FIGARO

FIGARO GAS SENSOR TGS 822

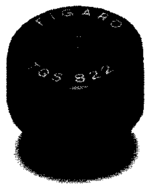
FIGARO ENGINEERING INC.

The TGS822 is a tin dioxide (SnO_2) semiconductor gas sensor; designed for detecting vapors of organic solvents. The electric resistance of the TGS822 decreases largely with the increase of gas or vapor concentrations in ambient atmosphere. The decrease of resistance is used as an electrical output signal for gas detection.

The features are;

- High sensitivity to vapors of organic solvents.
- High stability and reliability over a long period.
- Large output signal for a simple and low-cost circuit.

TGS822



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1. Structure

Fig.1 shows the structure of the TGS822. Inside the plastic housing with the two flame arresters of stainless steel double-gauze on its top and bottom, the gas sensing element is hung on the four pins by two lead wires. The sensing element is a tin dioxide ceramic formed on an alumina ceramic tube on which two gold electrodes are pre-printed. The element is heated by the heater coil located inside the tube and connected to the pins No.2 and 5. One electrode is connected to the pins No.1 and 3 by the lead wire, and the other is connected to No.4 and 6.

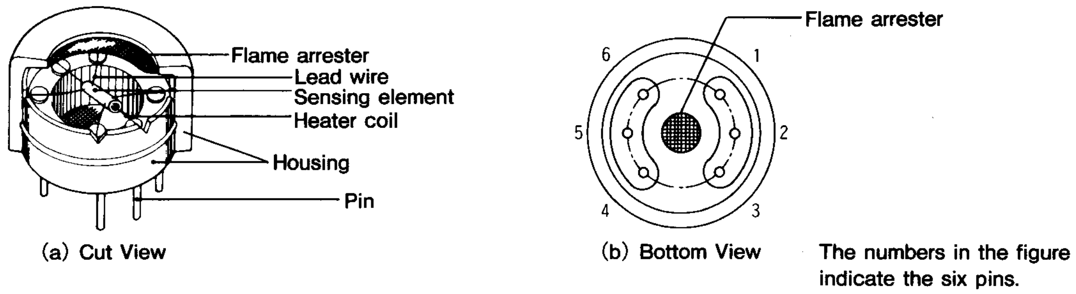


Fig. 1. Structure of the TGS 822

2. Basic Measuring Circuit

Fig.2 shows the basic measuring circuit for the TGS 822. The change in sensor resistance is measured as a change in the voltage across the load resistor (R_L). Either AC or DC can be applied to Vc and V_H.
A measured output signal (V_{RL}) can be converted into sensor resistance (Rs) by means of the following formula:

$$Rs = \frac{Vc \times R_L}{V_{RL}} - R_L$$

Vc: circuit voltage
V_H: heater voltage
R_L: load resistance
V_{RL}: output signal
Rs: sensor resistance

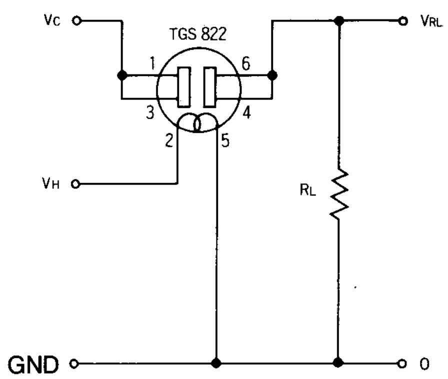


Fig. 2. Basic Measuring Circuit of the TGS 822

Note: The numbers in the figure indicate the six pin numbers, which correspond to the ones in Fig.1(b). Pins 1 & 3 and 4 & 6 are connected internally.

3. Operating Conditions

The operating conditions of the electric circuit for the TGS822 should conform to the ratings listed in Table Ⅰ. If not, the standard sensitivity characteristics of the sensor cannot be obtained. Since the power dissipation over the sensing element (Ps) depends upon Vc and R_L, the combination of Vc and R_L should be selected for Ps not to exceed 15mW.

Table Ⅰ Operating Conditions for the TGS 822

Parameter	Symbol	Ratings	Remarks
Circuit voltage	Vc	24V max	AC or DC
Heater voltage	V_H	5V±0.2V	AC or DC
Power dissipation over the sensing element	Ps	15 mW max	$Ps=Vc^2 Rs/(Rs+R_L)^2$
Storage temp. range		−30∼+70℃	No condensation on the sensor.
Operating temp. range		−10∼+40℃	

4. Specifications

The specifications of the TGS 822 are shown in Table II ~ V and Fig.3.

Table II **Electric and sensitivity characteristics**

Items	Conditions	Ratings
Sensor resistance (Rs)	Rs in 300 ppm ethanol/air	1 KΩ~10KΩ*
Change ratio of resistance	$\frac{\text{Rs in 300 ppm ethanol/air}}{\text{Rs in 50 ppm ethanol/air}}$	0.4 ± 0.1*
Heater resistance (R_H)	at room temperature	38Ω ± 3Ω
Heater power consumption	V_H=5V	660mW ± 55mW

* These are obtained under the conditions shown in Table III.

Table III **Standard test conditions**

Atmospheric conditions	Clean air Temperature: 20 ± 2℃ Relative humidity: 65 ± 5%
Circuit conditions	Vc=10 ± 0.1V (AC or DC) V_H=5 ± 0.05V (AC or DC) R_L=10.0KΩ ± 1%
Conditioning	7 days energizing or more

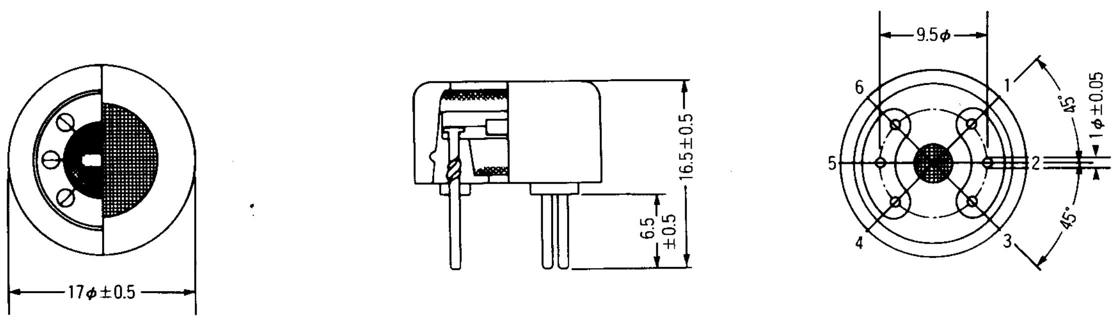
Table IV **Mechanical durability**

Items	Test conditions	Criterion
Vibration test	Frequency: 1000 cpm Vertical amplitude: 4 mm Duration: 1 hr.	Should maintain the characteristics shown in Table II.
Shock proof test	Acceleration: 100 G Number of impacts: 5	

Table V **Material**

Sensing element	Tin dioxide (SnO_2) ceramic
Heater coil	Chrome alloy (Diameter: 60 μm)
Lead wire	Gold alloy (Diameter: 80 μm)
Housing	Nylon 66 (UL 94HB)
Pin	Nickel
Flame arrestor	Double 100-mesh stainless steel gauze (SUS316)
Weight	ca. 2.6 g

Fig. 3. Dimensions



5. Characteristics

5-1. Sensitivity

Fig.4. shows the sensitivity characteristics of the TGS822 to ethanol vapor and other various gases and vapors. The ordinate is the ratio of sensor resistances measured at various concentrations of gases compared to the sensor resistance at 300ppm ethanol vapor. Reducing gases and vapors make the sensor resistance decrease. The extent of the decrease depends upon not only the concentration but also the kind of gases and vapors. So, the sensor shows different characteristics for each gas or vapor. The TGS822 is highly sensitive to vapors of organic solvents as shown in Fig.4.

Ro: sensor resistance at 300ppm of ethanol in air.
Rs: sensor resistance at various concentrations of gases.

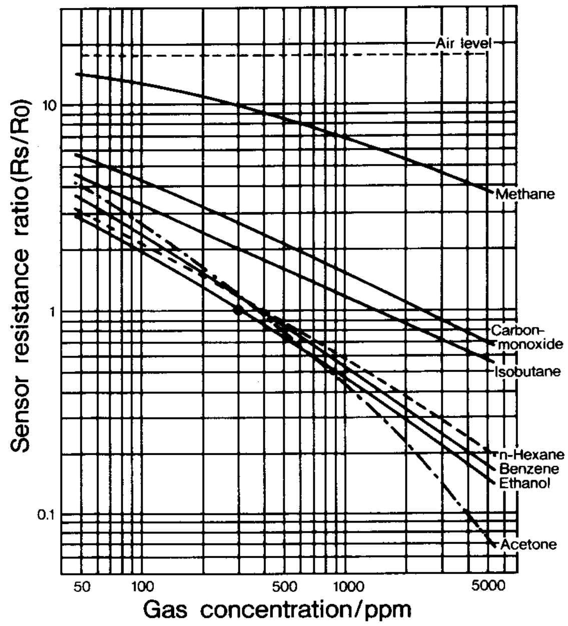


Fig. 4. Sensitivity characteristics of the TGS 822

5-2. Response

Fig.5. shows the response of the TGS822 when the atmosphere changes from clean air to 300ppm ethanol vapor ①, and reverts back to clean air ②.

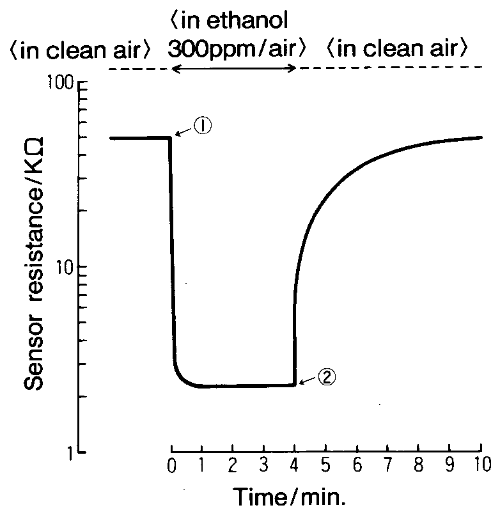


Fig. 5. Response of the TGS 822

5-3. Dependency on Temperature and Humidity

The sensitivity characteristics of the TGS 822 are influenced by atmospheric temperature and humidity. The dependency is shown in Fig.6. The compensation with an electric circuit is required for better accuracy. (Refer to the chapter 6)

Ro: sensor resistance at 300ppm of ethanol in air at 20°C, 65% R.H.
Rs: sensor resistance at 300ppm of ethanol at different temperatures and humidities.

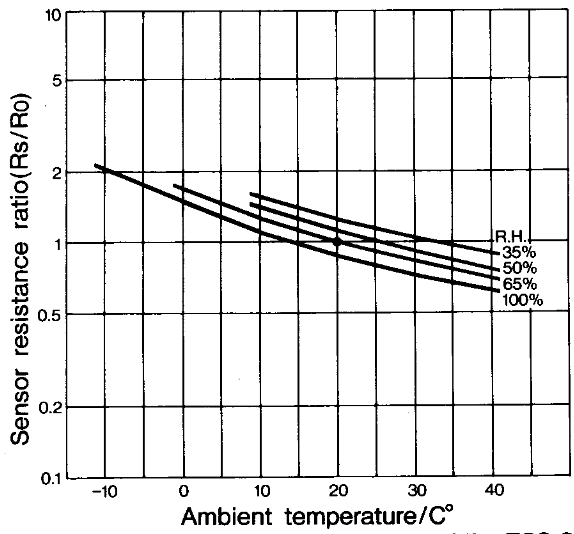


Fig. 6. Dependency on temperature and humidity of the TGS 822

5-4. Initial Action

When the TGS822 is energized after a long storage without energizing, the sensor resistance drops largely in about ten seconds regardless of the presence of gases, and then reaches a stable level according to the ambient atmosphere. Such behavior in the process to warm up a sensor is called "Initial Action".
An example of the initial action in clean air is shown in Fig7. The time required until the sensor resistance in air exceeds the resistance in 50ppm ethanol would be just under two minutes, in case the sensor has been stored without energizing for one month. This time is variable depending on atmospheric conditions during the storage of an unenergized sensor, and, generally, increases the longer the storage period is.
This "Initial Action" should be taken into consideration when applying the sensor to an intermittent-operating device like a portable type gas detector, because the device does not work normally during this time period. If necessary, the sensor could be heated up to a certain high temperature for 10~30 seconds to shorten this period before the sensor is operated at a specified sensor temperature. This is termed "heat-cleaning". (Refer to the chapter 6)

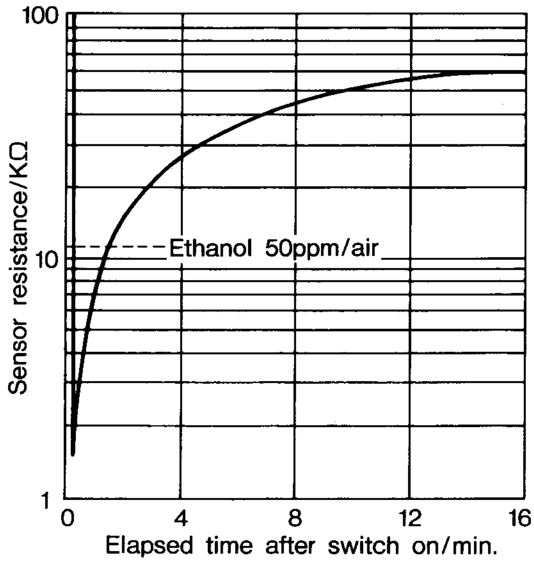


Fig. 7. Initial action of the TGS 822
Note: The sensor was stored for 1 month without energizing in natural air during summer time in Japan.

5-5. Stability

The sensitivity of the TGS822 is very stable over a long period in continuous or intermittent operation as shown in Fig.8. In the case of continuous operation, the TGS822 requires a certain period to reach a stable sensitivity after switch on. This initial transitional period depends on a storage period, but doesn't exceed seven days. Such excellent stability is one of the most advantageous features of the TGS822.

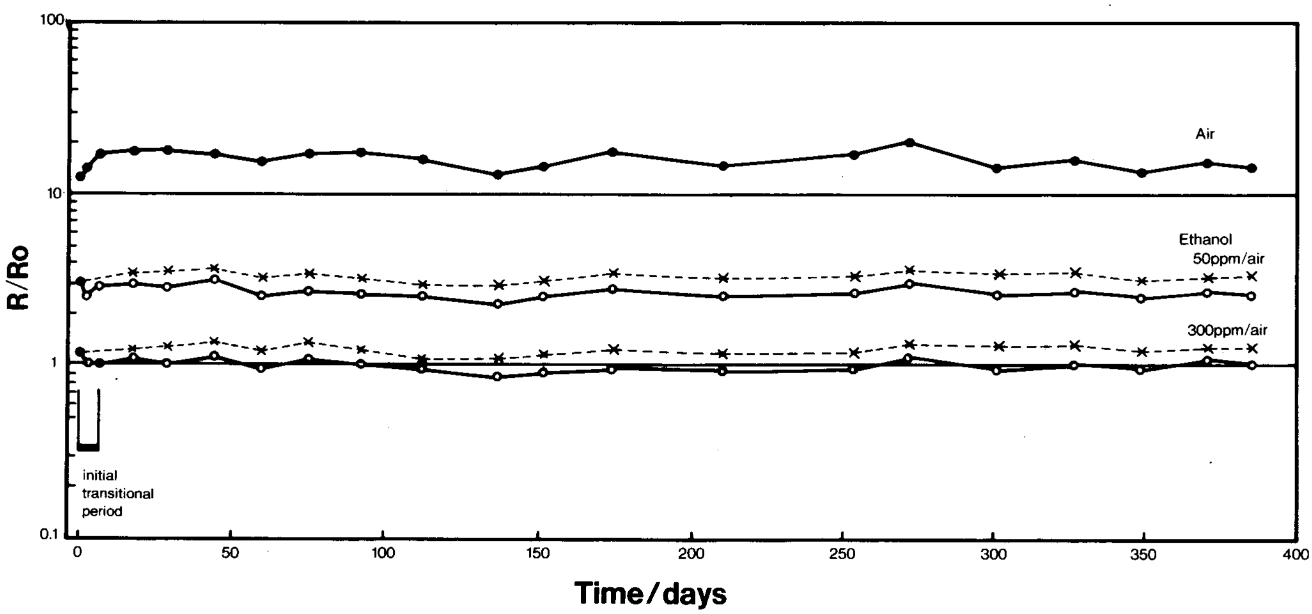


Fig. 8. Stability
Note: The data are normalized by the sensor resistance at 300ppm of ethanol after 7 days energizing.
——: Energized in natural air. ●○ } Measured after 1hr energizing in 20°C, 65%R.H.
······: Unenergized in natural air. × }

NOTE

1. All the sensor characteristics in this catalog except Fig.6 are measured under the standard test conditions shown in Table III.

2. All the sensor characteristics in this catalog except Fig.7 and a part of Fig.8 are measured when the sensor is fully stablilized after the transitional period.

3. All the sensor characteristics in this catalog represent typical characteristics, the characteristics of individual sensors distribute in a certain range, so some of them may show some difference from the typical ones.

6. Application Circuits

6-1. A Breath Alcohol Analyzer Circuit

One of the typical applications of the TGS822 is a breath alcohol analyzer to check alcohol concentrations in the breath. Fig.9 shows an example circuit for a battery operated detector, which includes a heat-cleaning circuit and LED, to indicate alcohol concentration levels as well as the "ready" for analizing and battery condition.

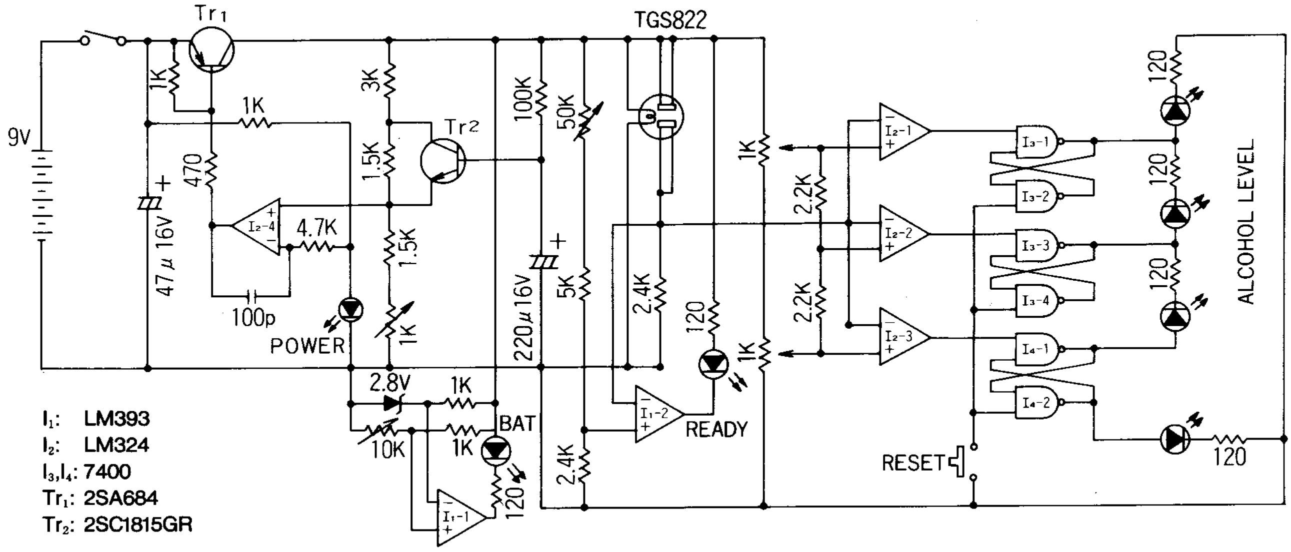
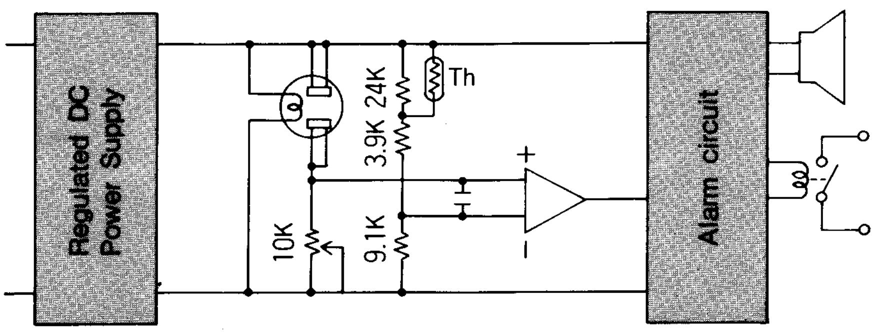


Fig. 9. A breath alcohol detector circuit

6-2. A Temperature Compensating Circuit

In order to conpensate for dependency on temperature and humidity and obtain better accuracy, it is required to adopt a conpensating circuit with a thermistor and/or a humidity sensor to a device with the TGS822. An example circuit to use a thermistor for temperature compensation is shown in Fig.10. When suitable ratings of a thermistor and resistors are selected, a reference voltage for a comparator can vary according to ambient temperature. As a result, the dependency on temperature of the TGS822 can be conpensated for.



Th: Thermistor, Ishizuka Electronics Corp. 5KD-5 Rth (25°C); 5KΩ, B constant; 4100
Fig. 10. A temperature compensating circuit

HEAD OFFICE:
FIGARO ENGINEERING INC.
1-5-11 Senbanishi,
Mino, Osaka 562-8505, Japan
Tel. (81)727-28-2561 Fax. (81)727-28-0467
E-mail: 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
E-mail: figarousa@figarosensor.com

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