59 | Volatile sulfide/amine odor |
| 60～69 | Other gasses |
| 70～79 | Multiple gasses |
| 80～89 | Cooking control |
| 90～99 | |
| 00～09 | Air quality control |

## Sensor structure and packaging

There are four types of sensor elements and four different configurations. The equivalent circuit for each type of sensor is illustrated below in the basic measuring circuit with a special symbol and is represented by a sensor resistance ($R_S$) and a heater resistance ($R_H$).

Each sensor requires two voltage inputs. Heater voltage ($V_H$) is applied to an integrated heater to maintain the sensing element at the required temperature. A circuit voltage ($V_C$) is applied to allow measurement of the voltage ($V_{out}$) across a load resistor ($R_L$) which is connected in series with the sensor.

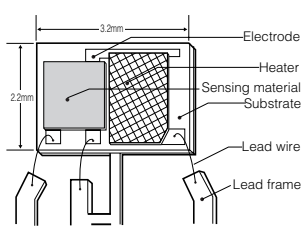
A common power supply circuit can be used for both $V_C$ and $V_H$ to fulfill electrical requirements which are specified for each type of sensor.
The value of $R_L$ can be chosen to optimize the alarm threshold value or output voltage range for signal processing. The value of $R_L$ should be chosen to keep the power consumption of the metal oxide semiconductor ($P_S$) below a limit of 15 mW. The value of $P_S$ will be highest when the value of sensor resistance ($R_S$) is equal to $R_L$ on exposure to gas. The value of $P_S$ is calculated using the following formula:

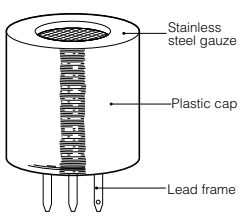
$$P_S = \frac{(V_C - V_{out})^2}{R_S}$$

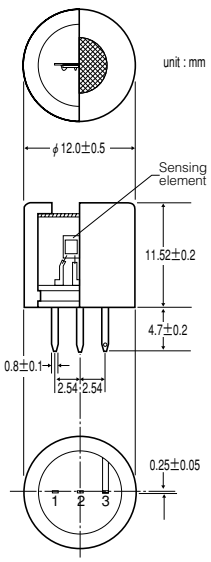
The sensor resistance ($R_S$) is calculated with a measured value of $V_{out}$ from the following formula:

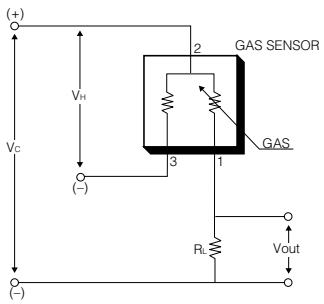
$$R_S = \frac{(V_C - V_{out})}{V_{out}} \times R_L$$

| | |
|---|---|
| Model | **TGS 21XX** |
| Element type | **S1** |
| Package type | **Plastic** |




Configuration : -Single sided, 1 element

Features : -Simple structure

Benefits : -Suitable for large volume and low cost applications

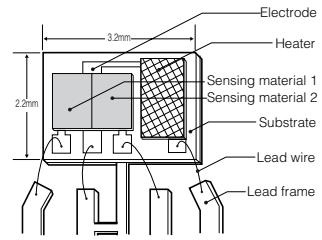
**Pin connection**

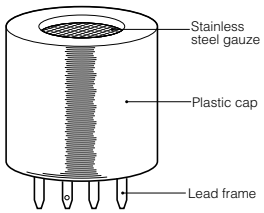
1 : Sensor electrode(–)
2 : Common(+)
3 : Heater(–)

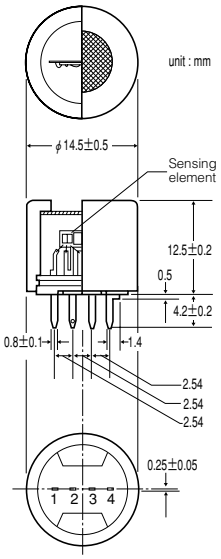
**Circuit conditions**

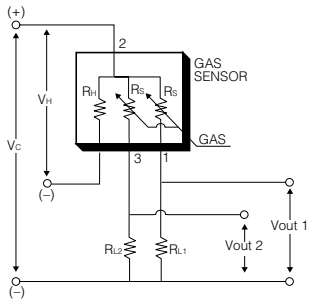
$V_C$: 5V±0.2V DC
$V_H$: 5V±0.2V DC
$R_L$: Variable(Ps≦15mW)

## Model TGS 22XX
## Element type S2
## Package type Plastic




Configuration : -Single sided, 2 element

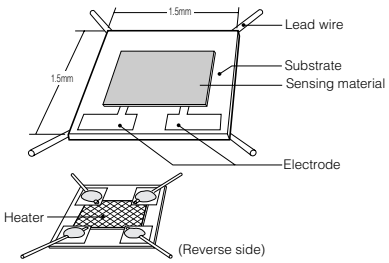
Features : -Dual elements on one chip

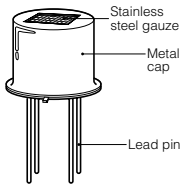
Benefits : -Two output signals for enhanced information
-High selectivity

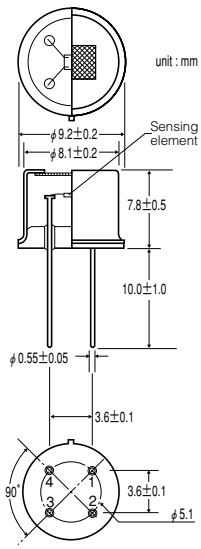
### Pin connection
1 : Sensor electrode 1(–)
2 : Common(+)
3 : Sensor electrode 2(–)
4 : Heater(–)

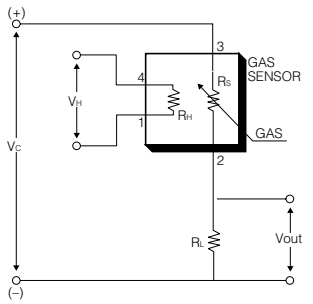
### Circuit conditions
$V_C$ : 5V±0.2V DC
$V_H$ : 5V±0.2V DC
$R_{L1}$ : Variable(Ps≦15mW)
$R_{L2}$ : Variable(Ps≦15mW)

## Model TGS 26XX
## Element type D1
## Package type Metal can




Configuration : -Double sided, 1 element
-Heater printed on reverse side of chip

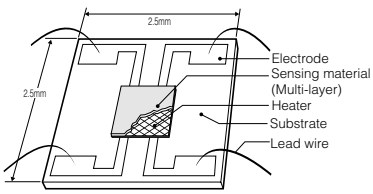
Features : -Small package

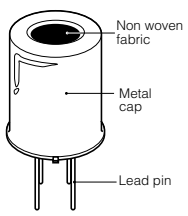
Benefits : -Low power consumption

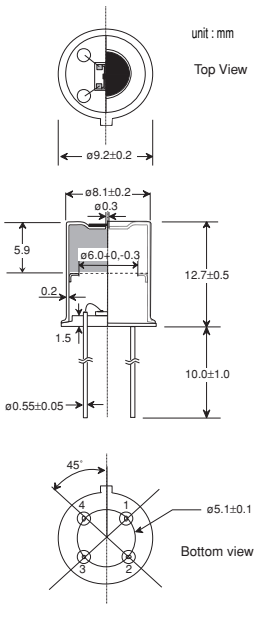
### Pin connection
1 : Heater
2 : Sensor electrode (–)
3 : Sensor electrode (+)
4 : Heater

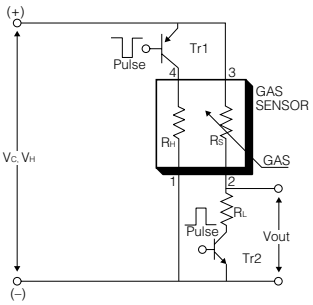
### Circuit conditions
$V_C$: 5V±0.2V DC/AC
$V_H$: 5V±0.2V DC/AC
$R_L$: Variable(Ps≦15mW)

## Model TGS 24XX
## Element type M1
## Package type Metal can




Configuration : -Multi-layer, 1 element

Features : -Pulsed heating

Benefits : -Low power consumption
-Battery back up

### Pin connection
1 : Heater
2 : Sensor electrode (–)
3 : Sensor electrode (+)
4 : Heater

### Circuit conditions
$V_C$: 5V±0.2V DC(Pluse drive)
$V_H$: 5V±0.2V DC(Pluse drive)
$R_L$: Variable(≧10KΩ)

Note:Typical voltage drop in Tr1 is 0.2V.

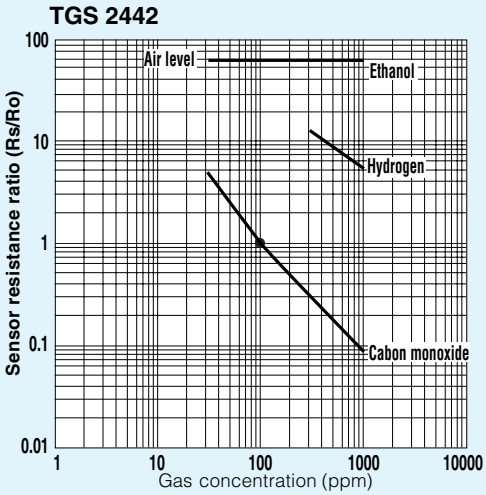
# Sensitivity characteristics

The sensitivity of the Figaro Gas Sensor is defined by the relationship between gas concentration changes and sensor resistance changes. This relationship is based on a logarithmic function.

Sensitivity characteristics of Figaro sensors are shown in the following figures. In these figures, the sensor resistance values (Rs) are normalized according to the sensor resistance at specified conditions (Ro) for each model, and the Y-axis is indicated as sensor resistance ratio: Rs/Ro.

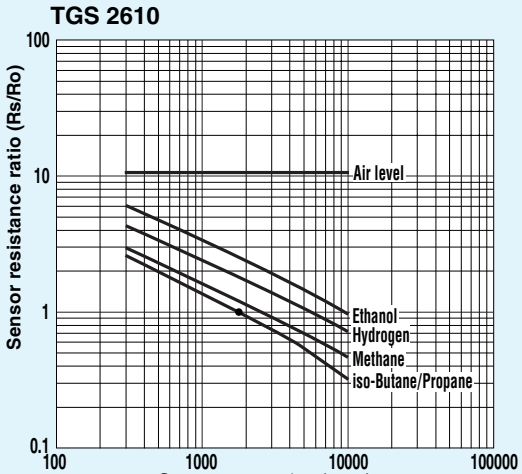
All the sensor characteristics in this catalogue represent typical characteristics.

## Toxic gas detection

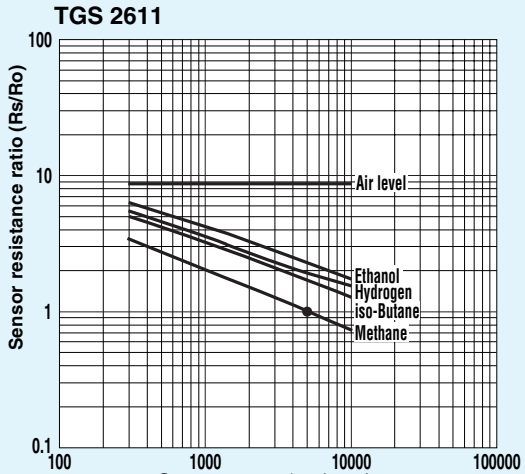



$R_0$: Rs at 100ppm Carbon monoxide

## Combustible gas detection

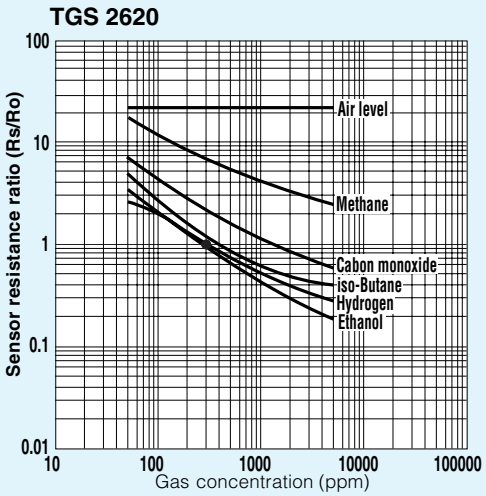



$R_0$: Rs at 1800ppm iso-Butane



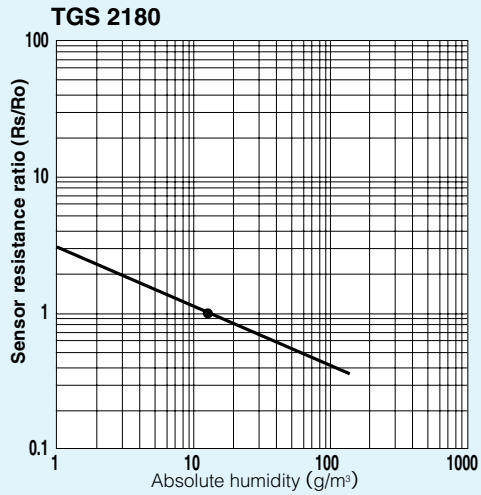

$R_0$: Rs at 5000ppm Methane

## Solvent vapor detection




$R_0$: Rs at 300ppm Ethanol

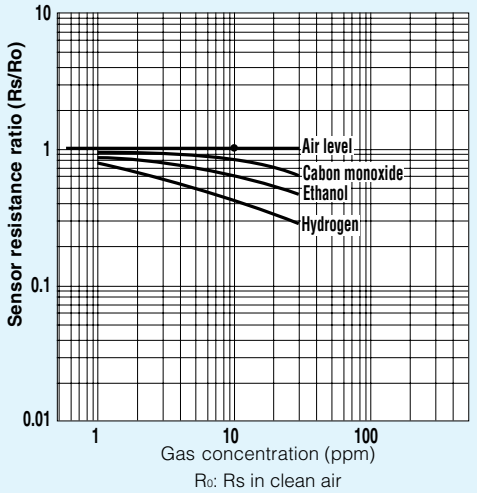
## Cooking control




$R_0$: Rs in clean air at 20°C, 65%R.H.

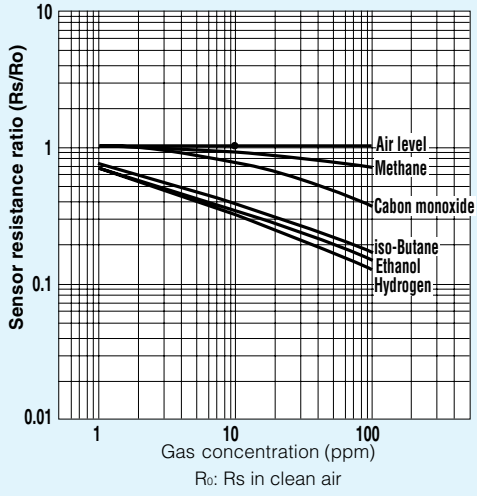
## Air quality control

**TGS 2100**




R₀: Rs in clean air

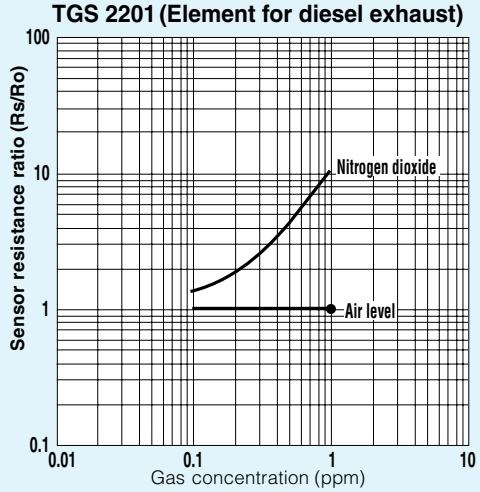
**TGS2600**




R₀: Rs in clean air

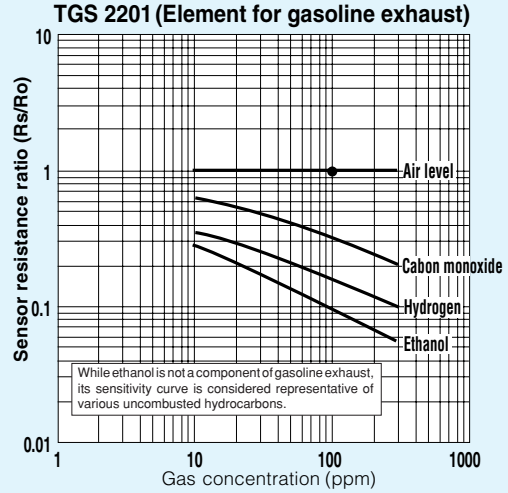
## Automobile ventilation control

**TGS 2201 (Element for diesel exhaust)**



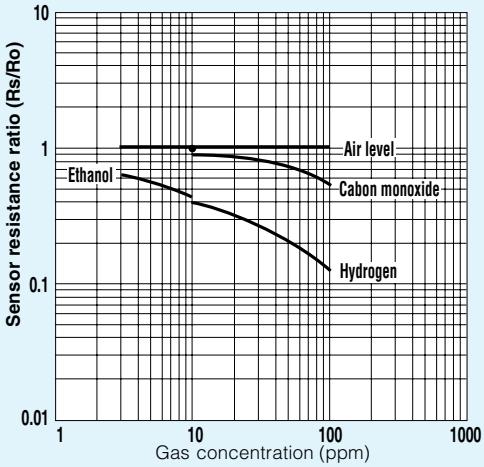

R₀: Rs in clean air

**TGS 2201 (Element for gasoline exhaust)**




R₀: Rs in clean air

**TGS 2104**




R₀: Rs in clean air

# Specifications

The electrical characteristics in this table represent typical values and characteristics.

## 1.Target gases & Standard Circuit conditions

| Model | Target gases | Typical detection ranges | Heater voltage | Circuit voltage | Load resistance | Sensor power consumption |
|---|---|---|---|---|---|---|
| | | | $V_{H}$ | $V_C$ | $R_L$ | $P_S$ |
| TGS2610 | Butane<br>LP gas | 500ppm～10,000ppm | 5V±0.2V(DC/AC) | 5V±0.2V(DC/AC) | Variable | ≦15mW |
| TGS2611 | Methane<br>Natural gas | 500ppm～10,000ppm | 5V±0.2V(DC/AC) | 5V±0.2V(DC/AC) | Variable | ≦15mW |
| TGS2620 | Alcohol<br>Organic solvents | 50ppm～5,000ppm | 5V±0.2V(DC/AC) | 5V±0.2V(DC/AC) | Variable | ≦15mW |
| TGS2442 | Carbon monoxide | 30ppm～1,000ppm | 5V±0.2V(DC,Pulse) ** | 5V±0.2V(DC,Pulse) | Variable<br>(≧10KΩ) | |
| TGS2180 | Water vapor | 1g/m³～150g/m³ | 5V±0.2V(DC) | 5V±0.2V(DC) | Variable | ≦15mW |
| TGS2100 | General air contaminants | 1ppm～30ppm | 5V±0.2V(DC) | 5V±0.2V(DC) | Variable | ≦15mW |
| TGS2600 | General air contaminants | 1ppm～30ppm | 5V±0.2V (DC/AC) | 5V±0.2V(DC/AC) | Variable | ≦15mW |
| TGS2104 | Gasoline exhaust | 10ppm～1,000ppm | 7V±0.35V(DC) | 15VDC Max | Variable | ≦15mW |
| TGS2201 | Gasoline exhaust | 10ppm～1,000ppm | 5V±0.15VDC | 15VDC Max | Variable | ≦15mW |
| | Diesel exhaust | 0.1ppm～10ppm | | | | |

$$P_S = \frac{(V_c - V_{out})^2}{R_S}$$

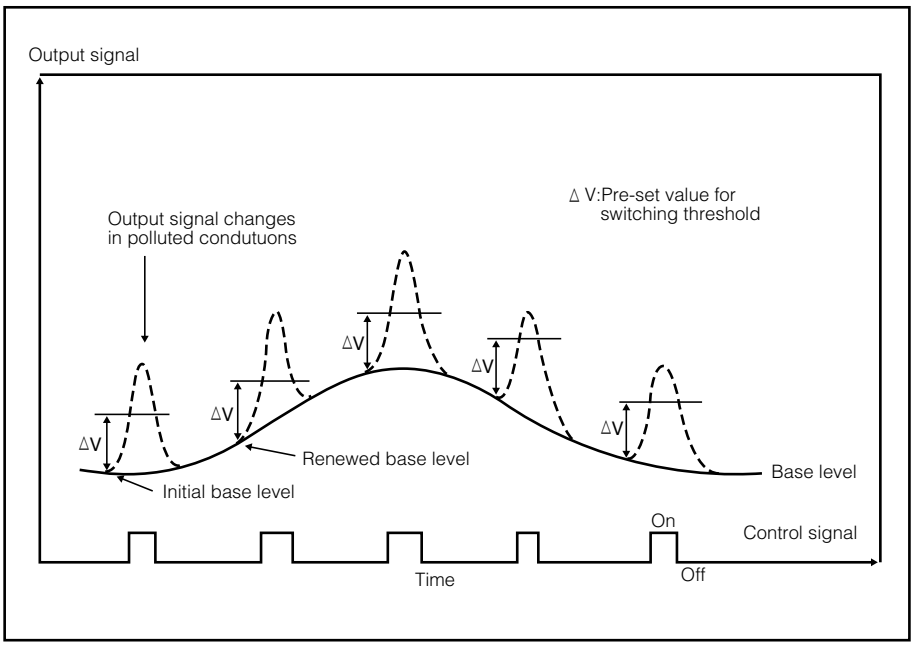
** VH is the voltage across the heater and a transister Tr1.

## 2.Electrical characteristics

Standard test conditions : 20℃±2℃, 65%±5% R.H.

| Model | Heater resistance at room temp | Heater current | Heater power consumption | Sensor resistance | Resistance ratio of sensor | Standard test gas |
|---|---|---|---|---|---|---|
| | $R_H$ | $I_H$ | $P_H$ | $R_S$ | | |
| TGS2610 | 59Ω | 56mA | 280mW | 0.68KΩ～6.8KΩ in 1,800ppm | $\frac{R_S(\text{iso-}C_4H_{10}\ 3{,}000\text{ppm})}{R_S(\text{iso-}C_4H_{10}\ 1{,}000\text{ppm})}$ =0.50～0.62 | iso-Butane |
| TGS2611 | 59Ω | 56mA | 280mW | 0.68KΩ～6.8KΩ in 5,000ppm | $\frac{R_S(CH_4\ 9{,}000\text{ppm})}{R_S(CH_4\ 3{,}000\text{ppm})}$ =0.54～0.66 | Methane |
| TGS2620 | 83Ω | 42mA | 210mW | 1KΩ～5KΩ in 300ppm | $\frac{R_S(\text{EtOH 300ppm})}{R_S(\text{EtOH 50ppm})}$ =0.3～0.5 | Ethanol |
| TGS2442 | 17Ω | 203mA (for 14msec) | 14mW (average) | 6.81KΩ～68.1KΩ in 100ppm | $\frac{R_S(\text{CO 300ppm})}{R_S(\text{CO 100ppm})}$ =0.23～0.49 | Carbon monoxide |
| TGS2180 | 18Ω | 166mA | 830mW | 23KΩ～145KΩ in Air | $\frac{R_S(25℃68\%\text{R.H.})}{R_S(20℃65\%\text{R.H.})}$ =0.77～0.92 | Air and ethanol |
| TGS2100 | 20Ω | 152mA | 760mW | 7KΩ～65KΩ in Air | $\frac{R_S(H_2\ 10\text{ppm})}{R_S(\text{Air})}$ =0.2～0.6 | Air and hydrogen |
| TGS2600 | 83Ω | 42mA | 210mW | 10KΩ～90KΩ in Air | $\frac{R_S(H_2\ 10\text{ppm})}{R_S(\text{Air})}$ =0.3～0.6 | Air and hydrogen |
| TGS2104 | 50Ω | 91mA | 637mW | 10KΩ～50KΩ in Air | $\frac{R_S(\text{CO 30ppm})}{R_S(\text{Air})}$ =0.45～0.75 | Air and Carbon monoxide |
| TGS2201 | 35Ω | 100mA | 502mW | 10KΩ～80KΩ in Air | $\frac{R_S(10\text{ppm of CO})}{R_S(\text{Air})}$ =0.4～0.8 | Air and Carbon monoxide |
| | | | | 0.1MΩ～2MΩ in Air | $\frac{R_S(0.3\text{ppm of } NO_2)}{R_S(\text{Air})}$ =4～20 | Air and nitrogen dioxide |

# Signal processing technique for air quality sensors




Basic diagram for air quality control system

## Air quality control

Detection of low concentrations of air pollution, eg. cigarette smoke, cooking fumes, etc. is possible with the combination of an air quality sensor and exclusively designed microprocessor 93619A.

The microprocessor calculates the average value of the sensor resistance in ambient air over a certain period and renews the base level. This reduces influence from humidity, temperature and basic environmental changes. This method is effective for automatic controls in ventilation systems by detecting rapid changes in the atmosphere from the base levels.



## LIMITED WARRANTY

Figaro Engineering Inc. warrants its products to be free from defects in materials and workmanship for a period of one (1) year from the date of the original retail purchase of its products. Figaro will, at its option, either repair or replace any products returned to the factory which Figaro shall, upon inspection, determine to be defective. The foregoing shall constitute the sole remedy for any breach of Figaro's warranty.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.


**FIGARO GROUP**

HEAD OFFICE
**FIGARO ENGINEERING INC.**
1-5-11 Senbanishi,
Mino, Osaka 562-8505, Japan
Tel. (81)72-728-2561
Fax. (81)72-728-0467
Email: figaro@figaro.co.jp

OVERSEAS
**FIGARO USA, INC.**
3703 West Lake Avenue, Suite 203
Glenview, IL 60025-1266, U.S.A.
Tel. (1)847-832-1701
Fax. (1)847-832-1705
Email: figarousa@figarosensor.com

www.figarosensor.com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**Please contact**


225048-0208-1K