TVOC Gas Sensor

Model: TVOC Sensor

Technical Manual

(Version: V1)

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TVOC Sensor is a new type of TVOC gas sensor that adopts advanced NBHive® production technology, depositing metal oxide semiconductor gas-sensitive materials on a high specific surface area three-dimensional nano-honeycomb structured substrate, featuring high sensitivity, low power consumption, long life, and miniaturization.

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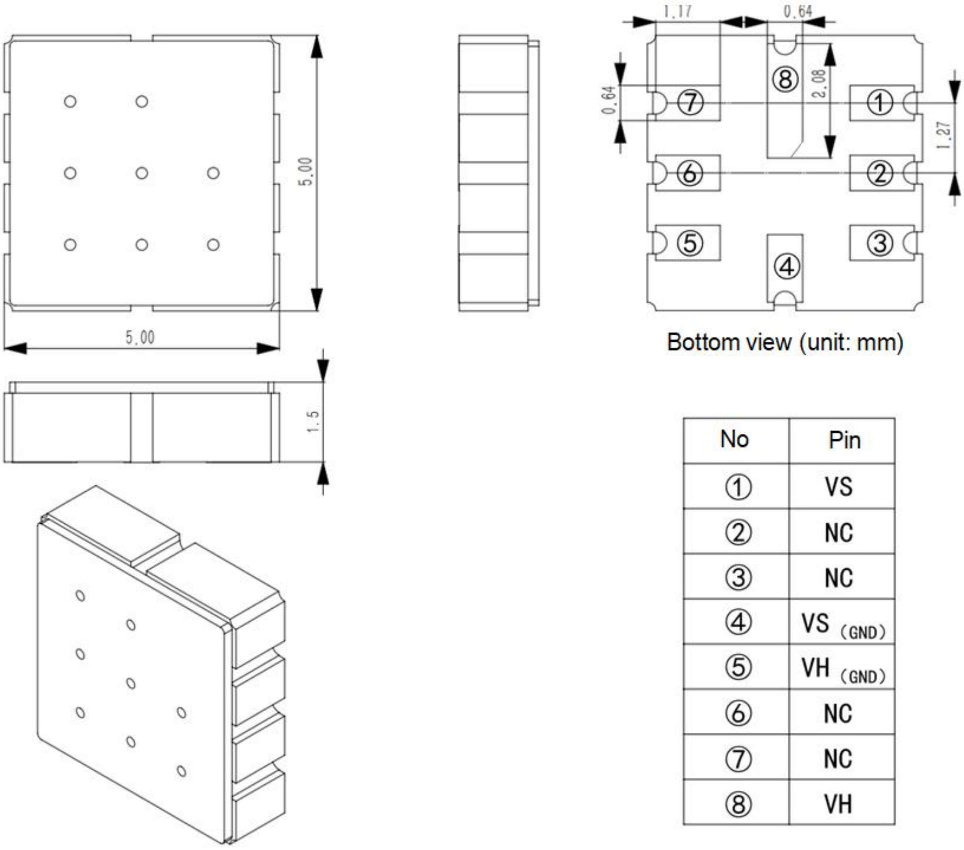
Ⅰ Basic Information and Specifications

1. Product features	2. Application scenarios
High sensitivity	Environmental monitoring
Low power consumption	Smart home appliances
Long lifespan	Fresh air ventilation system
Miniaturization	Smart industry
Simple measurement circuit	Automotive electronics

3. Product Structure

TVOC Sensor is a novel metal oxide TVOC gas sensor with a three-dimensional nano-honeycomb structure. The VS pin is the sensor signal pin, NC is the not connected pin, VH is the heater pin, and VS (GND) and VH (GND) are the respective ground pins, as shown in Figure 1-1.



No	Pin
①	VS
②	NC
③	NC
④	VS (GND)
⑤	VH (GND)
⑥	NC
⑦	NC
⑧	VH

Figure 1-1 Structure diagram

4. Test Circuit

The resistance of the gas-sensitive material in the TVOC sensor changes with the concentration of gases in the environment. The higher the concentration of TVOC gas, the smaller the sensor resistance. The measurement adopts a circuit that divides the voltage in series with a reference resistor, as shown in the circuit diagram in Figure 1-2. The calculation formula for the sensor response magnitude S is as follows:

$$Rs = \frac{Rref}{\frac{VCC}{VS} - 1}$$

$$S = \frac{R_S}{R_0}$$

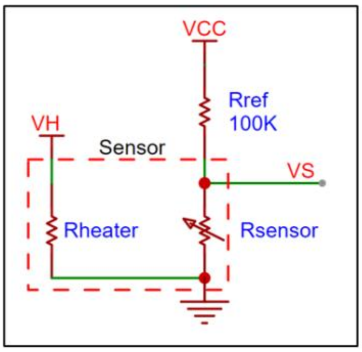


Figure 1-2 Circuit diagram

The VCC is the pull-up voltage value in the series voltage divider circuit of the sensor, Rref is the reference resistor, VS is the divided voltage value of the sensor, R0 is the baseline resistance of the sensor in clean air, Rs (shown as Rsensor in the figure) is the response resistance of the sensor in the target gas, VH is the heating voltage. When the sensor is exposed to the TVOC target gas, the response resistance decreases, and the response magnitude reduces.

5. Specification Table

Specifications	
Heater voltage (VH)	3.3 ± 0.1 V
Heater power consumption	160 ± 10 mW
Heater resistance (Rheater)	35 ± 4 Ω
Clean air resistance (R0)	10 KΩ ~ 500 KΩ
Detection concentration range	0.1 ppm ~ 100 ppm
Detection lower limit	10 ppb
Standard test conditions	Temperature and humidity: 25 ± 5 °C, 60 ± 5% RH
Response time	< 20 s
Storage conditions	Clean air seal or vacuum seal

Ⅱ Sensor Characteristics

1. Sensor Sensitivity

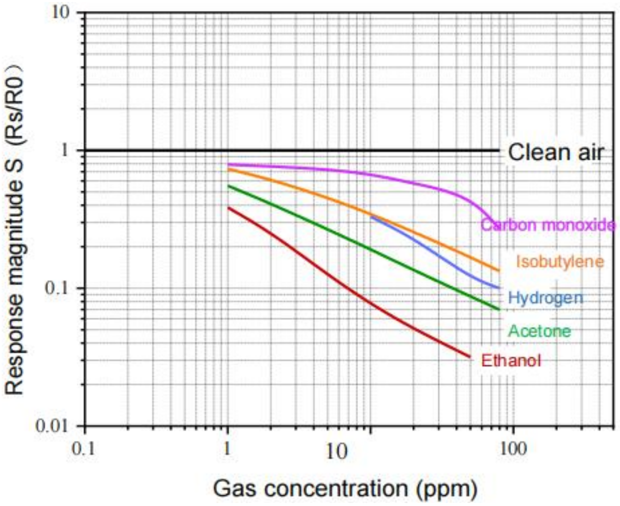


Figure 2-1 Sensitivity curves of the sensor for different gases

The sensitivity curves of the sensor for different gases are shown in Figure 2-1. The Y-axis represents the response magnitude S of the sensor in different gases.
Note: The sensitivity curve was tested under standard test conditions, where the temperature was 25 ± 5°C and the humidity was 60 ± 5% RH.

2. Sensor Temperature and Humidity Curve

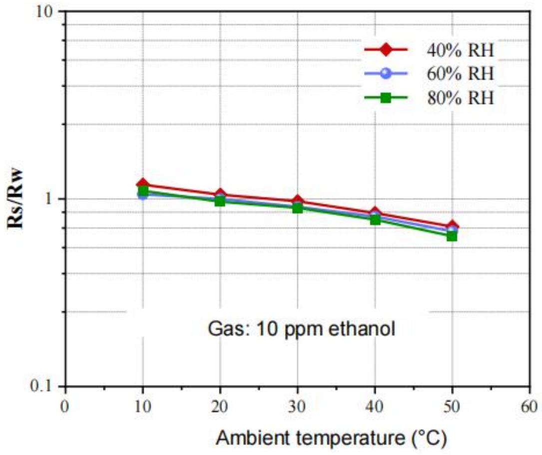


Figure 2-2 Dependence of the sensor on temperature and humidity

The dependence of the sensor on temperature and humidity in 10 ppm ethanol gas is shown in Figure 2-2. The Rs is the response resistance of the sensor under different temperature and humidity conditions. The Y-axis is the normalized result of the sensor response resistance Rw under different temperature and humidity conditions, with the sensor response resistance Rw at 20℃/60% RH as the reference.

3. Heater Voltage

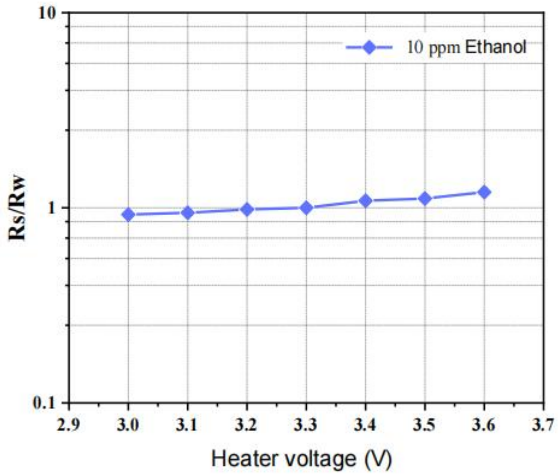


Figure 2-3 Dependence of the sensor on the heater voltage

As shown in Figure 2-3, the response resistance of the sensor changes as the heater voltage changes. The Rs is the response resistance of the sensor at different heater voltages, and the Y-axis is the normalized result of the response resistance of the sensor at different heater voltages with reference to the response resistance Rw of the sensor at 3.3V.

4. Gas Response and Recovery

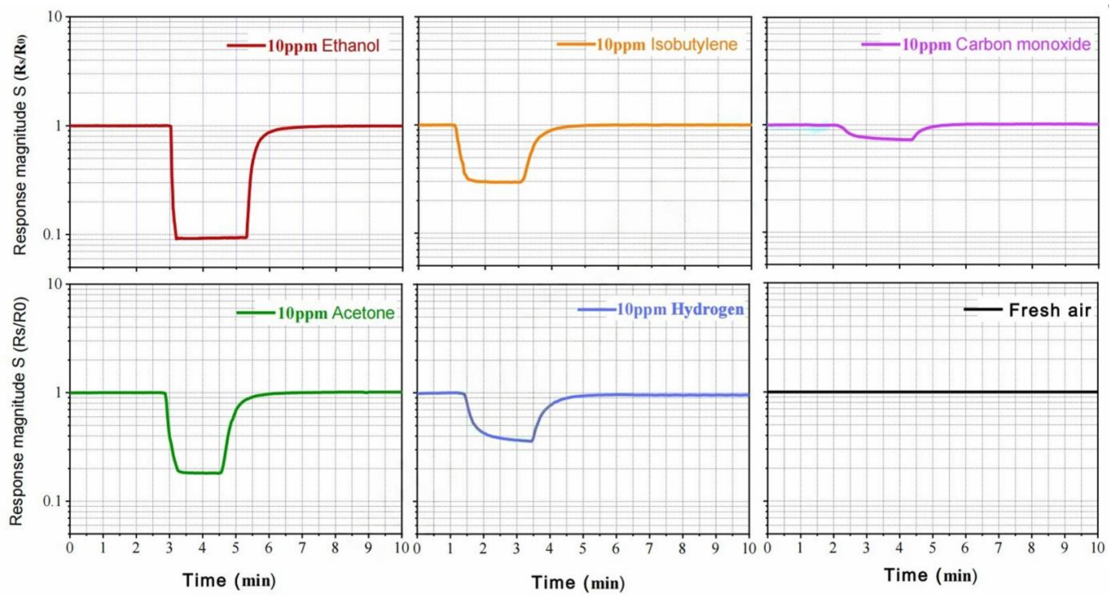


Figure 2-4 Response recovery of the sensor to different gases

Figure 2-4 shows the response and recovery process of the sensor to different gases, and the Y-axis is the response magnitude S of the sensor in different gases. The sensor responds quickly to a wide range of gases, and when the gas is discharged, the sensor returns to its initial value in a short time.

5. Initial Action

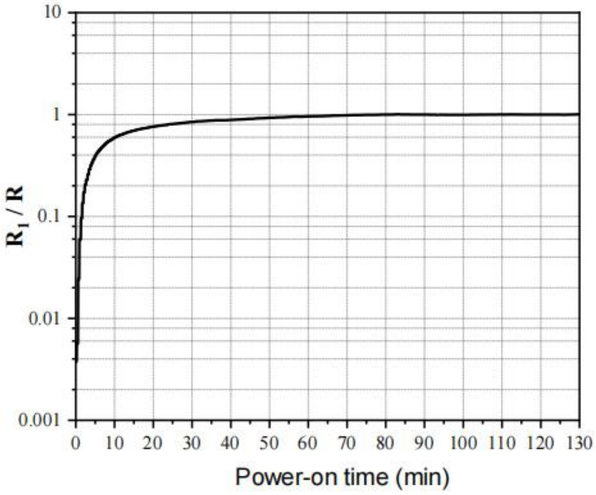


Figure 2-5 Initial action diagram of the sensor

As shown in Figure 2-5, the initial action of the sensor when powered on under standard test conditions after being stored in clean air or vacuum sealed for 30 days. The R1 is the real-time resistance of the sensor in clean air, and the Y-axis is the normalized result of the sensor resistance at different power-on times, based on the resistance R of the sensor after 100 minutes of power-on.

Note: The resistance of the sensor is very small during the initial power-on period, and it will gradually reach a stable state as the power-on time increases. Therefore, it is recommended to implement a delay during the power-up of the device to avoid false alarms.

6. Sensor Repeatability

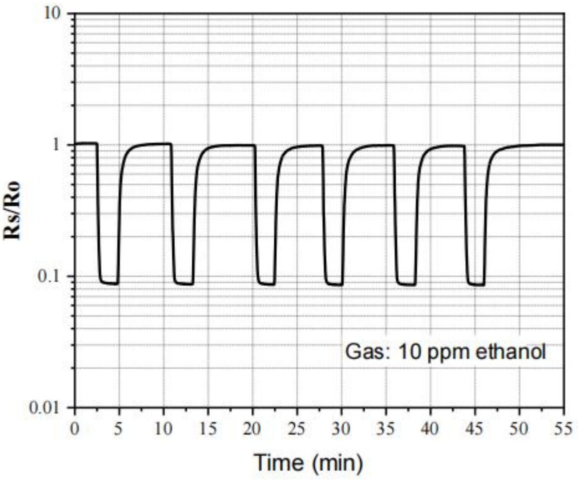


Figure 2-6 Multiple response recovery of the sensor in 10 ppm ethanol gas

Figure 2-6 shows the change in response of the sensor when tested repeatedly in 10 ppm ethanol gas. The repeatability of the sensor is demonstrated by testing the response and recovery process in 10 ppm ethanol gas several times. The Rs is the real-time response resistance of the sensor, and the Y-axis is the normalized result of the real-time response resistance of the sensor with reference to the baseline resistance R0 of the sensor in clean air.

7. Long-term Stability

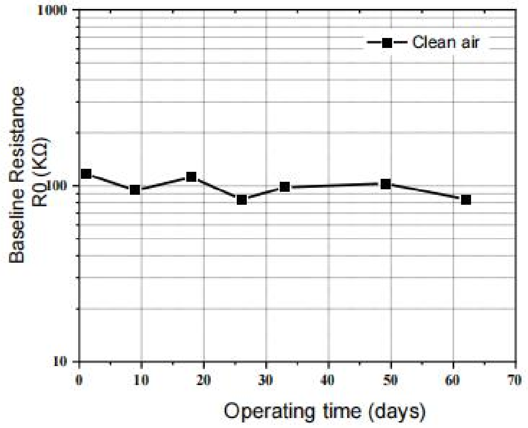


Figure 2-7 Long-term stability of the sensor in clean air

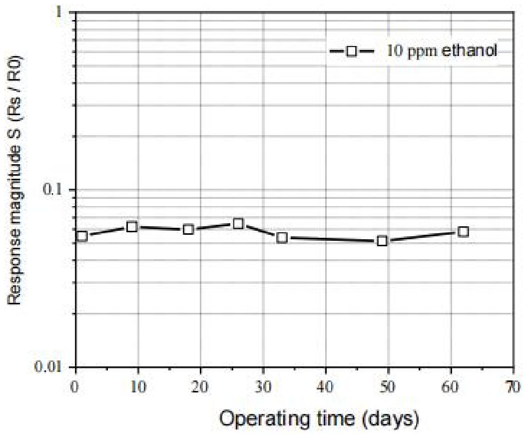


Figure 2-8 Long-term stability of the sensor in 10 ppm ethanol gas

The long-term stability of the sensor after more than 60 days of long-term tracking is shown in Figures 2-7 and 2-8. Figure 2-7 shows the change in resistance of the sensor in clean air. First, the sensor was powered in clean air, and then it was tested for long-term stability under standard test conditions. Figure 2-8 shows the change in resistance response of the sensor in 10 ppm ethanol gas, and the Y-axis represents the response magnitude S of the sensor in 10 ppm ethanol gas.

Ⅲ Precautions

(1) Avoid exposure to vapors of silicon ether compounds

If the sensor is exposed to silicone compound vapors (e.g., from Silicon ether adhesives, hair styling products, or silicone rubber), the sensitive material of the sensor will be poisoned and deactivated, resulting in varying degrees of deviation in sensitivity and other typical performance characteristics.

(2) Avoid exposure to highly corrosive environments

Long-term exposure to high concentrations of corrosive substances (e.g., hydrogen sulfide, sulfur oxides, chlorine, hydrogen chloride, etc.) can cause irreversible damage to sensor performance.

(3) Avoid contact with water

Prolonged exposure to water or high humidity environments may cause sensor failure or internal short circuits.

(4) Avoid excessive voltage

Apply heater voltage according to the reference circuit provided in this technical manual to achieve optimal performance. If the heater voltage is too high, the sensor may experience performance drift or damage.

(5) Long-term use in high-concentration target gas environments

Long-term use in an environment with high concentrations of target gas may cause the sensor to enter a saturated state. In this case, move the sensor to clean air and appropriately increase the heater voltage to thermally clean the sensitive materials.

(6) Storage time too long

The sensor should be stored in an airtight package containing clean air or vacuum-sealed, and should not be packaged in silicone products. The longer the storage time, the longer the preheating time required for the sensor to reach a stable state.

(7) Shock and shock

Vibrations and shocks during use or storage may cause damage to the sensor. Therefore, it should be kept in the factory foam packaging as much as possible.