The TGS sensor type #812 is a general purpose gas sensor with high sensitivity to propane, butane and carbon monoxide and so can be used in combustible and toxic gas detection applications.

Electrically it requires a stabilized 5 volt heater supply and a circuit voltage not exceeding 24 volts.

1. Structure and Configuration of the TGS #812

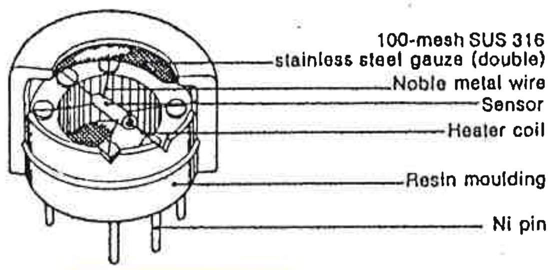


FIG. 1. TGS #812 CONFIGURATION.

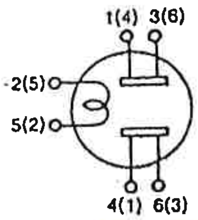
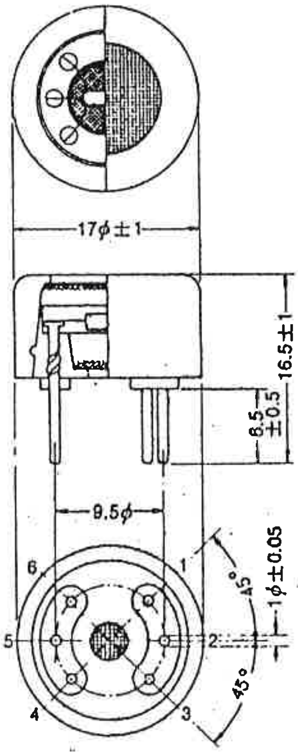


FIG. 2. TGS #812 DIAGRAM OF THE ELECTRIC CIRCUIT.

◆ **Remarks:**
Pins numbered 1 and 3 are connected internally.
Pins numbered 4 and 6 are connected internally.



Dimensions in millimeter

FIG. 3. TGS #812 STRUCTURAL SPECIFICATIONS.

Figs 1 & 3 show the structure and configuration of the TGS #812 sensor.

The TGS #812 is a sintered bulk semiconductor composed mainly of tin dioxide (SnO_2). The semiconductor material and electrodes are deposited on a ceramic tubular former.

The heater coil is located inside the ceramic former. This coil, made of 60 micron diameter chrome alloy wire, has a resistance of 38 Ω.

The lead wires from the sensor electrodes are a gold alloy of 80 micron diameter. The heater and lead wires are spotwelded to the sensor pins which are arranged to fit a 7 pin miniature tube socket. The pins can withstand a withdrawal force in excess of 5kg.

The sensor base and cover are made of nylon 66 conforming to UL 94HB Authorized Material Standard. The deformation temperature for this material is in excess of 240°C.

The upper and lower openings in the sensor case are covered with a flameproof double layer of 100 mesh stainless steel gauze conforming to SUS 316. 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.

The type #812 sensor meets the mechanical requirements listed in Table I.

TABLE I VIBRATION AND SHOCK TEST

1. VIBRATION TEST		2. SHOCK TEST	
◆ Conditions:		◆ Conditions:	
Frequency	1000cpm	Acceleration	100G.
Total amplitudes	4mm	Number of tests	5
Duration	1hr.		
Direction of vibration	Vertical		

2. Basic Measuring Circuit

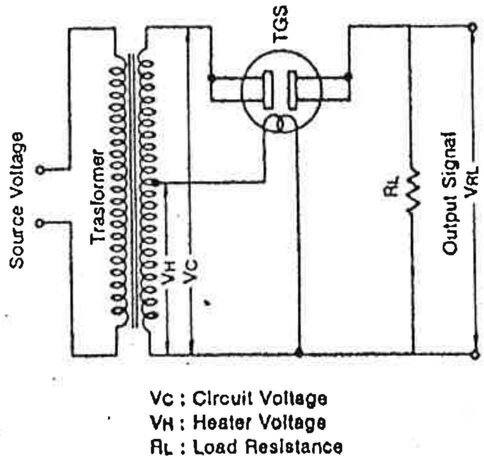


FIG. 4. BASIC MEASURING CIRCUIT WITH TGS SENSOR.

Fig. 4 shows the basic test circuit for use with sensor type #812. The variation in resistance of the TGS sensor is

N.B. Various sensor/circuit functions (VRL, Rs, R/Ro etc.) are used in this data booklet. Direct comparison is not always possible between data for different sensor types.

measured indirectly as a change in voltage appearing across the load resistor RL. In fresh air the current passing through the sensor and RL in series is steady, but when a combustible gas such as hydrogen, carbon monoxide etc. comes in contact with the sensor surface, the sensor resistance decreases in accordance with the gas concentration present. The voltage change across RL is the same when VC and VH are supplied from AC or DC sources. The circuit must conform to the values listed in Table II.

3. Circuit Configurations

Table II lists the safe operating area for type #812 sensor. The values of VC, VH and PS cannot be exceeded. Subject to a maximum sensor dissipation of 15 mW, the values of VC and RL can be chosen to meet design requirements. In practice VC can be 5, 6, 12 or 24 volts, and be supplied from a battery or A.C. source. If the current passing through the sensor is restricted below 0.5 milliamp, then the inclusion of load resistor RL is not necessary.

TABLE II AREA OF SAFE OPERATION

◆ SENSOR POWER DISSIPATION (PS)	Max. 15mW
◆ CIRCUIT VOLTAGE (VC)	Max. 24V
◆ HEATER VOLTAGE (VH)	5.0V±0.2V

4. Test Circuit and Sensor Specification

TABLE III TEST CIRCUIT AND SENSOR PERFORMANCE

TYPE NO.	TGS #812
TEST CONDITION A) Circuit Voltage (VC) (B) Heater Voltage (VH) Heater Power Dissipation (PH) (C) Load Resistance (RL)	 10V (A.C. or D.C.) 5.0V (A.C. or D.C.) Approx. 650mW. 4KΩ
WARM-UP TIME	Approx. 2 min.
HEATER RESISTANCE (RH)	38Ω±3Ω
SENSOR RESISTANCE (RS)	1~10KΩ In Isobutane 1000ppm/air
RATIO OF RESISTANCE	RS in Isobutane 3000ppm/air / RS in Isobutane 1000ppm/air ≒0.63±0.05

5. Sensitivity Characteristics

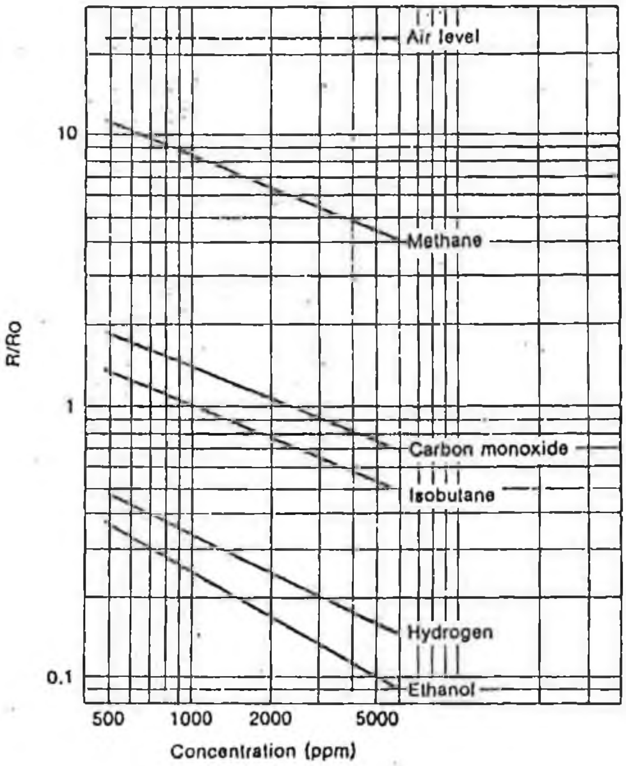


FIG. 5. RATIO OF RESISTANCE (R/Ro) vs. CONCENTRATION FOR #812.

◆**Remarks:** Ro: Sensor resistance in air containing 1000ppm of Isobutane.
R: Sensor resistance at different concentrations of gases.

Fig. 5 shows the basic characteristics of the type #812 sensor in relation to various gases. The data is plotted by calculating the ratio of sensor resistance at each measurement point compared to the resistance of the sensor when exposed to 1,000 ppm isobutane in a controlled atmosphere. An increase in sensor sensitivity is indicated by a decrease in the ratio calculated.

6. Dependency of Sensor on Supply Voltage

Fluctuations in supply voltage effecting VC and VH can result in changes in sensor resistance and output.

Fig. 6 shows the changes in sensor response to various gases when VH is altered by ±20% with constant VC. The data in Fig. 6 should not read as indicating that the value of VH can be chosen to suit a specific gas concentration. When VH is changed. by more than ±0.2 volts, other sensor characteristics such as initial warm up time, time dependency of the sensor etc. are also changed.

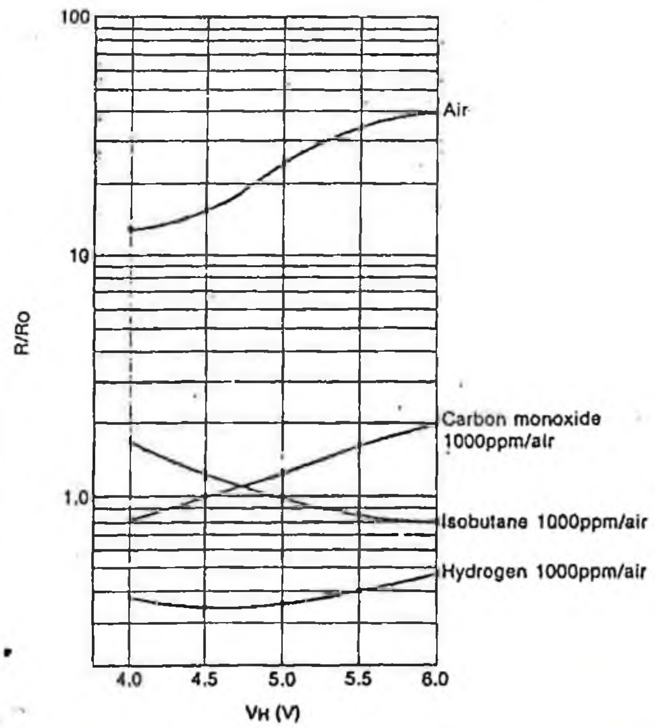


FIG. 6. EFFECT OF THE FLUCTUATIONS OF HEATER VOLTAGE ON #812 RATIO OF RESISTANCE (R/Ro).

◆**Remarks:** Ro: Sensor resistance in air containing 1000ppm of Isobutane at 5V (VH).
R: Sensor resistance in air containing 1000ppm of Isobutane at different heater voltages.

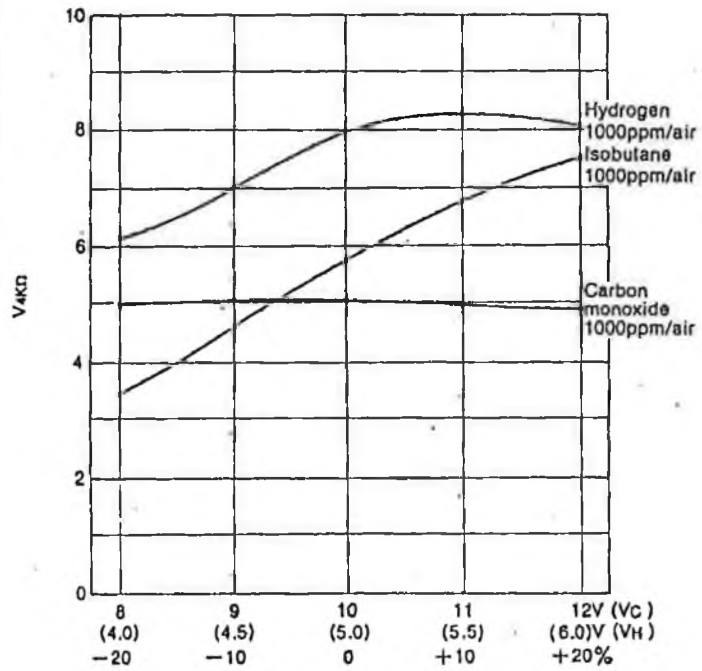


FIG. 7. EFFECT OF THE FLUCTUATIONS OF SUPPLY VOLTAGE ON #812 OUTPUT VOLTAGE ($V_{4K\Omega}$).

◆**Test condition:**
Vc 10V±20% / VH 5.0V±20% / RL 4KΩ

Fig. 7 shows the effects of supply voltage fluctuation on the output of the sensor measured as voltage across 4 kΩ resistor in the basic test circuit. Because changes in supply voltage effect both Vc and VH results shown in Fig. 7 differ from those shown in Fig. 6 where the VH only was changed. Where high accuracy of gas detection is required using type #812 sensor, it is recommended that a ±1% regulated voltage supply be employed.

7. Temperature and Humidity

The sensitivity characteristics of the TGS #812 sensor are altered by changes in atmospheric temperature and humidity. The detection principle of the TGS is based on chemical adsorption and desorption of gases on the sensor surface. Because these reactions are temperature dependent and water vapour can be considered a gas, the effects of temperature and humidity changes cannot be eliminated from the sensor. These effects can however be reduced by circuit design as described in section 10.

Fig. 8 shows the temperature/humidity dependency of the type #812 sensor.

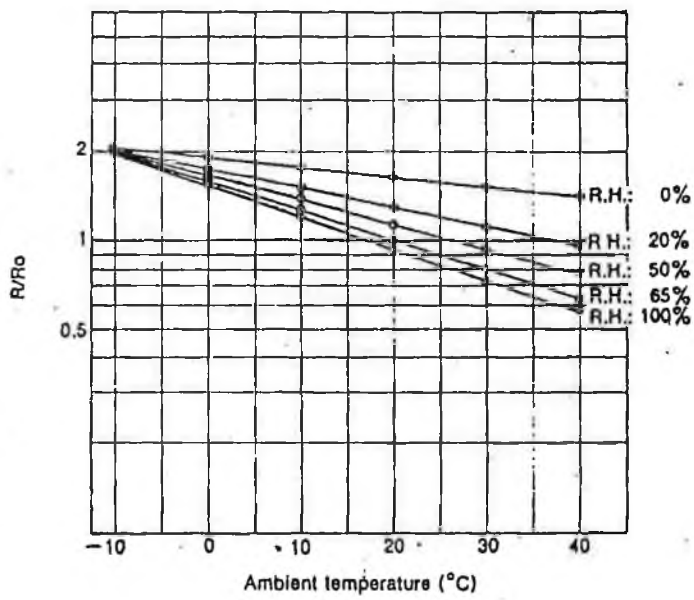


FIG. 8. TGS #812 DEPENDENCY ON TEMPERATURE AND HUMIDITY

◆**Test condition:**
Vc 10V A.C. / VH 5.0V A.C. / RL 4KΩ

◆**Remarks:** Ro: Sensor resistance in air containing 1000ppm of Isobutane gas at 20°C and 65% R.H.
R: Sensor resistance in air containing 1000ppm of Isobutane gas at different temperature and humidity.

M X E engineering b.v.

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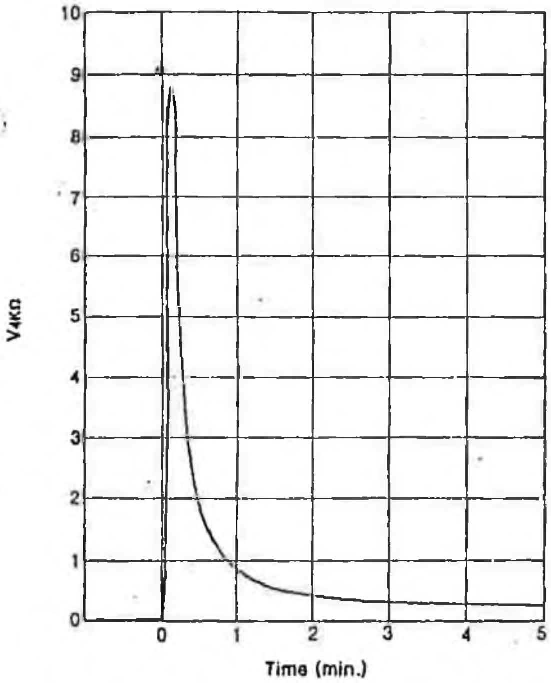
8. Time for Initial Stabilization

A TGS sensor which has been stored unenergized for a long period takes some time to reach its normal operating condition following switch on. This "Initial Action" characteristic is shown in Fig. 9.

From the moment of switch on the sensor's conductivity first rises rapidly and then falls towards its final stable value. The time taken to stabilize is a function of the sensor's storage time and atmosphere. In general, the longer the storage time the longer the initial action time. In the case of sensor type #812, the initial action time reaches its maximum value after about 20 days storage. In normal applications the initial action time will be less than 2 minutes.



G. 9. INITIAL ACTION OF TGS #812 STORED FOR 1 WEEK WITHOUT CURRENT-INPUT.

◆Test condition:
VC 10V A.C. / VH 5.0V A.C. / RL 4KΩ

9. Time Dependency Characteristics

Sensors which have been stored for more than 2 weeks display the time dependency characteristic shown in Fig. 10.

Fig. 11 shows the typical pattern of time dependency of sensor type #812, and is based on readings obtained as described in Fig. 10.

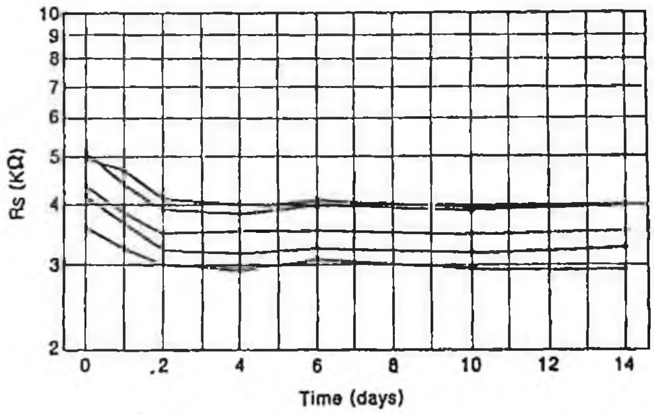


FIG. 10. SENSOR RESISTANCE vs. TIME

◆Sample: TGS #812 (5 pieces)

◆Test condition:
VC 10V A.C. / VH 5.0V A.C. / RL 4KΩ

◆Test gas: isobutane 1000ppm/air

◆Remarks:

① Sample sensors had been stored for more than two weeks before they were again switched on.

② $RS = RL \left(\frac{VC}{VRL} - 1\right)$

Fig. 11 shows the typical pattern of time dependency of the #812 sensor. During the transitional period ① the sensor's resistance is higher than its resistance in the stable period ②. The transition time will vary between individual sensors and will also depend on the sensor's storage history. This time dependency must be checked when calibrating detectors. Calibration should wait until the sensor has reached its stable resistance value corresponding to period ②. The pattern shown in Fig. 11 will repeat when the detector is installed by the final user.

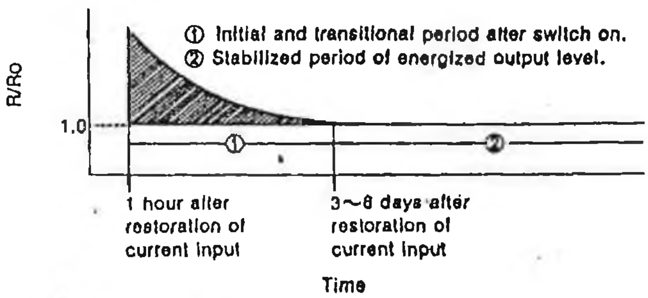


FIG. 11. TYPICAL PATTERN OF TGS #812 SENSITIVITY CHANGE WITH TIME.

◆Remarks: Ro: Sensor resistance at stabilized level.
R: Sensor resistance during stabilization.

10. Practical Detector Circuits using the 812 Sensor

1. Gas leak detector

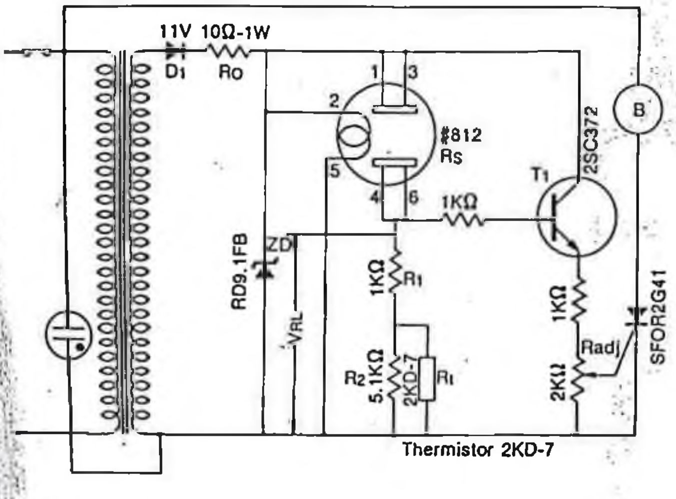


FIG. 12. AN EXAMPLE OF PRACTICAL CIRCUIT.
Circuit of L.P.G. Detector using 812 sensor, in which a temperature compensating circuit is included.
◆**Alarm:** 800~3500ppm of Isobutane gas
◆**Warm-up:** Within 2 minutes
◆**Ambient temperature:** −10~40°C
◆**Relative humidity:** 40~85%

The ratings of the components used in Fig.12 circuit are;

A. ZENER DIODE		
	Zener voltage	9.1V nominal ±10%
	Power dissipation	1W
	*Suitable zeners: Siemens Type 1N4739, Mullard Type BZX61C9V1	
	Motorola Type 1N3019	
B. THERMISTOR		
	Resistance at 25°C	2KΩ ±15%
	Temp. Coefficient	−4.7%/°C

Fig. 12 is an example of a practical domestic gas leak detector circuit using 812 sensor. For butane and propane an alarm level of 2,000 ppm isobutane is recommended. To improve accuracy while still using the minimum number of components, a simple temperature compensating circuit and voltage stabilizer are included.

Circuit description

The circuit voltage Vc=11VAC is half wave rectified before being fed to the heater stabilizer Ro and ZD, where it is regulated to 9.1 V.

The heater power consumption is 650 mW.

To compensate for the temperature dependency of the TGS a simple thermistor circuit R_1, R_2 & R_t is connected in series with the sensor. The voltage appearing across this sensor load will be

$$V_{RL} = \frac{9.1}{1+\frac{R_S}{R_L}} \quad \left(R_L = R_1 + \frac{R_2 R_t}{R_2 + R_t}\right)$$

Because of the temperature dependence of the sensor Rs will change with temperature. For example, the sensor's resistance will increase by a factor of approximately 2 between 20°C and −10°C in case of 65% R.H. as shown in Fig. 8. By careful choice of R_1, R_2 and R_t the temperature dependence of R_L can be matched to R_S. The variable resistor R_{adj} is used after the emitter follower circuit to set the detector alarm point. A fixed resistor would not be practical in this position due to the spread in sensitivity characteristics between individual sensors, e.g. Rs can range from 1 kΩ to 10 kΩ in 1,000 ppm isobutane.

2. Automatic Ventilator Controller

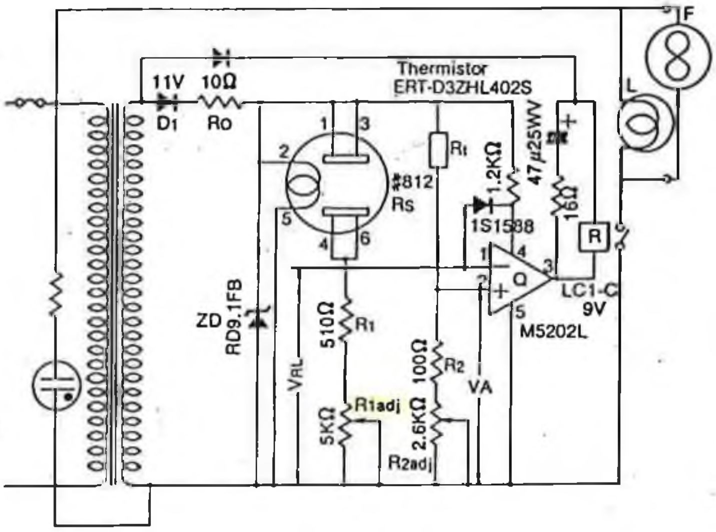


FIG. 13. AN EXAMPLE OF PRACTICAL CIRCUIT.
Circuit of ventilation controller using 812 sensor, in which a temperature compensating circuit is included.
◆**Ambient temperature:** 0~40°C
◆**Relative humidity:** 30~80%
◆**Remarks:** Alarm point is initially set at 300ppm of CO under atmospheric conditions of 20°C and 65% R.H.. The sensor has been continuously energized for 10 days before being installed.

The ratings of the components used in Fig.13 circuit are;

A ZENER DIODE		
	Zener voltage	9.1V nominal ±10%
	Power dissipation	1W
	*Suitable zeners: Siemens Type 1N4739, Mullard Type BZX61C9V1	
	Motorola Type 1N3019	
B. THERMISTOR		
	Resistance at 25°C	4KΩ ±15%
	Temp. Coefficient	−4.7%/°C
C. COMPARATOR/DRIVER		
	*Comparator	
	Supply voltage	6.5V Max.
	Differential input voltage	6.5V Max.
	Input current	100nA Max.
	*Driver	
	Sink current	60mA
	Saturation voltage	0.6V
	Output voltage	18~26V (Zener clamped)
D. RELAY		
	Coil voltage	9V
	Coil current	50mA
	Switching capacity	3A (Resistive load cosϕ=1)
		1.5A (Inductive load cosϕ=0.4)