

TECHNICAL INFORMATION FOR FC-CO-5000 CARBON MONOXIDE SENSORS



FC-CO-5000 is a UL recognized component in accordance with the requirements of UL 2075. Please note that component recognition testing has confirmed long term stability in 15ppm and monthly sensitivity test at 0, 30, 70, 150, and 400 ppm of CO; other characteristics shown in this sheet have not been confirmed. by UL as part of component recognition.

CONTENTS

1.GENERAL INFORMATION	4
1.1 PRODUCT INTRODUCTION	4
1.2 FEATURES	4
1.3 APPLICATIONS	4
1.4 BASIC MEASUREMENT CIRCUIT	4
1.5 DIAGRAM	5
1.6 TECHNICAL SPECIFICATION.....	5
1.7 MECHANICAL STRENGTH	6
1.8 PERFORMANCE TEST	6
1.8.1 RESPONSE CURRENT	6
1.8.2 RESPONSE-RECOVERY TIME	6
1.8.3 LINEARITY.....	7
1.8.4 REPEATABILITY	8
1.8.5 SENSITIVITY TEST.....	9
1.8.6 INFLUENCE OF STORAGE	9
1.8.7 NORMAL OPERATION TEST	10
1.9 RELIABILITY TEST.....	11
1.9.1 INTERFERENCE TEST	11
1.9.2 CORROSION TEST	12
1.9.3 LONG-TERM STABILITY TEST	13
1.9.4 FALSE ALARM TEST	14
1.10 ENVIRONMENTAL TEST.....	14
1.10.1 TEMPERATURE DEPENDENCY	14
1.10.2 HUMIDITY DEPENDENCY	15
1.10.3 VARIABLE AMBIENT TEMPERATURE TEST	16
2.CIRCUIT DESIGN.....	18
2.1 CIRCUIT DIAGRAM	18
2.2 SETTING REFERENCE VOLTAGE (VREF).....	18
2.3 ANTI-POLARIZATION CIRCUIT	18
2.4 CURRENT/VOLTAGE CONVERSION CIRCUIT	19
2.5 AMPLIFICATION FACTOR.....	19
2.6 SELECTION OF AMPLIFIER	19
2.7 ELECTRICAL NOISE PREVENTION	19
2.8 ANTI-UNDERSHOOT	20
2.9 SELF-DIAGNOSIS.....	20
2.10 COMPENSATION OF LONG TERM DRIFT.....	22
3.CALIBRATION OF THE SENSOR	22
3.1 CALIBRATION WITH CO GAS	22
3.2 CALIBRATION WITH SENSOR BARCODE	22

3.2.1.1 QR CODE :	22
3.2.1.2 MARKINGS :	23
3.3 TEMPERATURE COMPENSATION.....	23
3.4 CALCULATION OF CO CONCENTRATION.....	23
4.STORAGE	23
5.SOLDERING ON PCBA	23
6.GAS TEST	24
7.NOTES	24

ShenZhen ProSense Technologies Co.,Ltd.

1. GENERAL INFORMATION

1.1 Product Introduction

The Model FC-CO-5000 Carbon Monoxide sensor, known for its exceptional durability, operates on reliable fuel cell technology. When CO gas reaches the working electrode (anode), it is immediately oxidized, generating an electrical signal directly proportional to the CO concentration. By calibrating the sensor with a known CO concentration, its output current can be used for accurate quantitative measurement of CO levels.

Renowned for its long service life, high resistance to interference, and compact design, the FC-CO-5000 is an excellent choice for size-sensitive applications such as portable CO detectors, residential CO alarms, and multi-sensor fire detectors. Calibration data is embedded in a barcode printed on the sensor, allowing users to bypass expensive gas calibration processes and enabling individual sensor tracking.

With no consumable components, the FC-CO-5000 offers outstanding longevity and ensures a maintenance-free operation, making it a reliable and cost-effective solution for CO detection.

1.2 Features

- *Zero power consumption
- *High Accuracy
- *Anti-poisoning
- *Long Service Life
- *UL Recognized, FTAM2 Certified
- *Fulfill Requirements of GB 15322, UL 2034, EN 50291 and UL 2075 application
- *Fast Response
- *Anti-interference
- *Wide Temperature Range
- *Excellent Stability and Repeatability

1.3 Applications

- *Residential CO Detector
- *Commercial and Industrial CO Detector
- *Portable Generator CO Detection
- *Energy Storage System CO Detection

1.4 Basic measurement circuit

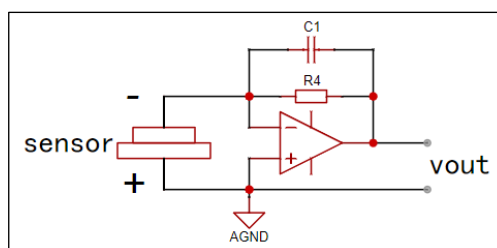


Figure 1 Basic measurement circuit

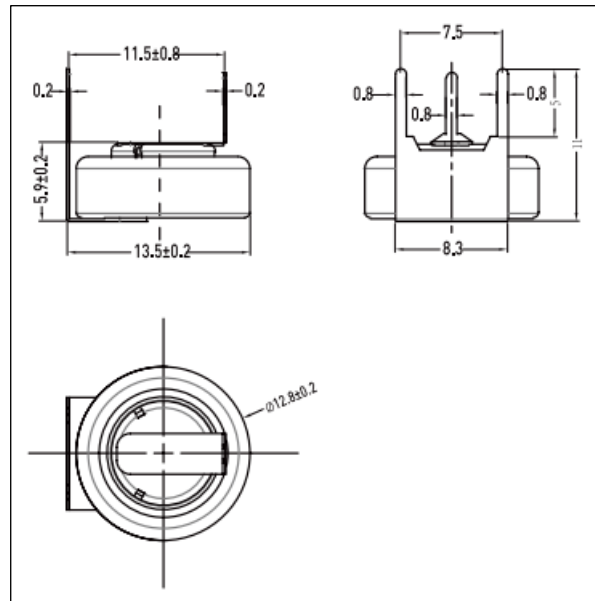
Figure 1 shows the basic circuit diagram of FC-CO-5000. The sensor generates a small current which is converted into sensor output voltage (V_{out}) by an op-amp/resistor ($R4$) combination. V_{out} is proportional to the carbon monoxide concentration. We do recommend application of JFET to prevent polarization of the sensor when circuit voltage is off. ProSense recommends the following electric parts as shown:

$R4$: 1Mohm

C1: 10uF

IC: TP5552(or any other amplifier with its Vos at the level of uV)

1.5 Diagram



Note: All dimensions are in mm

1.6 Technical Specification

Item	Specification
Model Number	FC-CO-5000
Principle	Micro fuel cell
Detection range	0-5000 ppm
Overload	10000 ppm
Sensitivity	1.5±1(nA/ppm)
Response time	< 60 Seconds
Repeatability	3%
Output	linearity
Operating temperature	-40°C~70°C
Operating pressure	1atm±10%
Operating humidity	10%—90%RH(non-condensation)
Lifetime	10 years+
Warranty	12 months
Weight	3g
Reading in 1000 ppm Alcohol	< 10 ppm

1.7 Mechanical strength

Sensor samples were tested according to the requirements specified by UL 2034 and the results demonstrate that the sensors' mechanical strength is sufficient to meet UL requirements:

Vibration: amplitude - 0.25mm, frequency - 35HZ, duration - 4 hours, x-y-z direction

Drop: height - 2.1m, repeat 5 times

1.8 Performance test

1.8.1 Response current

Table 1 shows the sensitivity of 15 sensors. I_0 refers to the output current in clean air; ΔI refers to the response current to 500 ppm Carbon Monoxide. S refers to the sensitivity of the sensor; t_{90} refers to the response time.

S/N	I_0 /nA	ΔI /nA	S(nA/ppm)	t_{90} /S
P1	-3	807	1.616	54
P2	0	888	1.775	54
P3	2	784	1.568	54
P4	-2	770	1.540	54
P5	-2	762	1.523	57
P6	1	831	1.661	57
P7	-3	720	1.440	54
P8	1	846	1.692	55
P9	-2	872	1.744	58
P10	0	812	1.624	54
P11	-1	572	1.524	54
P12	2	570	1.520	58
P13	2	591	1.578	57
P14	0	564	1.503	57
P15	1	534	1.422	58

Table 1 Typical specification of sensors

1.8.2 Response-recovery time

Figure 2 shows the gas response to 500 ppm CO and then returned to fresh air. It shows that the response time (t_{90}) is within 60 seconds and the recovery time (t_{10}) is within 60 seconds. This data demonstrate that FC-CO-5000 can meet the requirements in UL 2034.

t_{90} : time used to reach 90% of the saturated signal level

t_{10} : time used for the signal back to 90% of the base level

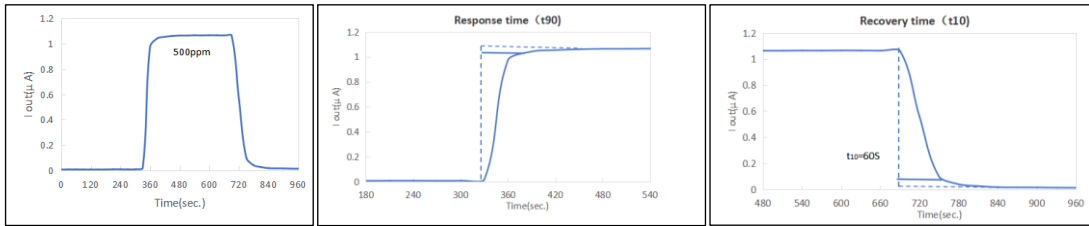


Figure 2 Response-recovery time

1.8.3 Linearity

Figure 3-5 shows the sensor's output to different CO concentration. The Y-axis shows output current ($I_{out}/\mu A$). The output current is linear to CO concentration with a deviation of less than $\pm 5\%$ in the range of 0~5000 ppm. The exact data are shown in table2.

C/ppm	S/N									
	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30
	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200	0.336	0.3	0.291	0.297	0.324	0.354	0.3435	0.3495	0.351	0.36
400	0.6705	0.6045	0.5835	0.5985	0.648	0.708	0.69	0.7005	0.702	0.72
600	0.9855	0.8955	0.864	0.8865	0.9615	1.044	1.0185	1.032	1.0365	1.062
800	1.293	1.188	1.146	1.176	1.2735	1.365	1.3395	1.3485	1.365	1.401
1000	1.6125	1.4865	1.434	1.473	1.5825	1.6905	1.665	1.674	1.701	1.7445
3000	4.9635	4.866	4.5045	4.818	4.9575	4.9665	4.962	4.965	4.9065	5.0325
5000	8.2635	7.896	7.5045	7.818	8.2575	8.2665	8.262	8.265	8.172	8.3805

Table 2 Output in different CO concentration

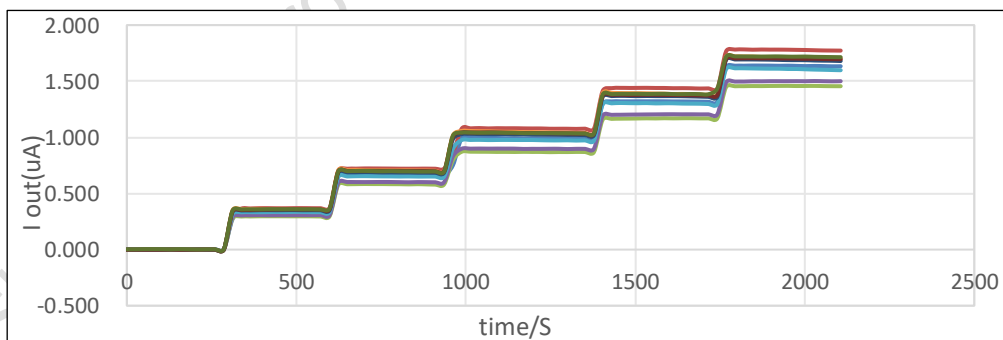


Figure 3 Response graph

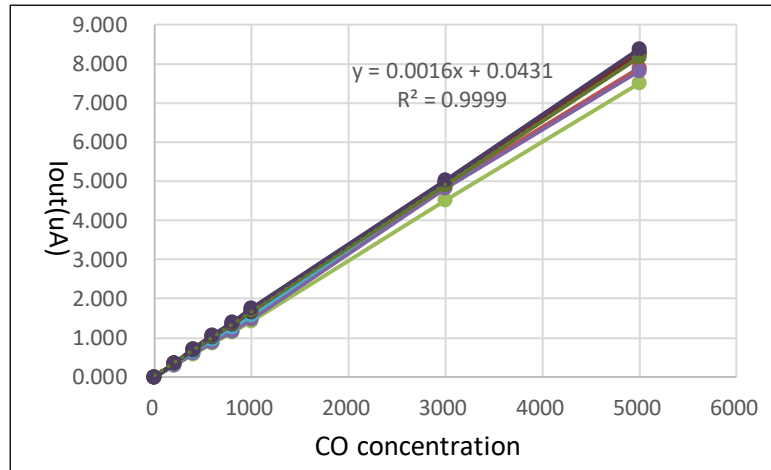


Figure 4 Linearity

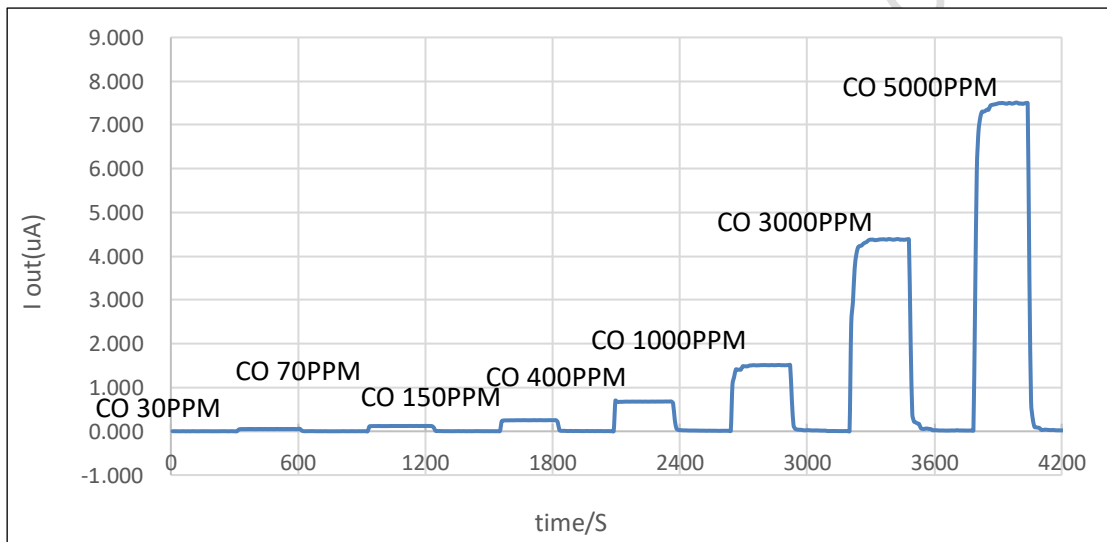


Figure 5 Response to different CO concentration

1.8.4 Repeatability

Figure 6 & Table 3 show the sensor response to the repeated exposure to 500 ppm CO for 4 times at an interval of 10 minutes. The data show extremely high reproducibility of the output signal, the deviation being less than $\pm 5\%$.

	1#	2#	3#	4#
	$\Delta I1/\mu A$	$\Delta I3/\mu A$	$\Delta I4/\mu A$	$\Delta I5/\mu A$
No.1	0.771	0.818	0.805	0.801
No.2	0.773	0.815	0.805	0.804
No.3	0.766	0.812	0.802	0.795
No.4	0.770	0.817	0.805	0.800
RSD	0.3%	0.3%	0.1%	0.4%

Table 3 Data of repeatability test

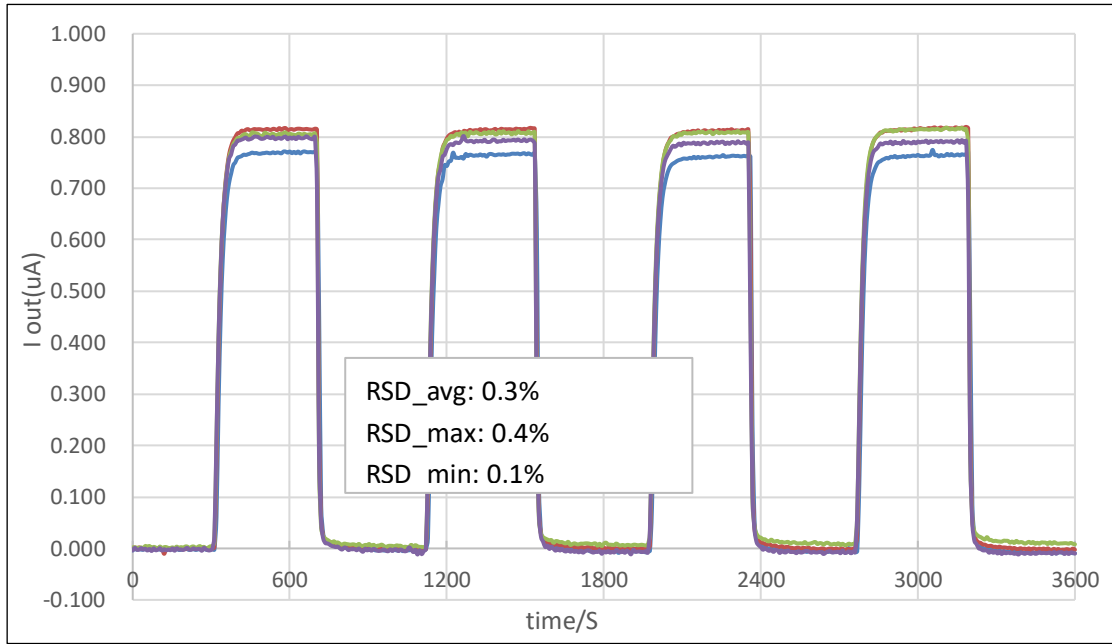


Figure 6 Repeatability in 500 ppm CO

1.8.5 Sensitivity test

The sensor was exposed to different concentration of CO at 20 °C & 40%RH for different time period as shown in Table 4 as required by the “Sensitivity Test” in UL 2034. Figure 7 shows the CO sensitivity of the sensor before, during and after the Sensitivity Test, which demonstrates the excellent reproducibility of FC-CO-5000.

S/N	Concentration/ppm	Exposure time/min
1	30	900
2	70	240
3	150	90
4	400	30

Table 4 Concentration & Exposure time

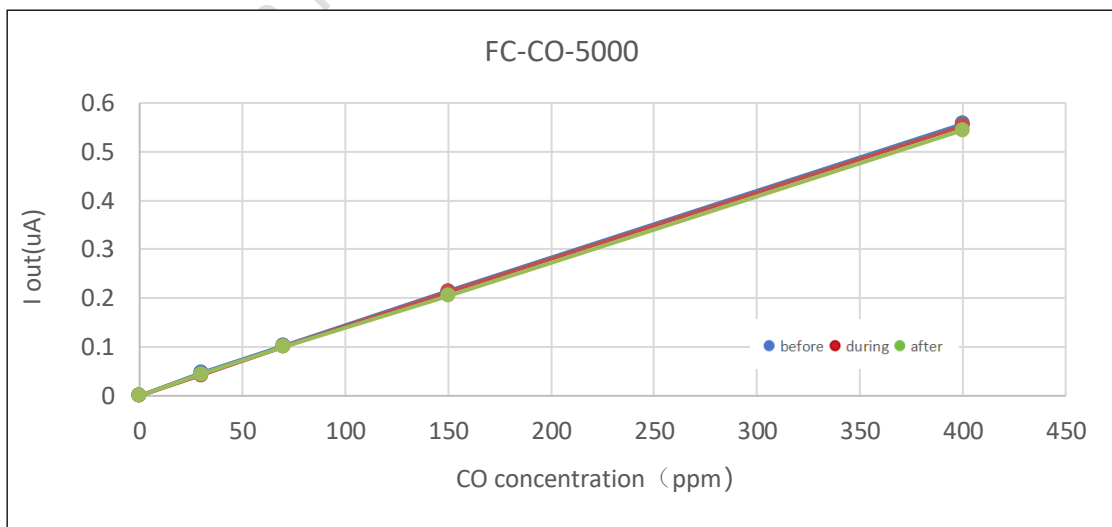


Figure 7 Sensitivity test

1.8.6 Influence of storage

Figure 8 shows the impact of storage condition on the initial output of the sensor in fresh air. The purpose of the test is to determine the settle down time of the sensor in short-circuited condition and open-circuited condition separately. Two groups of sensors are stored for more than 3 months under two separate conditions between the working and counter electrodes: in short-circuited condition, and in open-circuited condition. From figure 8 we can see that the sensors stored in short-circuit condition settled down within minutes while it takes about one hour for the open-circuited sensors to settle down because of the accumulation of polarization current on the working electrode. Since sensors are shipped in an open-circuited condition, stabilization time of one hour (typical) is recommended for sensors soldered on PCBAs which include an anti-polarization circuit, and for PCBAs without anti-polarization circuit more than 2 hours are strongly recommended.

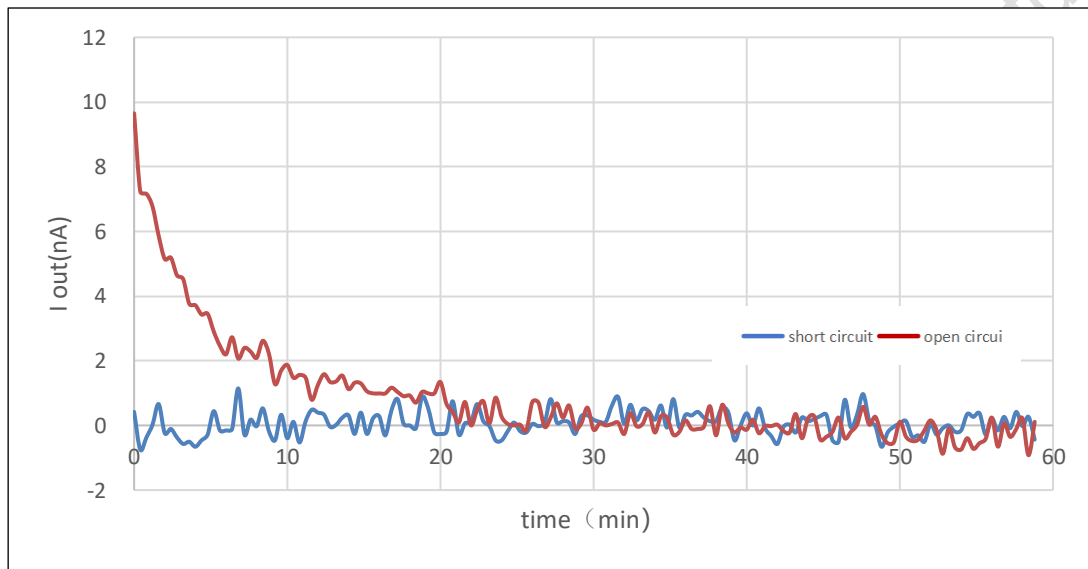


Figure 8 Influence of storage

1.8.7 Normal operation test

Figure 9 shows the result of the “Normal Operation Test” required by UL 2034 where the sensor is exposed to 600 ppm of CO for 12 hours at 20 °C/40%RH. The chart shows the CO sensitivity before, during and after the Normal Operation Test, which demonstrates that FC-CO-5000 is not influenced by long exposure to high concentration of CO.

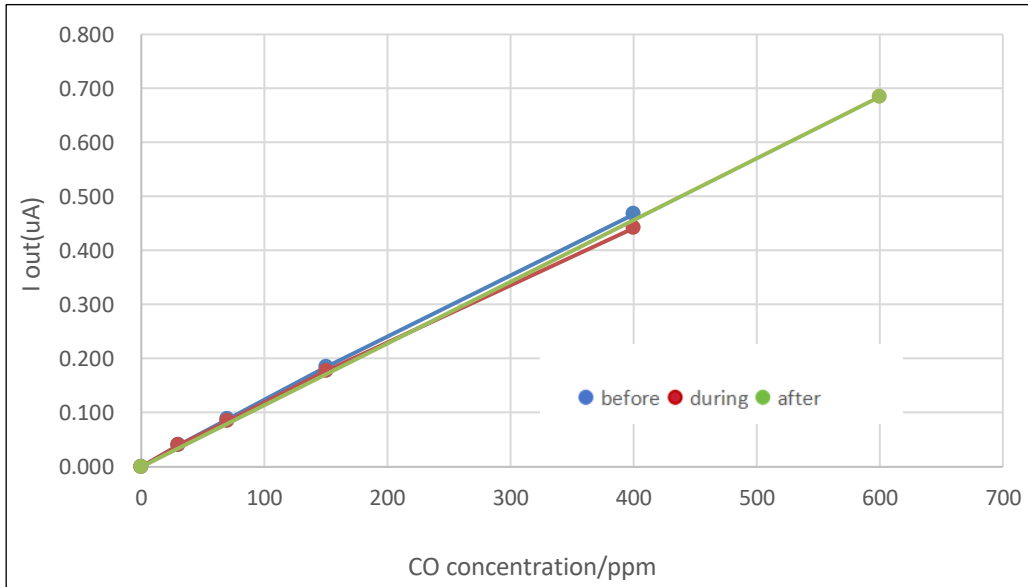


Figure 9 Normal operation test

1.9 Reliability test

1.9.1 Interference test

1.9.1.1 Cross sensitivity to interference gas

Table 5 lists the sensor's response to different interference gas at certain concentration and the exposure time is 5 minutes.

S/N	Interference gas	concentration(ppm)	CO output(ppm)
1	H ₂	1000	<400
2	CH ₄	1000	<10
3	C ₂ H ₅ OH	1000	<10
4	HMDS	1000	<20
5	Toluene	1000	0
6	Isopropanol	1000	<10
7	Freon R22	1000	<10
8	Acetone AD-1	1000	0
9	Trichloroethane	1000	0
10	NH ₃	200	0
11	C ₂ H ₄	200	<30
12	Ethyl acetate	200	0
13	C ₂ H ₂	200	<300
14	HCHO	200	<10

Table 5 Interference gas test

Note: Data in table 7 is typical response of a sensor to the interference gas and can not be used directly for compensation of cross sensitivity. The exposure time in this test is 5 min, the sensor's response varies with exposure time.

1.9.1.2 Durability test

Figure 10 shows the results of the durability test of the sensor against various interference gases as specified by UL 2034. The sensor was tested in 30 ppm CO, followed by the interference gases listed in figure 10, and 30 ppm CO as the last one. For every interference gas test the sensor was exposed to the certain gas at certain concentration for 2 hours and then 1 hour in fresh air. From figure 10 it can be seen that the sensor generates negligible response to the interference gases. Figure 11 shows the sensitivity test result of the sensor before and after the durability test which demonstrates that the sensor is not affected by the durability test.

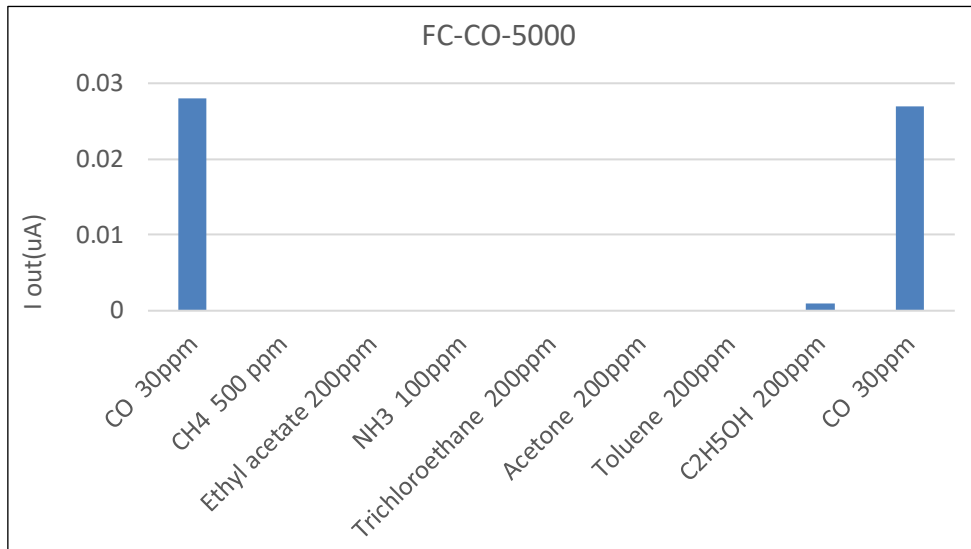


Figure 10 Interference gas test

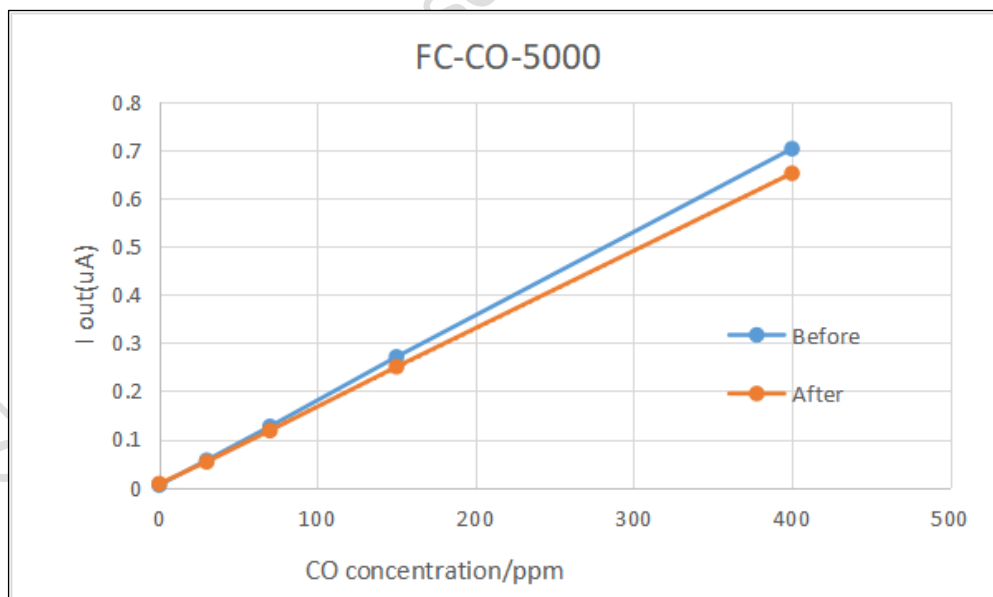


Figure 11 Effect of durability test on sensitivity

1.9.2 Corrosion test

Figure 12 shows the sensitivity of the sensor before and after the corrosion test. The sensor is exposed to 1 ppm H₂S for 4 weeks to test the anti-corrosion performance. After 4 weeks exposure there's no change on the enclosure of the sensor and figure 12 shows that the sensitivity is not

affected by H₂S, either.

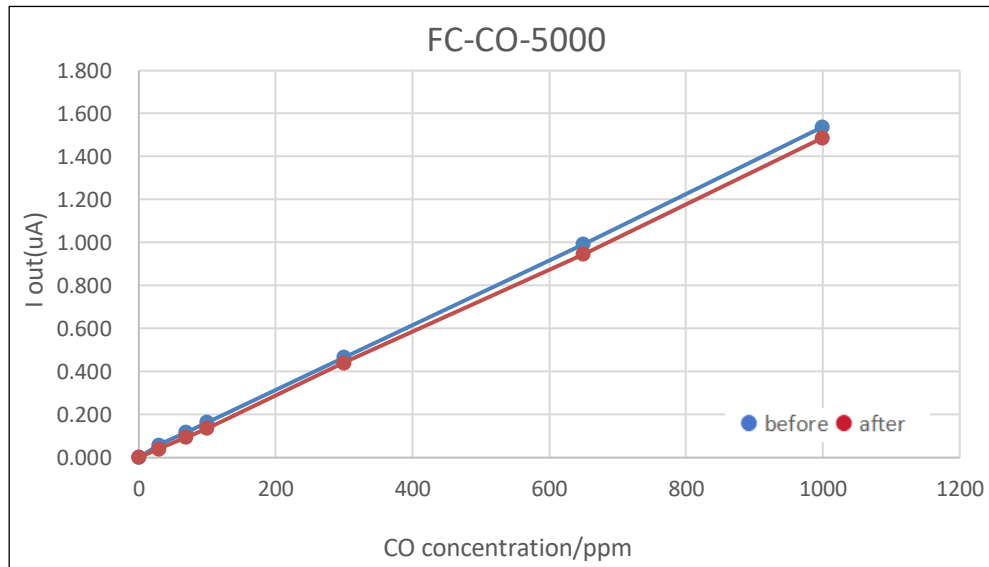


Figure 12 Corrosion test

1.9.3 Long-term stability test

Figure 13 & 14 show the long-term stability data for FC-CO-5000. The samples were short-circuited stored in the kitchen and tested from time to time. The Y-axis in figure 13 shows the output current of the sensor in normal air while the Y-axis in figure 14 shows the output current of the sensor in 400 ppm CO. These charts demonstrate that the sensor is very stable during 1500 days.

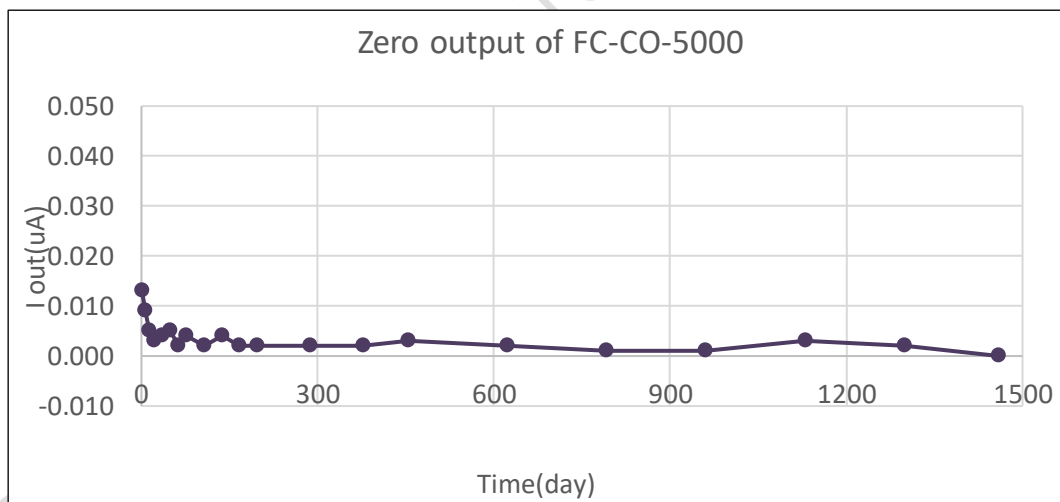


Figure 13 Zero output

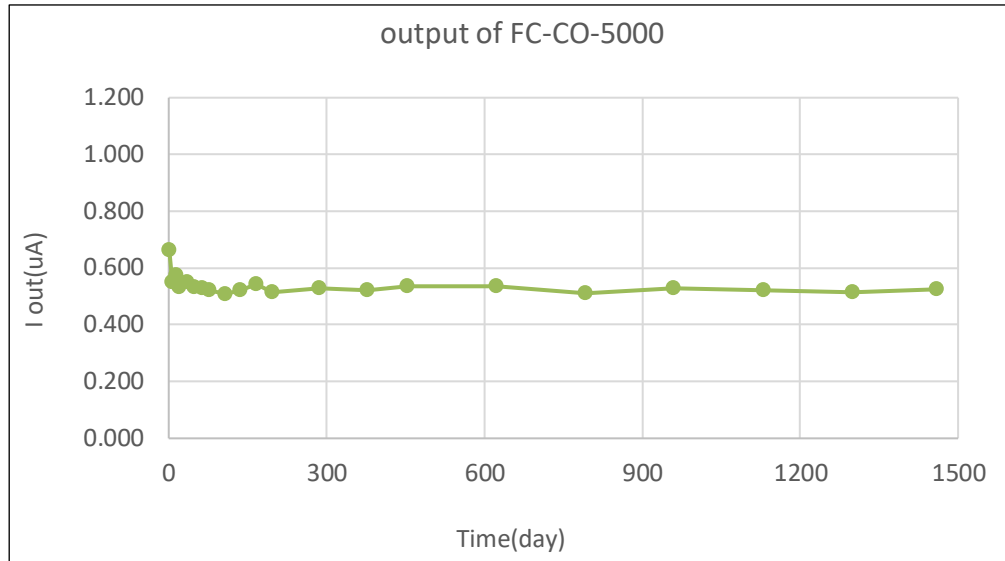


Figure 14 Output in 400 ppm CO

1.9.4 False alarm test

Figure 15 shows the sensitivity of the sensor before and after the false alarm test specified by UL 2034. The tested samples were continually exposed to 30 ppm CO for 30 days during the period the sensor didn't give alarm. The sensitivity before and after the test shows in figure 15 demonstrates that the sensitivity is negligibly affected by the long term exposure to 30 ppm CO gas.

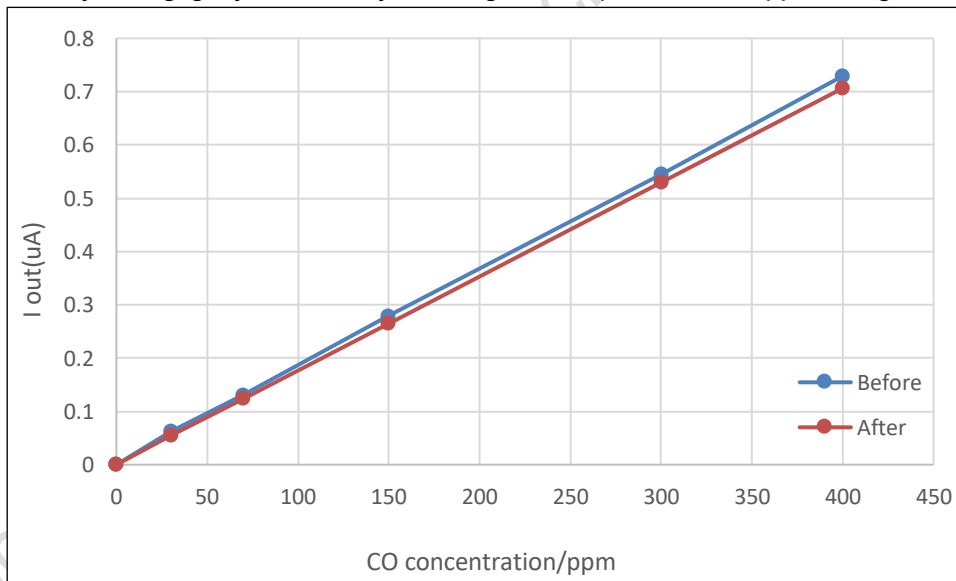


Figure 15 False alarm test

1.10 Environmental test

1.10.1 Temperature dependency

Figure 16 shows the influence of temperature on sensor output performance when the humidity is constant at 50%RH. During this test, the samples are placed in the testing system the humidity in which is constant at 50% and record the output of the sensor to 500 ppm CO once every 5°C from -40 to 70°C.

Note: The compensation coefficient is the average data of 1000 sensors and the exact coefficient

varies slightly from sensor to sensor. If precise compensation is necessary please test the influence factor separately.

I: The output current in 500 ppm CO at different temperature & 50%RH;

I: The output current in 500 ppm CO at 25°C & 50%RH;

t (°C)	-40	-35	-30	-25	-20	-15	-10	-5
I/I ₀	21%	28%	34%	38%	43%	51%	59%	65%
t (°C)	0	5	10	15	20	25	30	35
I/I ₀	71%	78%	83%	88%	95%	100%	106%	111%
T (°C)	40	45	50	55	60	65	70	
I/I ₀	114%	116%	119%	120%	120%	121%	121%	

Table 6 Compensation coefficient

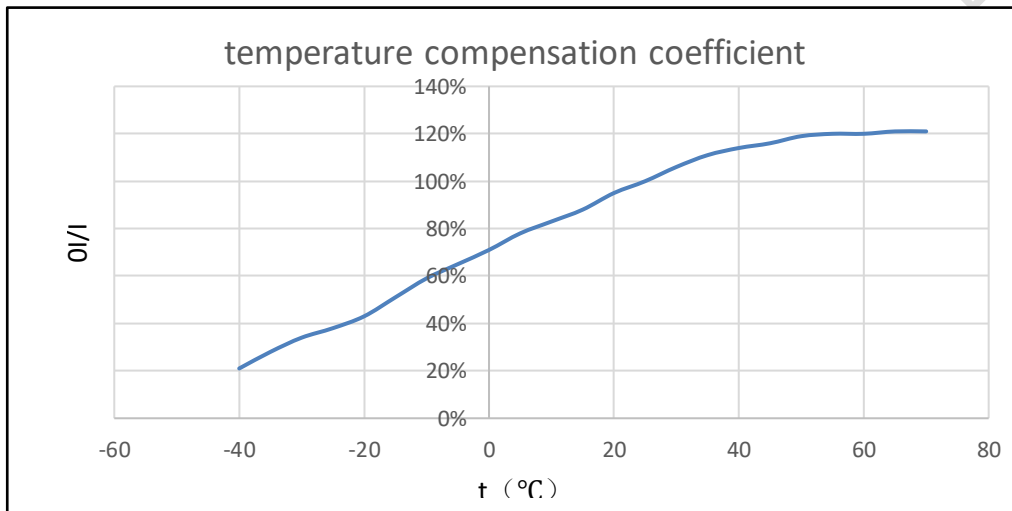


Figure 16 Temperature influence test

1.10.2 Humidity dependency

Figure 17 demonstrates the humidity dependency of FC-CO-5000 under constant temperatures of 20°C and 50°C. During this test, the samples are placed in the testing system the temperature in which is constant at 20°C and 50°C separately and record the output of the sensor to 500 ppm CO under different humidity as shown in table 7. The data demonstrate that humidity dependency is negligible as temperature varies.

temperature/°C	Humidity	temperature/°C	Humidity
20	10%RH	50	10%RH
	50%RH		50%RH
	95%RH		95%RH

Table 7 Experimental factors

I: the output current in 500 ppm CO at different temperature & humidity;

I₀: the output current in 500 ppm CO at 20°C & 50%RH;

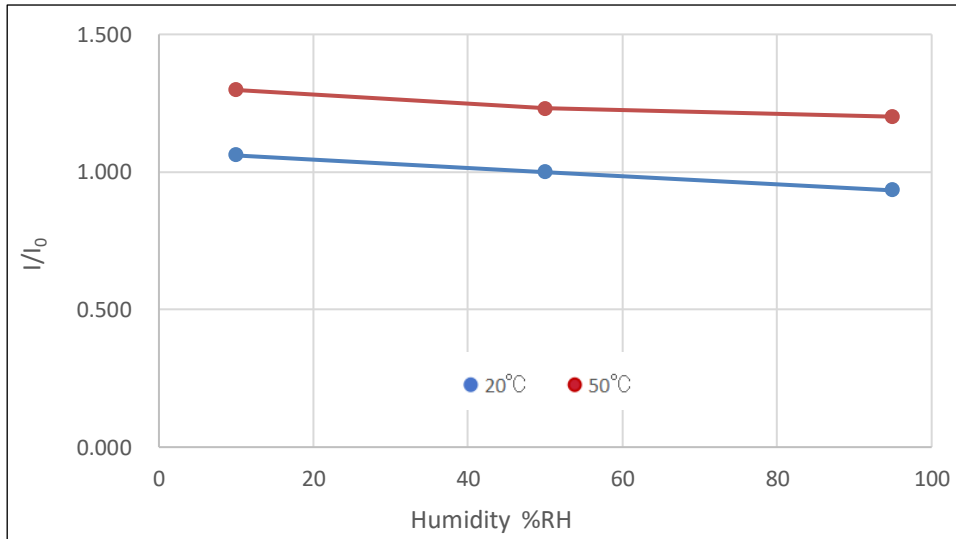


Figure 17 Humidity influence

The results show that the humidity has little influence on the sensor performance.

1.10.3 Variable ambient temperature test

Test in this chapter is taken to verify that high/low temperature will not damage the sensor. The “variable Ambient Temperature Test” is carried out as specified in UL 2034.

1.10.3.1 Operation in high and low temperature test

The test samples are exposed to the environment as specified in table 8 and exposure for at least 3 hours in a certain environment. The output of the samples to 30, 70, 150, 400 ppm CO concentration recorded and is shown in Figure 18 from which we can see that the sensor’s performance will not be influenced by humidity.

Temperature/°C	Humidity/%RH
-10	50
0	15
20	50
35	50
49	40

Table 8 Environment factors

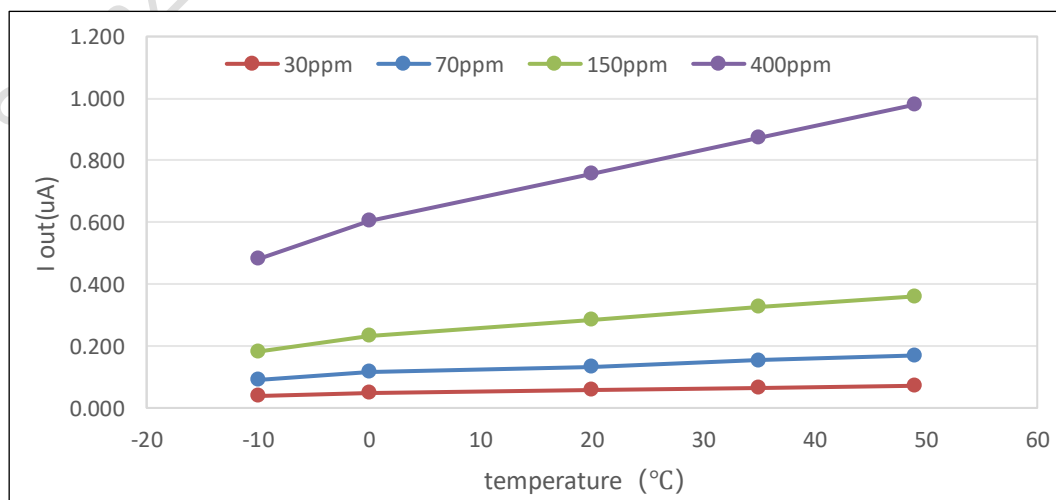


Figure 18 Operation in high and low temperature test

1.10.3.2 Effect of shipping and storage

Figure 19 shows the effect of shipping and storage according to the requirements of UL2034. During this test, the samples with sensitivity performance tested before the test were subjected to 70 °C for 24 hours followed by one hour at room temperature and then 3 hours at -40 °C. After the exposure to extreme environment the samples were stabilized at room temperature for 3 hours, then the sensitivity performance was checked once more. The comparison of the sensitivity before and after the test is shown in Figure 19 which demonstrates the sensor can meet the requirement of UL 2034.

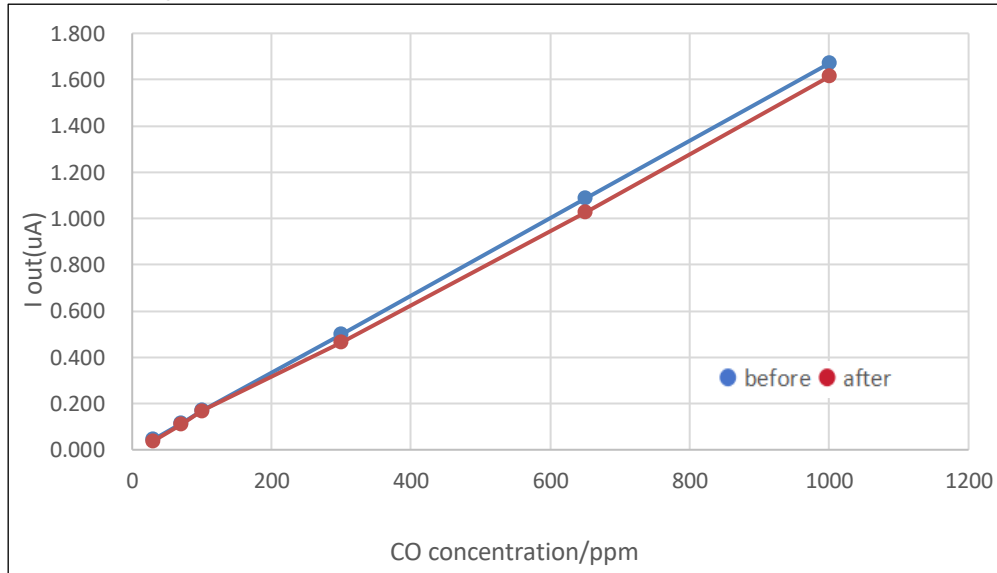


Figure 19 Effect of shipping and storage

1.10.3.3 Temperature cycle test

As required by UL2034--stability Test, the samples were exposed to ten cycles (<1hour and >15minutes) of temperature from 0 °C & 100%RH to 49 °C & 40%RH. Figure 20 shows CO sensitivity performance before and after the cycle test, which demonstrates that the influence of the extreme conditions on FC-CO-5000 is negligible.

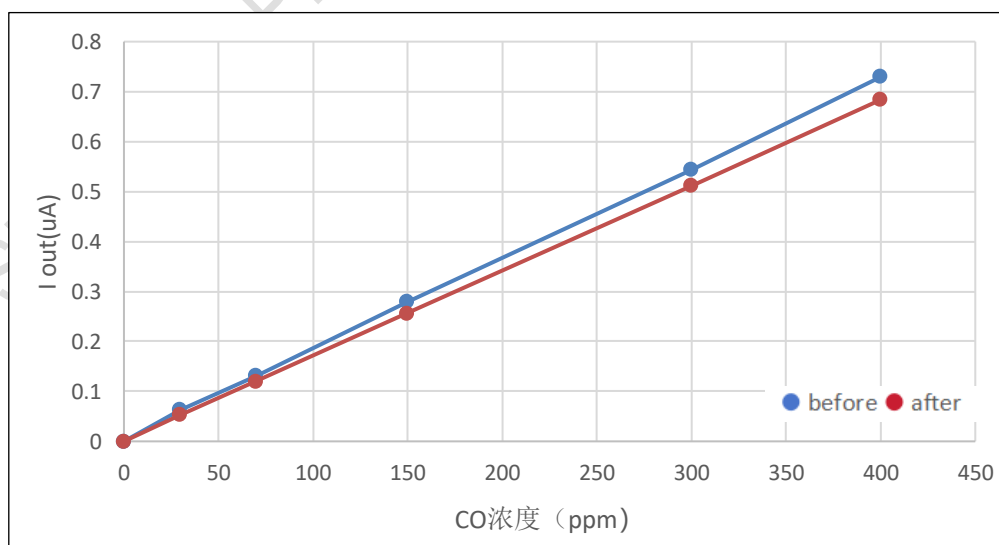


Figure 20 Temperature cycle test

2.CIRCUIT DESIGN

2.1 Circuit diagram

FC-CO-5000, based on the proven fuel cell technology, generates a current signal which is proportional to the concentration of CO. To use the sensor for CO detection, the output current is usually converted to voltage for measurement. Figure 21 is an example circuit. In this circuit the output voltage(V_{out}) is measured to get the exact CO concentration. If the circuit is powered by 3.3V, the V_{out} without sensor connected should be 0.148V(V_{ref}), V_{out} increases with the CO concentration. By measuring the V_{out} increase can CO concentration be calculated.

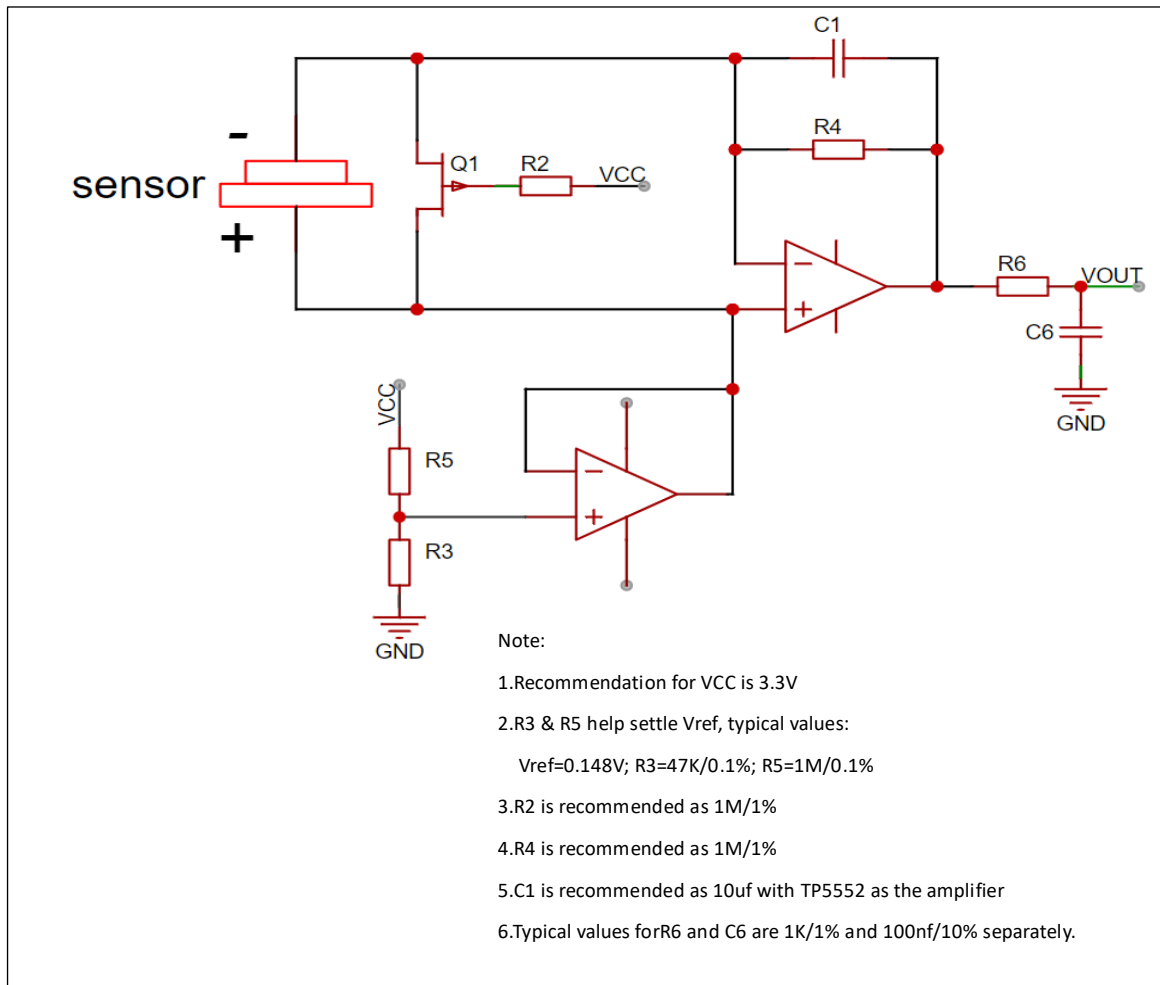


Figure 21 Sample circuit diagram

2.2 Setting reference voltage (V_{ref})

There is a certain ratio that the V_{out} in 0 ppm CO would be less than zero and the circuit able to detect negative voltage is very complicated. For easier detection the V_{out} without sensor is set a little higher than 0 which is 0.148V in the example circuit. If V_{ref} is set too high the resolution will be decreased while too low V_{ref} is set there's the possibility that the V_{out} would be less than 0 in fresh air.

2.3 Anti-polarization circuit

For sensors based on fuel cell technology, an electrical charge will accumulate at electrodes when the sensor is in open-circuited condition(working and counter electrode are not connected) which is

called polarization. Once the two electrodes are connected the accumulated charge will be discharged which is called anti-polarization. The longer the sensor is open-circuited the more time is needed for anti-polarization. Since the sensors are stored and shipped in open-circuited condition, when it is powered on a long time will be needed for the Vout to settle down just as shown in Fig 8. An anti-polarization circuit is necessary for quick stabilization of Vout. As shown in Fig 21, a JFET is recommend for this purpose.

2.4 Current/voltage conversion circuit

The sensor current output is converted into voltage as shown in Figure21. Vout is expressed by the following formula:

$$V_{out} = (S \cdot C + I_0) / 1000000000 \cdot R + V_{ref}$$

Vout : output voltage in V

S : sensor sensitivity in nA/ppm

C : CO concentration in ppm

I₀ : output current in 0 ppm CO in nA

R : feedback resistor in Ohm

Vref : offset voltage of the circuit in V, Vref is 0.148V for a circuit powered by 3.3V

Vref can be calculated as follows for circuit with other working power

$$V_{ref} = V_{CC2} \cdot (R_3 / (R_5 + R_3))$$

2.5 Amplification factor

The output current should be amplified before converting to voltage to get sufficient resolution since the output current is in the range of nA/ppm. The exact amplification gain is determined by VCC, target CO range, working temperature range, sensitivity of the sensor, target accuracy, MCU selected and so on. The exact amplification gain can be calculated as follows:

$$R = (V_{max} - V_{ref}) / (S_{max} \times T \times C_{max})$$

where : Vmax : Voltage at Cmax

Vref: Offset voltage of the circuit in V, which is 0.148V for a circuit powered by 3.3V

Smax: The biggest possible sensitivity(nA/ppm) which is 1.5 for this sensor

T: Temperature coefficient as shown in table 7

Cmax: Upper detection limit in ppm

The following is an example of how to decide amplification gain. If the upper detection limit is 1000 ppm, the amplification gain is:

$$R = (3.3 - 0.148) / (1.5 / 1000000000 \cdot 1.31 \cdot 1000) = 1.6M$$

2.6 Selection of amplifier

Since the output current is small and the amplification gain is large, the sensor is easily influenced by external electrical noise. Amplifier with Vos at the level of uV such as TP5552 from 3peak is recommended, if Vos is higher than 100uV the external electrical noise will be amplified at the same time which leads to low signal/noise ratio, poor accuracy and false alarm.

2.7 Electrical noise prevention

As explained in 2.6 the external electrical noise affects the detection accuracy, it is necessary to take measurements to minimize the electrical noise. Voltage follower circuit design and increasing the value of C1 are two effective ways. The example circuit in Figure 21 adopts voltage follower design.

For a certain amplification gain increasing the value of C1 can reduce the electrical noise significantly at a risk of lowering response speed. The selection of amplifier may influence the response speed, too. Please fix the details of circuit by testing. For TP5552, R4 in the range from 100K to 1M&C1 in the range from 10nf to 10uf the response time is almost the same and 10uf is recommended for minimizing of the electrical noise.

2.8 Anti-undershoot

When CO sensors based on fuel cell technology are exposed to high CO concentration for a long time, the output voltage in fresh air will be lower than the initial position which is called undershoot. The reason of anti-shoot is that it is a long time for the counter electrode to consume CO reaching there in high concentration which leads to a long recovery time. Chapter 5.3.6 in EN 50291 requires the sensor to settle down after one hour in fresh air after 15 minutes in 5000 ppm CO. The electrodes and structure in FC-CO-5000 are designed specially to eliminate anti-undershoot without adjust of circuit. So detectors with FC-CO-5000 integrated can easily pass the 5000 ppm test specified in EN 50291 without modification of circuit.

2.9 Self-diagnosis

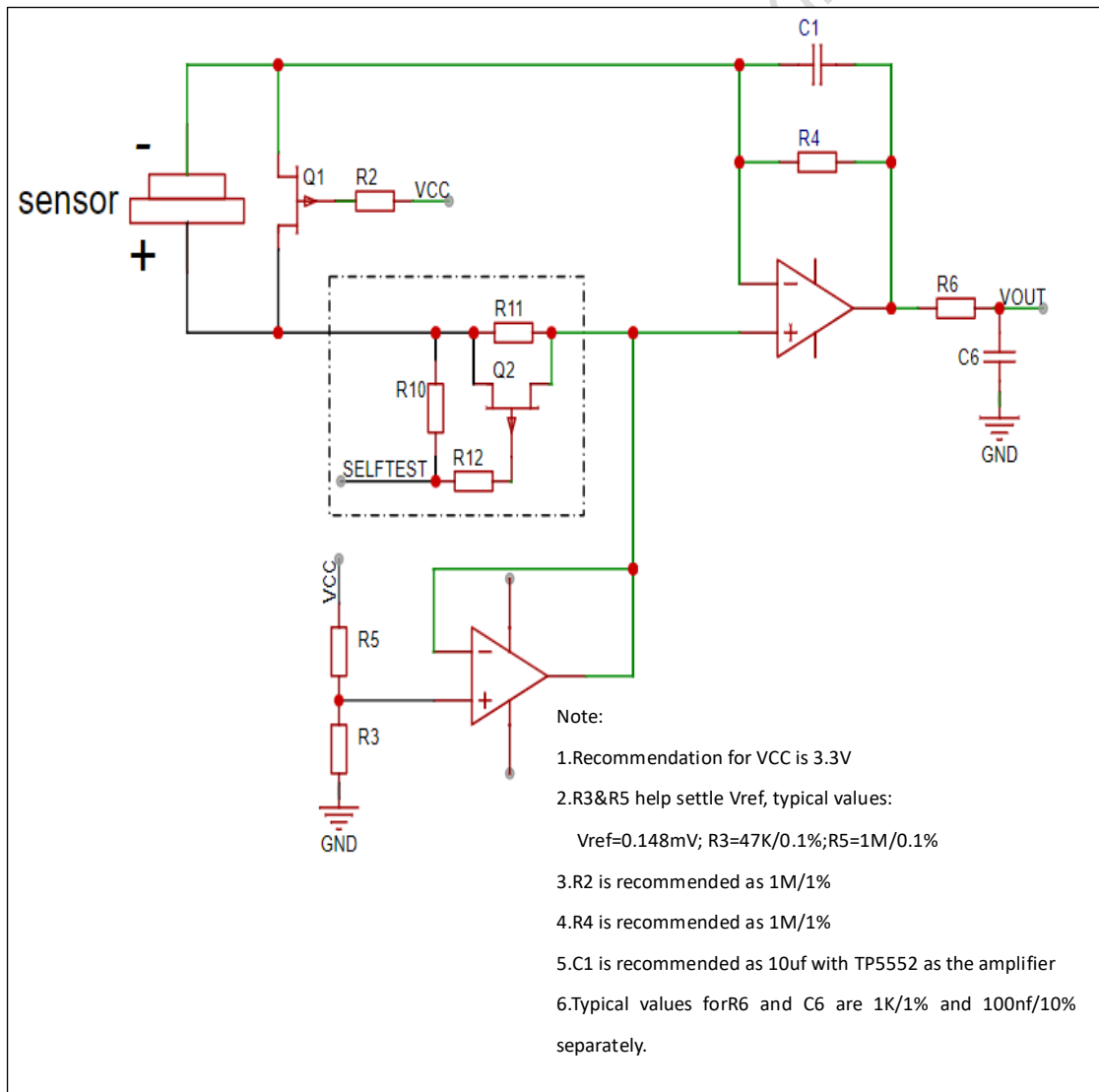


Figure 22 Example circuit diagram

UL2034 requires that the malfunction of a sensor can be detected timely by self-diagnosis circuit which will charge the sensor with an external power supply once the sensor is disconnected from the amplifier circuit. Malfunction of a sensor such as wire breakage or short circuit can be detected by analyzing the following discharge pattern. But this method can not find the drift of sensitivity or loss of sensitivity because of lack of gas diffusion into the sensor.

Basic steps of self-diagnosis:

- 1) Before self-diagnosis the self-test port is set at GND by MCU
- 2) Start the JFET at Q1 to disconnect the sensor temporarily from the circuit
- 3) Self-test port is set to 3.3V for a certain period (less than 5 seconds is recommended) to charge the sensor
- 4) At the end of step 3 self-test port is set again at GND and the sensor is connected back to the circuit to discharge the electrical charge accumulated on the sensor

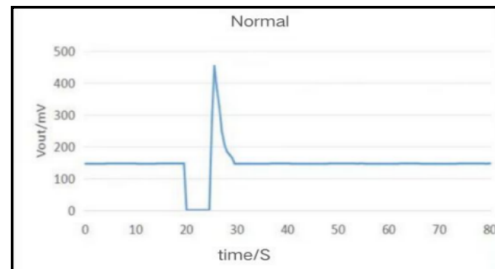
By recording the output data after the sensor is connected back to the circuit can we distinguish sensors with malfunction from normal ones

Self-diagnosis test result :

The sample is a sensor carried out the test at room temperature with amplification gain set at 430K.

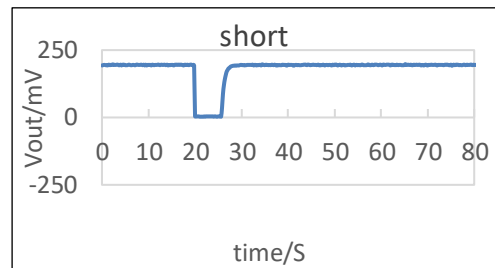
Normal sensor :

Vout drops to GND followed by rising up to nearly 1V and then returns to its original level after the electrical charge on the sensor is discharged.



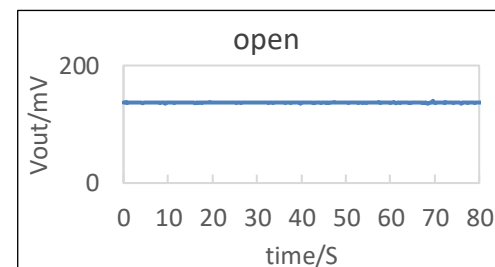
Short sensors :

Vout drops to GND and then returns to its original level



Open sensors :

Vout ≈ Vref



Notes :

- Do not perform the self-diagnosis test in the presence of any gas that can be detected by the sensor

- It is recommended that the charging time not to exceed 10 seconds, about 5 seconds will be better
- since the judgement level depends on the circuit design, please set it according to the actual circuit.
- Recovery time must be taken into consideration while set the interval among self-diagnosis tests. If a second test is started before Vout returns to its initial level (Vref), the sensor may be damaged.

2.10 Compensation of Long Term Drift

Electrochemical sensors' sensitivity tends to decrease slightly over time due to loss of active points on catalysts in real detection circumstance. It is recommended that compensation of the sensitivity loss at a pace of 3% per year should be taken to achieve a more accurate result.

3.CALIBRATION OF THE SENSOR

Calibration from sensor to sensor is strongly recommended to get the accurate detection. Calibration can be finished by the following two methods:

3.1 Calibration with CO gas

- 1)Subject the sensors in the calibration system
- 2)Recording the output current of the sensors in fresh air, named as I_0 in nA. Remember to get the stable output as I_0 and the time needed depends on anti-polarization
- 3)Inject CO gas at a certain concentration
- 4)After stabilizing sensor output, measure sensor output, named as I_1 in nA
- 5)Calculate the sensitivity of the sensor in nA/ppm

$$S = (I_1 - I_0)/C,$$

In the above formula, C refers to the CO concentration in ppm

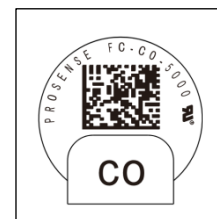
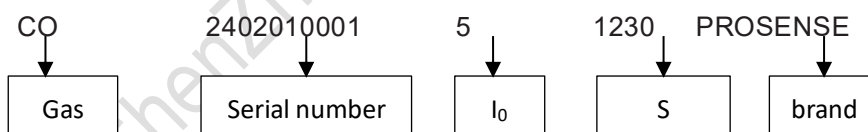
Note: Temperature should be kept constant during the calibration

3.2 Calibration with sensor barcode

Every sensor is calibrated in ProSense's factory before shipping and the information is stored in the barcode on the sensor. With this method, the cost and procedure will be greatly decreased, while it is highly recommended to calibrate the Carbon Monoxide Alarms or detector with CO gas.

3.2.1 Rules for barcode on sensor :

3.2.1.1 QR code :



Group 1: CO, targeted gas;

Group 2: 2402010001,ten numbers,serial number of the sensor;

Group 3: 5, one byte for symbol (be deleted if it is positive), one or two numbers, output current in 0 PPM CO in nA. To get the exact number the data in the barcode should be divided by 10, for the above example, I_0 is:5/10=0.5nA.

Group 4: 1230,three to four numbers, sensitivity of the sensor in nA /ppm, To get the exact number the data in the barcode should be divided by 1000, for the above example,


$$S \text{ is: } 1230/1000000=1.23\text{nA/ppm}$$

Group 5: PROSENSE, brand

3.2.1.2 MARKINGS :

PROSENSE: The tradename of the sensor which be marked on the sensor;

FC-CO-5000: The product model of the sensor which be marked on the sensor;

: The UL Recognized Component Mark which be marked on the sensor.

3.2.2 Input calibration information into microprocessor :

1)Manually input the user readable value printed on the sensor body.

2)Using a barcode reader to read the barcode and input directly to the microprocessor.

3.3 Temperature compensation

The sensor performance can be compensated with information in table 6 & figure 16.

3.4 Calculation of CO concentration

CO concentration can be calculated according to the following equation :

$$C = ((V_{out} - V_{ref}) * 1000000000 / R - I_0) / S_1$$

C : CO concentration in ppm

V_{out} : output voltage in V

V_{ref} : offset voltage of the circuit in V

R : amplification gain in Ohm

I₀: output in fresh air in nA

S₁ : sensitivity after temperature compensation in nA/ppm

4.STORAGE

Prior to usage, sensors should be stored in ProSense's original package under conditions of 5~30°C & 30~80%RH. Dew condensation shall be avoided.

5.SOLDERING ON PCBA

Please pay attention to the following points for soldering :

- 1) Flux should be sufficiently dried before sensors are soldered onto a PCBA to avoid any contamination of the sensor by flux vapor;
- 2) A certain period is needed for the sensor to settle down after soldering onto the PCBA because of the polarization caused by the shipment under open circuit;
- 3) Make sure that there is more than 1.5mm gap between the sensor and the PCBA to ensure that target gas can reach the sensor freely, please check figure23 for details.

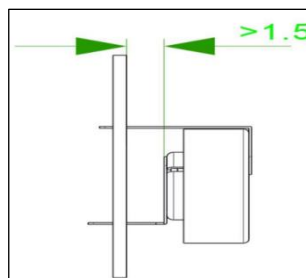


Figure 23 Example of soldering

- 4)Recommended conditions for manual soldering:

Temperature of soldering copper head: 360℃

Period: < 5 sec.

6. Gas test

Gas mixture of CO and O₂ should be used instead of mixture of CO and N₂ since O₂ is necessary for the detection. If N₂ is used instead of O₂ in the mixture the sensor will become invalid quickly.

7. Notes

- Avoid exposure to high concentration organic solvents/vapor and corrosive gases;
- Avoid storage or application in environment with high concentration of dust, oil vapor and sufficient oxygen is necessary for proper operation;
- Sensor characteristics may be irreversibly changed by exposure to high concentrations of basic gases such as ammonia. Avoid long term exposure to or use of packing materials that may generate basic gases;
- Vibration and shock may cause an open or short circuit inside the sensor;
- Please follow the working environment when using the sensor, application of the sensor in circumstances beyond those allowed in the datasheet will damage the sensor;
- Sensor characteristics may be changed due to soaking or splashing the sensor with water;
- Dew and ice should be avoided both inside and outside the sensor to ensure the gas access to the sensor;
- Manual soldering is recommended to avoid the influence of flux;
- The charge voltage should not be too large and the charge time should be less than 5 seconds during the self diagnosis to avoid damage of the sensor. Self-diagnosis should be carried out in 0 ppm CO;
- It is recommended that there should be at least 60 seconds interval between self-diagnosis and normal detection;
- The calibration information is stored in the barcode but calibration with CO is recommended for accuracy detection;
- Any disassemble of the sensor is forbidden which will make the guarantee invalid.



ShenZhen ProSense Technologies Co. Ltd.

Add: Floor 1, buliding4, LianJian S&T Park, DaLang, LongHua district, ShenZhen,China

Tel: +86-755-36690079

Mobile: +86 135 1091 6915

Email: sales@szprosense.com

Website: <http://www.szprosense.com>