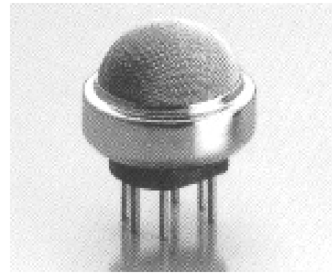
an ISO9001 company

Technical Information for Ammonia Sensors

Figaro TGS 8-series sensors are a type of sintered bulk metal oxide semiconductor which offer low cost, long life, and good sensitivity to target gases while utilizing a simple electrical circuit. The TGS826 displays high sensitivity to ammonia.



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

1. Basic Information and Specifications

1-1 *Features*

* High sensitivity to amine compunds
* Quick response to low concentrations of ammonia
* Uses simple electrical circuit
* Ceramic base resistant to severe environment

1-2 *Applications*

* Ammonia leak detection in refrigerators
* Ventilation control for the agricultural and poultry industries

1-3 *Structure*

Figure 1 shows the structure of TGS826. This sensor is a sintered bulk semiconductor composed mainly of metal oxide. The semiconductor material and electrodes are formed on an alumina ceramic tube. A heater coil is located inside the ceramic tube. Lead wires from the sensor electrodes are a gold alloy. Heater and lead wires are connected to the sensor pins which have been arranged to fit a 7-pin miniature tube socket.

The sensor base is made of a ceramic base which can withstand environments as high as 200°C. The upper and lower openings in the sensor case are covered with a flameproof double layer of 100 mesh stainless steel gauze (SUS316). Independent tests confirm that this mesh will prevent a spark produced inside the flameproof cover from igniting an explosive 2:1 mixture of hydrogen/oxygen.

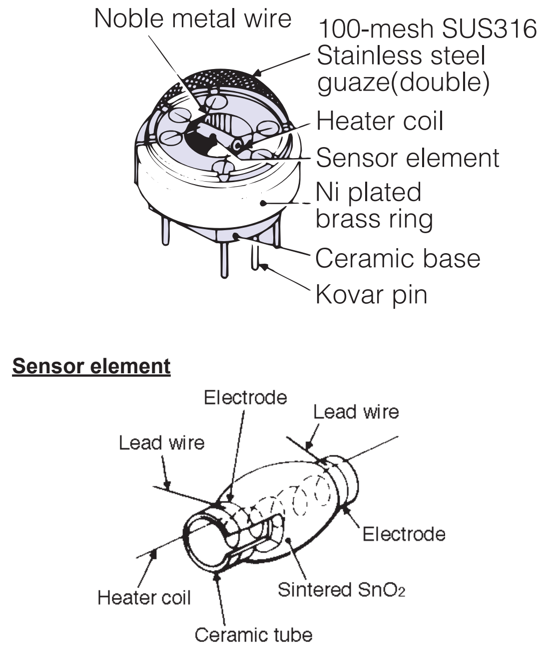


Fig. 1 - Sensor structure

1-4 *Basic measuring circuit*

Figure 2 shows the basic measuring circuit for use with TGS826. Circuit voltage (Vc) is applied across the sensor element which has a resistance between the sensor's two electrodes and the load resistor (RL) connected in series. The sensor signal (VRL) is measured indirectly as a change in voltage across the RL. Since the sensor has a polarity, DC voltage should always be applied for circuit voltage (a white dot indicates pin #2). The Rs is obtained from the formula shown at the right.

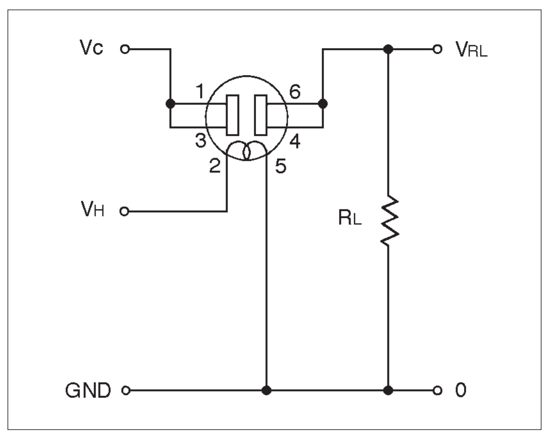


Fig. 2 - Basic measuring circuit
(pin #2 is indicated by a white dot on the sensor's base)

$$Rs = \frac{Vc - VRL}{VRL} \times RL$$

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)	Max. 24V (DC only)
Heater voltage (V_H)	5.0V ± 0.2V AC/DC
Heater resistance (room temp)	30 ± 3Ω
Load resistance (R_L)	variable ($P_S \leq 15$mW)
Operating temperature	30˚C ~ 50˚C
Storage temperature	-40˚C ~ +80˚C
Optimal detection concentration	30 ~ 300ppm

1-6 *Specifications* NOTE 1

Item	Specification
Sensor resistance (50ppm ammonia)	20kΩ ~ 100kΩ
Sensor resistance ratio (Rs/Ro)	0.55 ± 0.15
Rs/Ro = Rs(150ppm ammonia)/Rs(50ppm ammonia)	
Heater current (R_H)	approx. 167mA
Heater power consumption (P_H)	approx. 833mW

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 5kg in each direction

Vibration - frequency-1000c/min., total amplitude-4mm, duration-one hour, direction-vertical

Shock - acceleration-100G, repeated 5 times

1-7 *Dimensions*

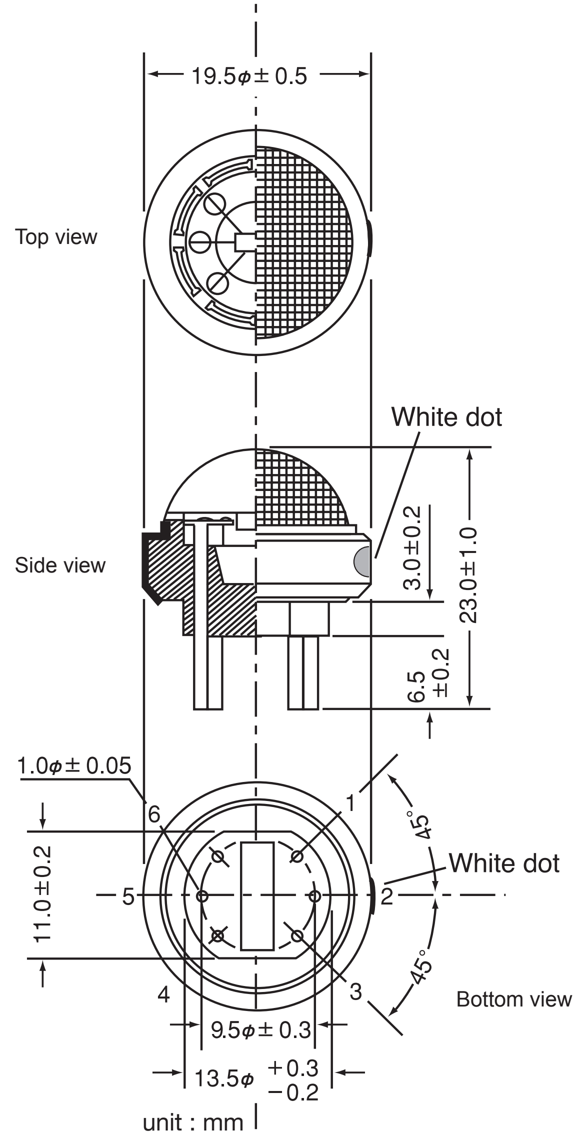


Fig. 3 - Sensor dimensions

NOTE 1: Sensitivity characteristics are obtained under the following standard test conditions:

(Standard test conditions)
Temperature and humidity: 20 ± 2˚C, 65 ± 5% RH
Circuit conditions: V_C = 5.0±0.01V DC
V_H = 5.0±0.05V DC
R_L = 33kΩ ± 1%
Preheating period: 7 days or more under standard circuit conditions

2. Typical Sensitivity Characteristics

2-1 *Sensitivity to various gases*

Figure 4 shows the relative sensitivity of TGS826 to various gases. The Y-axis shows the ratio of the sensor resistance in various gases (Rs) to the sensor resistance in 50ppm of ammonia (Ro).

Using the basic measuring circuit illustrated in Figure 2, together with a matched RL value equivalent to the Rs value in 50ppm of ammonia, will provide the sensor output voltage (VRL) change as shown in Figure 5.

NOTE:
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'*).

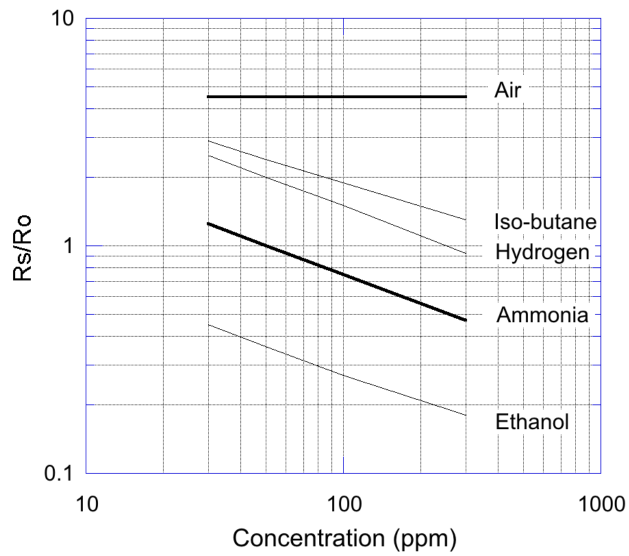


Fig. 4 - Sensitivity to various gases (Rs/Ro)

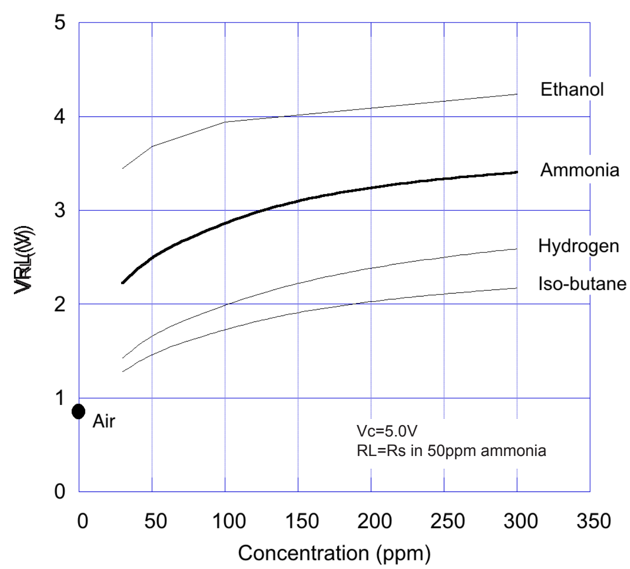


Fig. 5 - Sensitivity to various gases (VRL)

2-2 *Temperature and humidity dependency*

Figure 6 shows the temperature and humidity dependency of TGS826. The Y-axis shows the ratio of sensor resistance in 150ppm of ammonia under various atmospheric conditions (Rs) to the sensor resistance in 150ppm of ammonia at 20˚C/65%RH (Ro).

RH / (˚C)	0% RH	20%RH	40%RH	65%RH	100%RH
-30					1.41
-20					1.29
-10					1.19
0					1.09
10					1.00
20	1.22	1.13	1.06	1.05	0.92
30	1.15	1.06	1.00	0.97	
40	1.07	1.00	0.95	0.91	
50	1.02	0.96	0.92	0.86	

Table 1 - Temperature and humidity dependency
(typical values of Rs/Ro for Fig. 6)

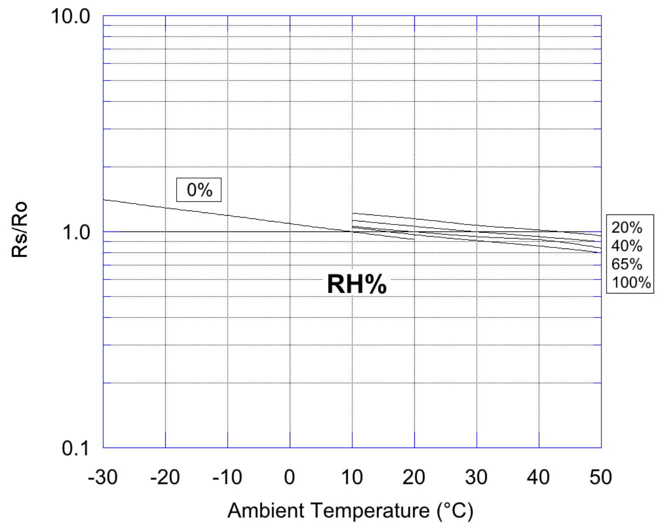


Fig. 6 - Temperature and humidity dependency (Rs/Ro)

Table 1 shows a chart of values of the sensor's resistance ratio (Rs/Ro) under the same conditions as those used to generate Figure 6.

2-3 *Heater voltage dependency*

Figure 7 shows the change in the sensor resistance ratio according to variations in the heater voltage (VH).

Note that 5.0V as a heater voltage must be maintained because variance in applied heater voltage will cause the sensor's characteristics to be changed from the typical characteristics shown in this brochure.

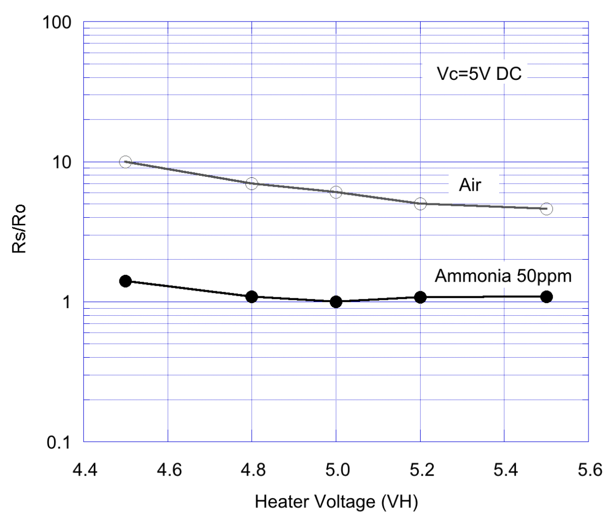


Fig. 7 - Heater voltage dependency
(Rs = Rs in 50ppm of ammonia,
Ro = Rs at 50ppm ammonia and VH=5.0V DC)

2-4 *Gas response*

Figure 8 shows the change pattern of sensor resistance (Rs) when the sensor is inserted into and later removed from 50 and 150ppm of ammonia.

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

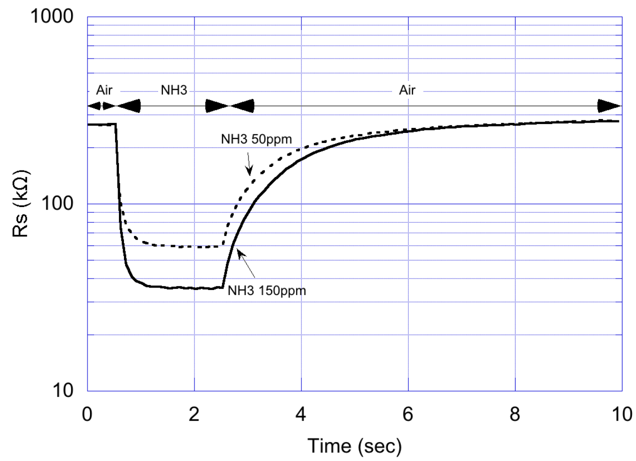


Fig. 8 - Response speed

2-6 *Initial action*

Figure 9 shows the initial action of the sensor resistance (Rs) for a sensor which is stored unenergized in normal air for 30 days and later energized in clean air.

The Rs drops sharply for the first seconds after energizing, regardless of the presence of gases, and then reaches a stable level according to the ambient atmosphere. Such behavior during the warm-up process is called "Initial Action".

Since this 'initial action' may cause a detector to alarm unnecessarily during the initial moments after powering on, it is recommended that an initial delay circuit be incorporated into the detector's design (*refer to Technical Advisory 'Technical Information on Usage of TGS Sensors for Toxic and Explosive Gas Leak Detectors'*). This is especially recommended for intermittent-operating devices such as portable gas detectors.

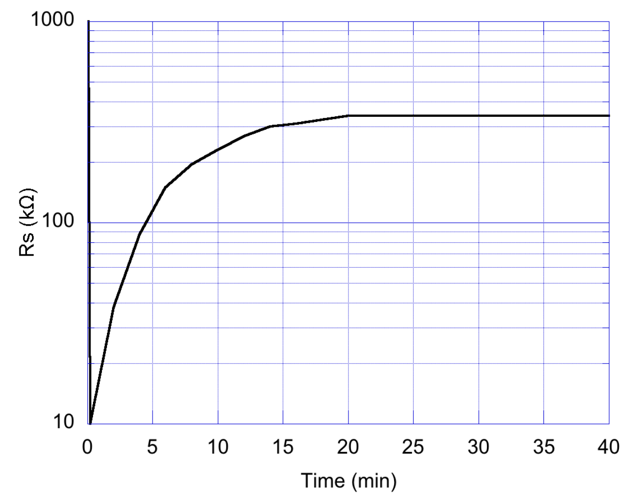


Fig. 9 - Initial action

2-7 *Long-term characteristics*

Figure 10 shows long-term stability of TGS826. The sensor is first energized for 7 days in normal air. Measurement for confirming sensor characteristics is conducted under ambient air conditions rather than in a temperature/humidity controlled environment. The cyclic change in sensitivity corresponds to the seasonal changes of temperature/humidity in Japan (*peak T/H conditions occur in July, as corresponds with the sensitivity peaks in this chart*). The Y-axis represents the ratio of sensor resistance in 50 and 150ppm of ammonia on the date tested (Rs) to sensor resistance in air at the beginning of the test period (Ro).

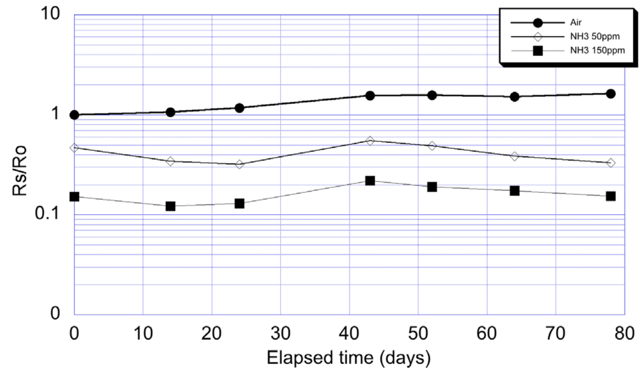


Fig. 10 - Long term stability--continuous energizing
(Ro = Rs in air on day 1)

Figure 11 shows the influence of storage in an unenergized condition on the sensor's resistance. Sensors were stored unenergized in air after 7 days of energizing. Then, sensors were energized for one hour before measurement was taken.

As this chart illustrates, the sensor shows good long term stability characteristics.

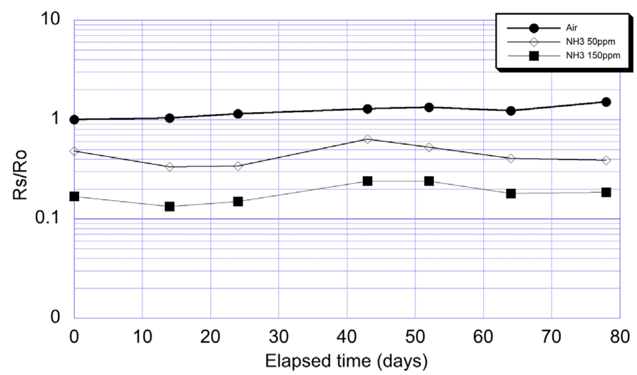


Fig. 11 - Long term stability - influence of unenergized state
(Ro = Rs in air on day 1)

3. Reliability

3-1 *Gas exposure test*

Figure 12 shows the effects of long-term exposure to high concentrations of ammonia. Sensors were energized for 7 days in normal air before measurement was taken. Then, sensors were energized in 1000ppm of ammonia for 35 days. Measurements in air and ammonia were taken after energizing in normal air for one hour.

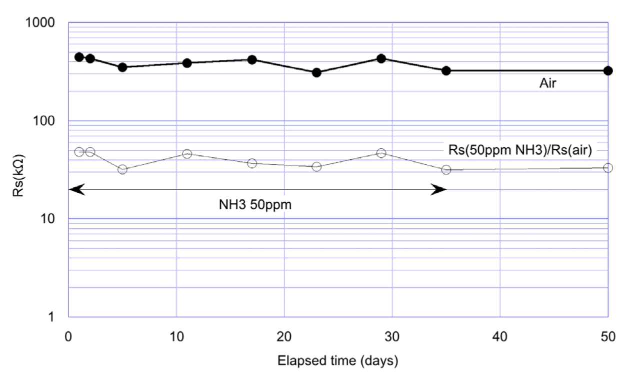


Fig. 12 - Gas exposure test

4 Cautions

4-1 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, SO_x, 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. This may also happen if the sensor is exposed to inorganic elements.

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) Application of voltage on lead wires
On six-pin type sensors, if a voltage is applied on the lead wires between pins 1 and 3 and/or pins 4 and 6, this would cause breakage of the lead wires (see Fig. 13).

4-2 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 <u>not</u> 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. For soldering conditions of 8-series gas sensors, refer to

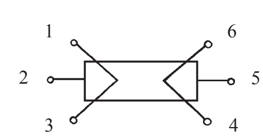


Fig. 13 - TGS826 pin configuration

Technical Advisory for Soldering 8-type Gas Sensors.

8) Polarity
If the polarity of Vc is reversed during powering, sensor characteristics may temporarily become unstable.

Special Note: A more narrowly defined range of Rs or Rs/Ro will be indicated on each production lot (*see Appendix*). Preselected ranges of Rs or Rs/Ro are **not** available.

FIGARO GROUP

HEAD OFFICE

Figaro Engineering Inc.
1-5-11 Senba-nishi
Mino, Osaka 562-8505 JAPAN
Tel.: (81) 72-728-2045
email: figaro@figaro.co.jp
www.figaro.co.jp

OVERSEAS

Figaro USA Inc.
121 S. Wilke Rd. Suite 300
Arlington Heights, IL 60005 USA
Tel.: (1) 847-832-1701
Fax.: (1) 847-832-1705
email: figarousa@figarosensor.com
www.figarosensor.com

Appendix

TGS 826 Pre-Sorted Groupings

The TGS 826 sensor has a wide specification range in terms of its rated value in 50ppm of NH3 and sensor resistance ratio (Rs in 150ppm of NH3 / Rs in 50ppm of NH3). To facilitate usage of this sensor, TGS 826 is shipped in pre-sorted groupings of 20 pieces per bag, with each bag marked with one of the following group numbers which indicate a more narrow range within the specification.

Please be advised that the sensor is produced to meet the overall specification range--production of specific groupings within the spec cannot be done.

Group #	Rs in 50ppm of NH_3 (kΩ)			$\frac{\text{Rs (in 150ppm of } NH_3)}{\text{Rs (in 50ppm of } NH_3)}$		
1-A	20 ~ 30			0.4 ~ 0.5		
1-B	20 ~ 30				0.5 ~ 0.6	
1-C	20 ~ 30					0.6 ~ 0.7
2-A		30 ~ 40		0.4 ~ 0.5		
2-B		30 ~ 40			0.5 ~ 0.6	
2-C		30 ~ 40				0.6 ~ 0.7
3-A			40 ~ 53	0.4 ~ 0.5		
3-B			40 ~ 53		0.5 ~ 0.6	
3-C			40 ~ 53			0.6 ~ 0.7
4-A	53 ~ 70			0.4 ~ 0.5		
4-B	53 ~ 70				0.5 ~ 0.6	
4-C	53 ~ 70					0.6 ~ 0.7
5-A		70 ~ 85		0.4 ~ 0.5		
5-B		70 ~ 85			0.5 ~ 0.6	
5-C		70 ~ 85				0.6 ~ 0.7
6-A			85 ~ 100	0.4 ~ 0.5		
6-B			85 ~ 100		0.5 ~ 0.6	
6-C			85 ~ 100			0.6 ~ 0.7