

FIGARO

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## Technical Information for Air Quality Control Module AM-1

The Figaro AM-1 is a sensor module which is useful for evaluating the application of Figaro's air quality sensors into air quality control products. The module contains a gas sensor, microprocessor, and control circuit.



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**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 SENSOR HAS NOT BEEN SPECIFICALLY TESTED BY FIGARO.

**TECHNICAL INFORMATION FOR AM-1****1. Product Description**

Figaro Engineering, Inc. has developed excellent air contaminant gas sensors (TGS2600 and TGS2602) and a microcomputer (FIC-02667) for automatic control of air quality control devices such as air cleaners and ventilators. For such applications, rather than measuring actual contamination levels, the output signal of Figaro sensors is compared to a benchmark level. The degree of change from the threshold value determines the level of operation of the air cleaning device.

Due to the complexity of understanding sensor performance and processing sensor output to optimize air quality controller performance, the AM-1 sensor module was prepared. This module allows users to minimize development time and produce an automatic air quality device with high sensitivity to changes in indoor air pollution and intricate operation similar to human reaction.

The AM-1 unit is composed of a user-selected air contaminant sensor and the FIC02667 microprocessor—its purpose is to help users understand and evaluate the features of these components by observing their actual performance.

Figaro's air contaminant sensors detect deoxidizable gases contained in indoor pollutants with excellent sensitivity through electrical resistance change.

The FIC02667 microprocessor evaluates pollution levels in four degrees according to a signal sent from the gas sensor. FIC02667 compensates the effects of humidity, atmospheric temperature and transient gases on the sensor, and generates control signals for an air quality controller based on its estimation of pollution levels. To use TGS sensors for automatic ventilation applications, special software would be required—please refer

to technical information titled “Signal Processing for Automatic Ventilation Systems using TGS Gas Sensors”.

The illumination of LEDs on the AM-1 indicates the level of atmospheric pollution, allowing this sensor module to function as a pollution monitor. LED illumination is decided by a control signal sent from the microprocessor.

**2. Components**

Figure 1 (below) shows the components of AM-1 and their functions:

a) *Input terminal*: DC  $5.0 \pm 0.2V$

b) *Gas sensor*

Users may choose among TGS2600 and TGS2602. A decrease in electrical resistance of the sensor ( $R_s$ ) occurs when indoor atmospheric pollution increases. The gauze of the sensor cap usually gets warm because the sensing element is heated—this is not an abnormal condition.

c) *Load resistor ( $R_4$ )*

Connected to the sensor in series. The change of the sensor's electrical resistance can be monitored by measuring voltage across the load

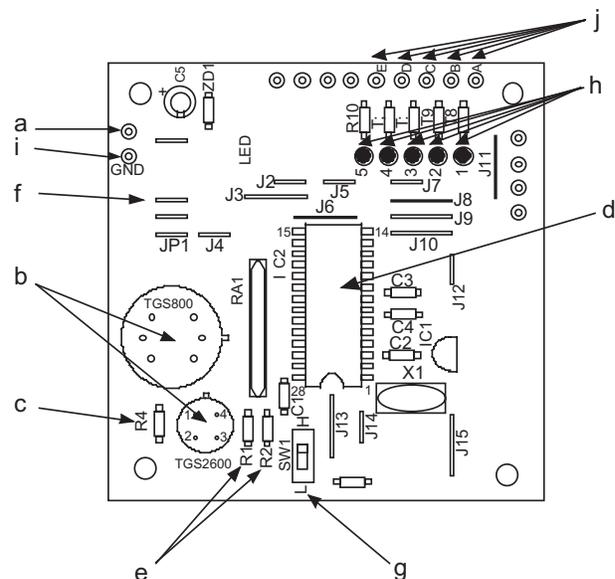


Figure 1 - AM-1 Components

resistor. This voltage is called sensor output (Vout).

d) *Microcomputer (FIC02667)*

The microprocessor reads the signal from the sensor, compares it to a memorized benchmark value corresponding to a clean atmosphere level, evaluates the degree of pollution and generates the appropriate signal to control an air quality controller.

e) *Operation mode resistors (R1, R2)*

See Appendix A (*Selection of Operation Modes for AM-1*)

f) *Operation mode jumper (JP3)*

See Appendix A (*Selection of Operation Modes for AM-1*)

g) *Sensitivity changeover switch*

The FIC02667 microcomputer contains software to control an air quality device at High and Low sensitivities. When in the down position (see Fig. 1), sensitivity is set to High. Setting the switch in the up position will make sensitivity Low.

h) *LED for pollution degree indication*

The degree of indoor atmospheric pollution is indicated by the LEDs as activated by the microcomputer. When LED 2 is on, one of the LEDs 3 through 5 lights up at the same time.

- LED 1 (green) : Good
- LED 2 (red) : Polluted
- LED 3 (amber) : Pollution - low
- LED 4 (amber) : Pollution - medium
- LED 5 (amber) : Pollution - high

LEDs 3 through 5 are connected with the microprocessor's three control ports which generate one signal each to direct the air quality controller—Low Operation, Medium Operation and High Operation. When the level of atmospheric pollution changes from 'Good' to 'Pollution - low', LED 4 will light for one second, followed by LED 3 in order to shorten the warm-up time of the fan's motor.

i) *Terminal for GND:*

Common terminal for the microprocessor's

output terminals (Item j below) and for the +5V power supply output terminal (Item k below).

j) *Terminals for the microprocessor's output*

LEDs 1 to 5 correspond to terminals A to E respectively. The output voltage at the terminal becomes 0 V when its corresponding LED is on and becomes 5V when its corresponding LED is off. Recording each terminal output together with the sensor output (measured across both ends of R4) on a chart, the user can examine the operation of AM-1 in detail. Furthermore, users can examine the effect of automatic control on air quality devices by connecting such devices to the desired terminals (A~E) via an interface circuit (See *Specifications—Page 4*).

k) *Output terminal of +5V power supply*

Can be used as power supply for an interface circuit (See *Specifications—Page 4*).

### 3. Performance

After powering on, the AM-1 goes through an Initial Clean-up Operation for two minutes, High Sensitivity Operation for three minutes, and then into Standard Operation.

a. *Initial clean-up operation*

For two minutes after first being powered on, LED 1 (Good) blinks on and off in a 0.5 second cycle regardless of pollution levels. If an air quality controller is connected to the unit, the device will not function during the Initial Clean-up Operation mode. At the end of this operation, LED 1 stays on continuously and the output signal level of the sensor is memorized by the microcomputer as a benchmark signal level for clean air.

**NOTE:** If polluted levels exist at the time of powering on, the initial baseline level would be set at such a high pollution level that the device would not activate despite the presence of pollutants.

**TECHNICAL INFORMATION FOR AM-1****b. Standard operation**

AM-1 in Standard Operation mode continuously indicates the degree of pollution with the LEDs, based on ratio of sensor resistance to the benchmark resistance value of 'clean air'. The benchmark signal level for clean air in the microcomputer is periodically (factory preset is every 20 minutes) or manually reset.

**4. Troubleshooting**

Problem	Cause	Solution
All LED's off	drop in power or disconnection	check power connections
	no power	check power
Other	malfunction of microcomputer caused by external noise	disconnect power, reconnect, and restart
	other	call for repair

**5. Specification**

Item	Specification	
Power Supply	DC 5 V±0.2 V	
Power Consumption	AM-1-2600 : Max 0.8W Others: Max 1.2W	
Target Gas	Indoor atmospheric pollution caused by deoxidizable pollutant gases ( <b>note: does not react to dust</b> )	
Sensitivity (factory preset)	High	3ppm of H <sub>2</sub>
	Low	6ppm of H <sub>2</sub>
LED display	LED1 (green)	good
	LED2 (red)	polluted
	LED3 (amber)	low pollution level
	LED4 (amber)	medium pollution level
	LED5 (amber)	high pollution level
Microprocessor output terminals	Active Level	"Low" (for C-MOS open drain output of each terminal)
	Max. output current	+20mA including LED driving current
Output terminal of +5V power supply	Max. output current	0.5 A
Operational temperature range	-10 ~ 50°C, 5 ~ 70%RH (avoid condensation on the unit)	
Storage temperature range	-20 ~ 60°C, 5~90%RH%	
Dimensions	70mm x 70mm x 40 mm	
Weight	20 g	

## 6. Product code for AM-1

The AM-1 unit can use the following Figaro air quality monitoring sensors. When purchasing this unit, please indicate which sensor module is required:

<u>Sensor</u>	<u>Module Code #</u>
TGS2600	AM-1-2600
TGS2602	AM-1-2602

## 7. Notes

### a. *Installation guidelines*

- 1) Avoid exposure to rain, direct sunlight and heat radiation
- 2) Protect against vibration
- 3) The sensor should not be located in an unventilated area. However, since the sensor is a heated element, it should not be placed where it is directly exposed to strong airflow.

b. Since AM-1 is designed for evaluation only, the operational stability of this unit against fluctuation of power supply voltage or external noise is not specified.

c. The air contaminant gas sensors used in this unit (TGS2600 or TGS2602) can also be purchased separately as well as the FIC02667 microprocessor.

### 8. Circuit diagram

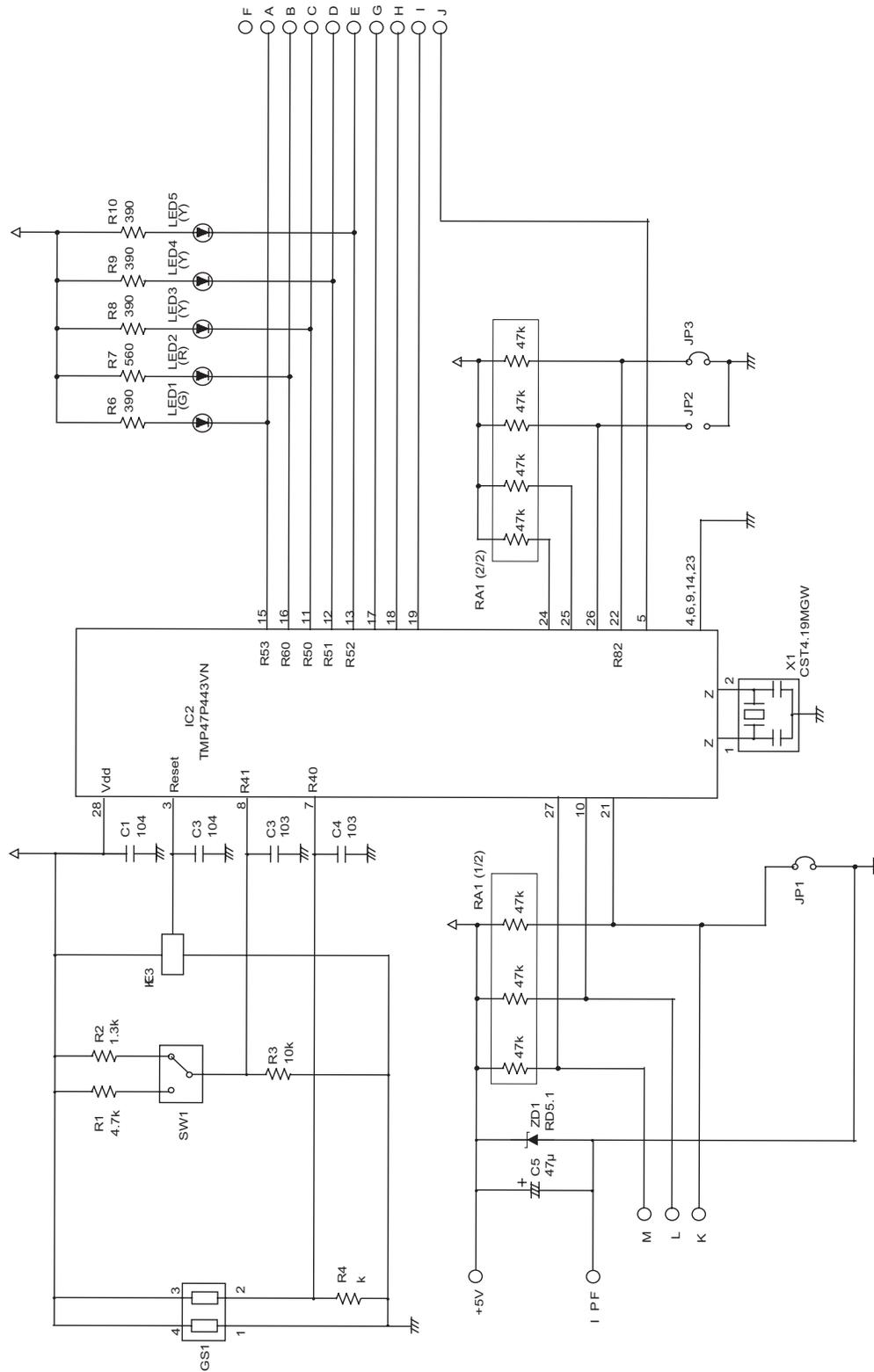


Figure 2 - Circuit diagram of AM-1

## Appendix A

The AM-1 unit has a specially developed microprocessor FIC02667 which has additional functions that can be selected by users according to the desired application.

### 1. Selection of Operation Modes

By using jumper J3, automatic operation can be selected according to the air quality controller's capacity control--two step (high/low) or three step (high/medium/low). Operation mode can be set by JP3 as follows:

Capacity	JP3
Two-step	Disconnect
Three step	Connect

Figaro provides the initial setting for JP3 as connected.

JP1 and JP2 are determined at the factory. Regarding these jumpers, please do not change the original settings.

### 2. Specifying Sensitivity

The FIC02667 can evaluate the degree of pollution by comparing the sensor resistance ratio (sensor resistance / benchmark value) with the preset threshold value ( $\Delta R$ ). To change the  $\Delta R$  value, the user should adjust the input voltage ( $V(K1)$ ) applied to the sensitivity control port of the microprocessor (Pin 6). The higher the input voltage, the greater the sensitivity. The sensitivity control input voltage must be in the range of 1.0 V to 4.5 V.

In the AM-1 unit, the  $V(K1)$  value can be adjusted by changing the resistance value of R4 and R5 according to the following formula:

$$\text{Sensitivity} = \text{"H"}: V(K1) = 5 * R6 / (R4 + R6)$$

or

$$\text{Sensitivity} = \text{"L"}: V(K1) = 5 * R6 / (R5 + R6)$$

### Threshold level for "On"

$$\text{Low pollution level} : V(K1) / 5$$

$$\text{Medium pollution level} : [V(K1) / 5] - 0.078$$

$$\text{High pollution level} : [V(K1) / 5] - 0.158$$

### Threshold level for "Off":

$$\text{Low pollution level} : [V(K1) / 5] + 0.023$$

$$\text{Medium pollution level} : [V(K1) / 5] - 0.078 + 0.023$$

$$\text{High pollution level} : [V(K1) / 5] - 0.158 + 0.023$$

In order to avoid a chattering for generating the output signal corresponding to each pollution level, a difference is preset for threshold values between "On" and "Off" in the FIC02667.

### Factory preset values for $V(K1)$ :

$$R4 = 1.3 \text{ k}\Omega$$

$$R5 = 4.7 \text{ k}\Omega$$

$$R6 = 10 \text{ k}\Omega$$

According to the above listed formulas and factory preset values of R4~R6, threshold values for  $V(K1)$  can be calculated as follows:

### Sensitivity changeover switch "H"

$$V(K1) = 4.42 \text{ V}$$

Pollution Level	On	Off
Low	0.884	0.907
Medium	0.806	0.829
High	0.728	0.751

Table 1-Threshold value for  $V(K1) = 4.42\text{v}$

### b. Sensitivity changeover switch "L"

$$V(K1) = 3.40 \text{ V}$$

Pollution Level	On	Off
Low	0.680	0.703
Medium	0.602	0.625
High	0.524	0.547

Table 2-Threshold value for  $V(K1) = 3.40\text{v}$

*TECHNICAL INFORMATION FOR AM-1*

**NOTE:**

The standard version of AM-1 does not have manual input functions.

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