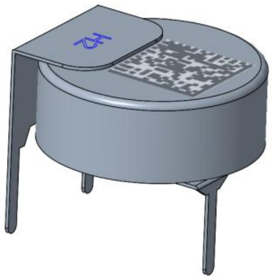
Technical Information of FC-H_2-XXXX



ShenZhen Prosense Technologies Co., Ltd.

Contents

NOTES：

This datasheet is for the serial products of FC-H2-XXXX including FC-H2-1000、FC-H2-5000、FC-H2-20000 which are different in detection range & sensitivity but are totally the same in detection principle, typical circuit design and other technical details. The details in this datasheet is based on FC-H2-5000, please modify the Resistor accordingly if you choose other models. UL2034 has high requirements for gas sensor performance. All tests mentioned in UL2034 are tested accordingly with H2 to check the stability of the sensor even if UL2034 is mainly about CO sensor.

1.General Information

1.1Product Introduction

FC-H_2-XXXX H_2 sensor with long service life works on the proven fuel cell technology. Once H_2 arrives at the working electrode(anode) it is oxidized instantaneously to generate an electrical signal which is proportional to the H_2 concentration. By calibrating the sensor with a known concentration of H_2, the output current of the sensor can be used to quantitatively determine H_2 concentration. FC-H_2-XXXX is famous for its long service life, high anti-interference ability and the sensor has a compact size which is the ideal choice for size oriented applications such as portable H_2 detectors, small residential H_2 detectors, and multi-sensor fire detectors. The calibration information is stored in barcode printed on the sensor, enabling users to skip the costly gas calibration process and allowing for individual sensor tracking. Since there is no consumption components in the sensor, FC-H_2-XXXX possesses excellent long service life and ensures maintenance-free operation.

1.2 Features

*0 power consumption *Fast response *High accuracy *Anti-interference

*Anti-poisoning *Wide temperature range *Long service life

*Good stability and repeatability

*Meet requirements of GB15322, UL2034 and EN50291

1.3 Applications

*Energy storage system; *Industrial safety; *H_2 alarm

1.4 Basic measurement circuit

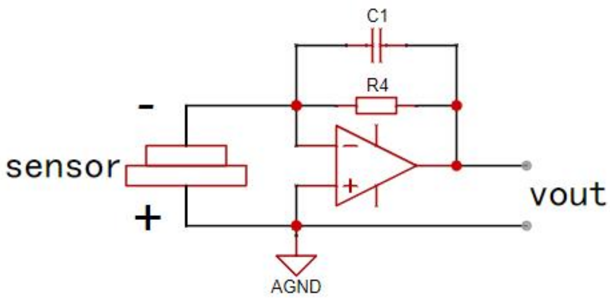


Figure 1 Basic measurement circuit

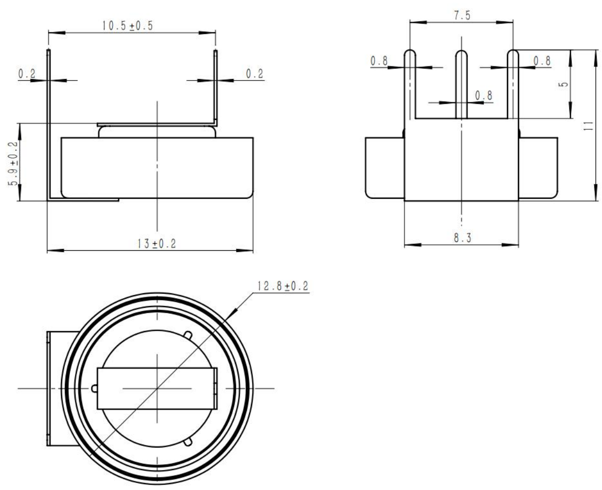
Figure 1 shows the basic circuit diagram of FC-H_2-XXXX. The sensor generates a small current which is converted into sensor output voltage (Vout) by an op-amp/resistor (R_4) combination. Vout is proportional to gas concentration. We do recommend application of JFET to prevent polarization of the sensor when circuit voltage is off. Prosense recommends the following electric parts as shown in table 1.

Table1 Recommended electric parts

	FC-H_2-1000	FC-H_2-5000	FC-H_2-20000
R_4	1Mohm	300K	200K
C_1	10uF	10uF	10uF

IC：TP5552 from 3PEAK（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		
Principle	Micro fuel cell		
Detection range	0-1000	0-5000	0-20000
Overload	2000	10000	40000
Sensitivity	0.4±0.2	0.4±0.2	0.2±0.1
Response time	＜60seconds		
Accuracy（25±3℃）	±3%F.S.		
Repeatability	3%		
Output	linearity		
Operating temperature	-40℃～70℃		
Operating pressure	1atm±10％		
Operating humidity	10％－90％RH（non-condensation）		
Lifetime	10 years		
Warranty	12 months		
Weight	3g		
Reading in 1000ppm Alcohol	＜10ppm		

1.7 Mechanical strength

Sensor samples were tested according to the requirements specified by UL2034 and the results demonstrate that the sensors' mechanical strength is sufficient to meet the 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 2 shows the sensitivity of 15 sensors. I_0 refers to the output current in clean air; ΔI refers to the response current to 500ppm H_2. S refers to the sensitivity of the sensor; t_{90}

refers to the response time.

Table2 Typical specification of sensors

S/N	I_0/nA	I_1/nA	ΔI/nA	S(nA/ppm)	T_{90}/S
E1	1	356	355	0. 355	45
E2	1	606	605	0. 605	53
E3	1	410	409	0. 409	49
E4	1	368	367	0. 367	49
E5	2	302	300	0. 3	49
E6	3	496	493	0. 493	47
E7	3	588	585	0. 585	48
E8	1	244	243	0. 243	48
E9	2	590	588	0. 588	49
E10	2	284	282	0. 282	48
E11	3	534	531	0. 531	47
E12	3	556	553	0. 553	49
E13	5	590	585	0. 585	49
E14	2	472	470	0. 470	48
E15	3	592	589	0. 589	47

1.8.2 Response-recovery time

Figure 2 shows the gas response to 500ppm H_2 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 90 seconds. This data demonstrate that FC-H_2-XXXX can meet the requirements in UL2034.

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

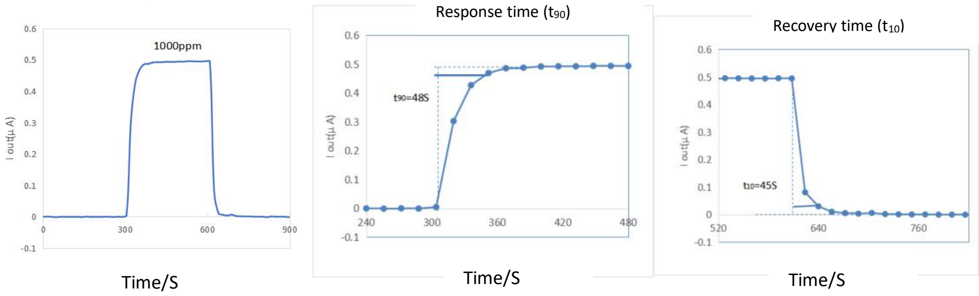


Figure 2 Response-recovery time

1.8.3 Linearity

Figure 3-4 shows the sensor's output to different H_2 concentration. The Y-axis shows output current (Iout/μA). The output current is linear to H_2 concentration with a deviation of less than ±5% in the range of 0~5000ppm. The exact data are shown in table 3.

Table3 Output in different H_2 concentration

Concentration /ppm	S/N					
	E1	E2	E3	E4	E5	E6
	I/u A	I/u A	I/u A	I/u A	I/u A	I/u A
0	0.001	0.000	0.002	-0.001	0.001	-0.002
100	0.051	0.048	0.049	0.046	0.042	0.045
300	0.146	0.141	0.140	0.141	0.130	0.134
700	0.334	0.324	0.321	0.326	0.302	0.309
1000	0.499	0.480	0.477	0.487	0.452	0.461
3000	1.492	1.424	1.424	1.483	1.364	1.392
5000	2.509	2.395	2.395	2.495	2.294	2.341

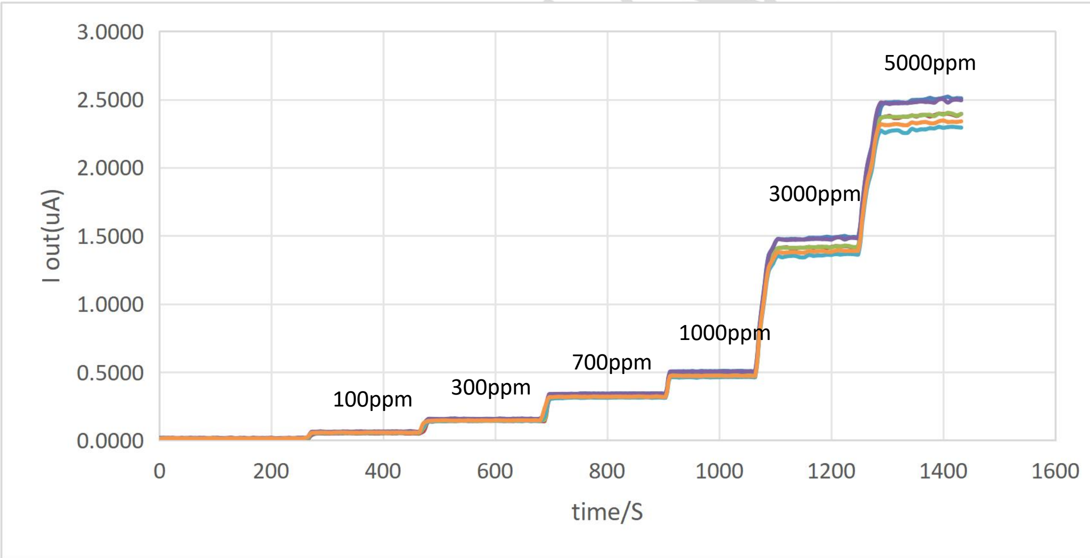


Figure 3 Response graph

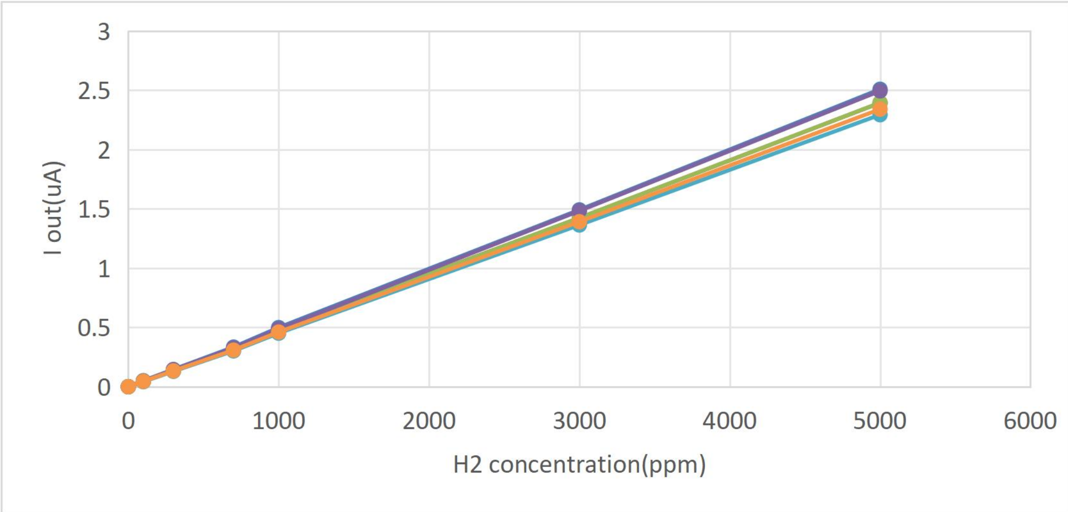


Figure 4 Linearity

1.8.4 Repeatability

Figure 5 & table 4 show the sensor response to the repeated exposure to 500ppm H_2 for 4 times at an interval of 10 minutes. The data shows extremely high reproducibility of the output signal, the deviation is less than ±5%.

Table 4 Data of repeatability test

S/N	1#	2#	3#	4#	5#
	ΔI_1/uA	ΔI_2/uA	ΔI_3/uA	ΔI_4/uA	ΔI_5/u A
E1	0.438	0.436	0.447	0.444	0.453
E2	0.408	0.407	0.413	0.411	0.415
E3	0.406	0.402	0.405	0.405	0.408
E4	0.447	0.444	0.441	0.442	0.439
E5	0.451	0.447	0.452	0.399	0.454
E6	0.496	0.493	0.496	0.494	0.495
Deviation	3%	3%	3%	4%	3%

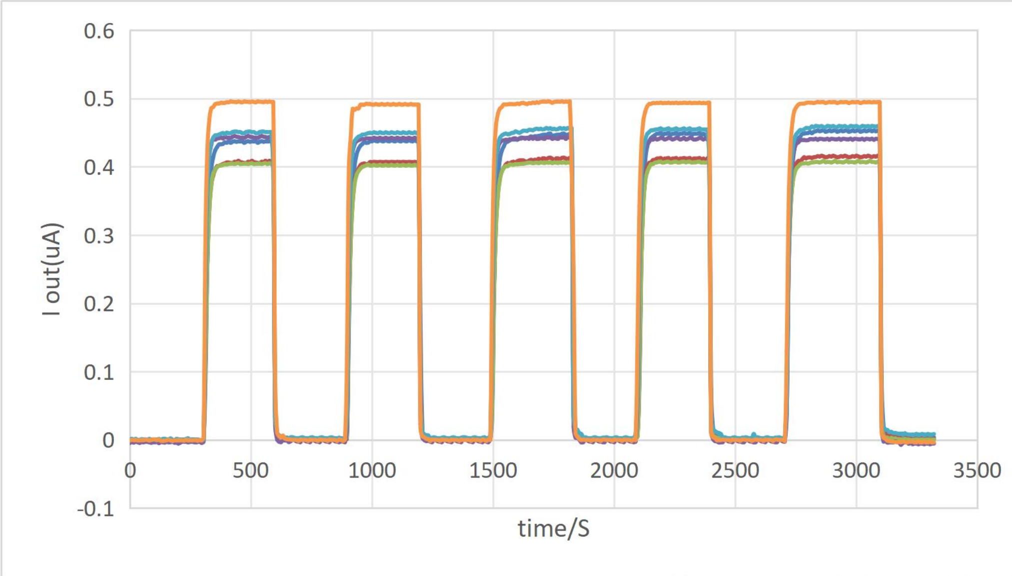


Figure 5 Repeatability in 500ppm H_2

1.8.5 Sensitivity test

The sensor was exposed to different concentration of H_2 at 20℃ & 40%RH for different time period as shown in table 6 as required by the "Sensitivity Test"in UL2034. Fig 6 shows the H_2 sensitivity of the sensor before, during and after the Sensitivity Test, which demonstrates the excellent reproducibility of FC-H_2-XXXX.

Table 5 Concentration & exposure time

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

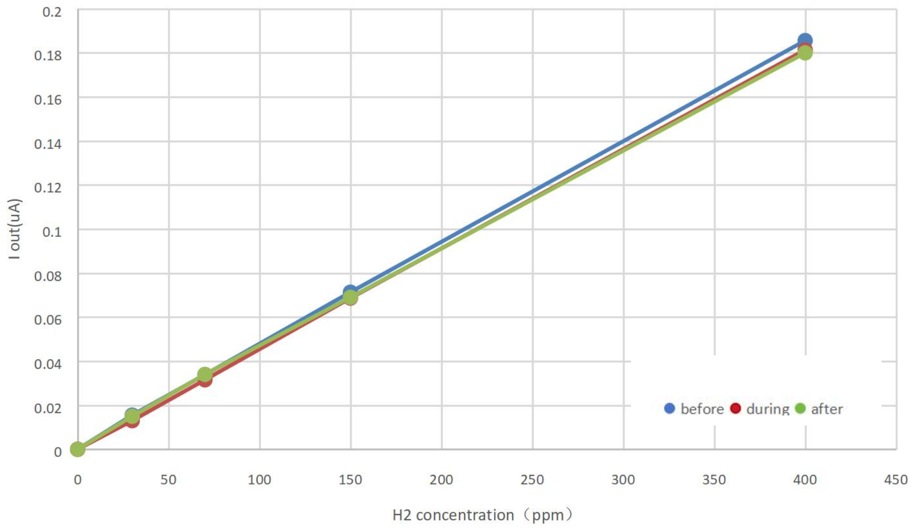


Figure 6 Sensitivity test

1.8.6 Influence of storage

Figure 7 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 7 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 electrodes. 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.

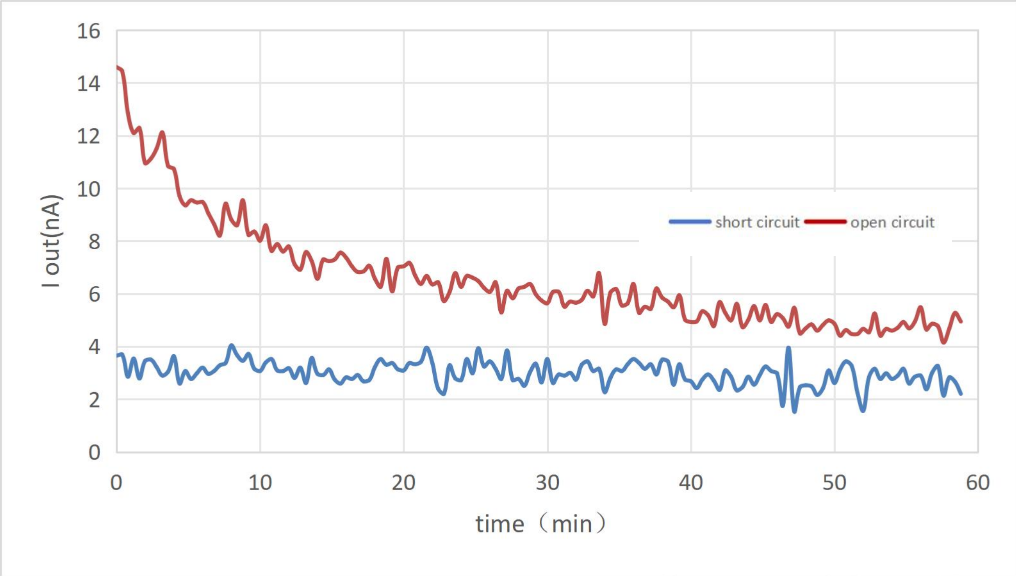


Figure7 Influence of storage

1.8.7 Normal operation test

Figure 8 shows the result of the "Normal Operation Test" required by UL2034 where the sensor is exposed to 600ppm of H_2 for 12 hours at 20℃ & 40%RH. The chart shows the H_2 sensitivity before, during and after the Normal Operation Test, which demonstrates that FC-H_2-XXXX is not influenced by long exposure to high concentration of H_2.

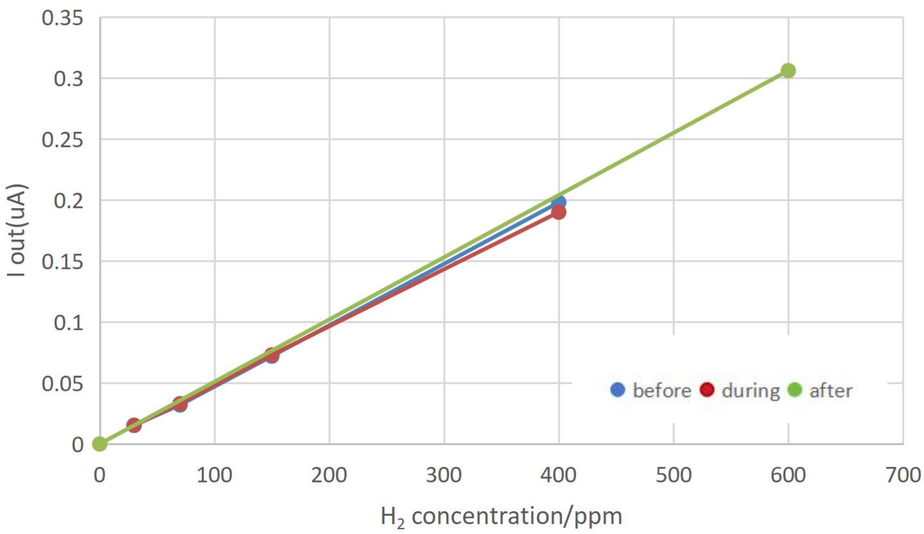


Figure8 Normal operation test

1.9 Reliability test

1.9.1 Interference test

1.9.1.1 Cross sensitivity to interference gas

Table 6 lists the sensor's response to different interference gas at certain concentration and the exposure time is 5 minutes.

Table 6 Interference gas test

S/N	Interference gas	Concentration （ppm）	H_2 output（ppm）
1	CO	1000	＜400
2	CH4	1000	0
3	C_2H_5OH	1000	＜10
4	HMDS	1000	＜10
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_2H_4	200	＜100
12	Ethyl acetate	200	0
13	C_2H_2	200	＜100
14	HCHO	200	＜30

Note： Data in table 6 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 5min, the sensor's response varies with exposure time.

1.9.1.2 Durability test

Figure 9 shows the results of the durability test of the sensor against various interference gases as specified by UL2034. The sensor was tested in 30ppm H_2, followed by the interference gases listed in figure 9, and 30ppm H_2 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 9 it can be seen that the sensor generates negligible response to the interference gases. Figure 10 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.

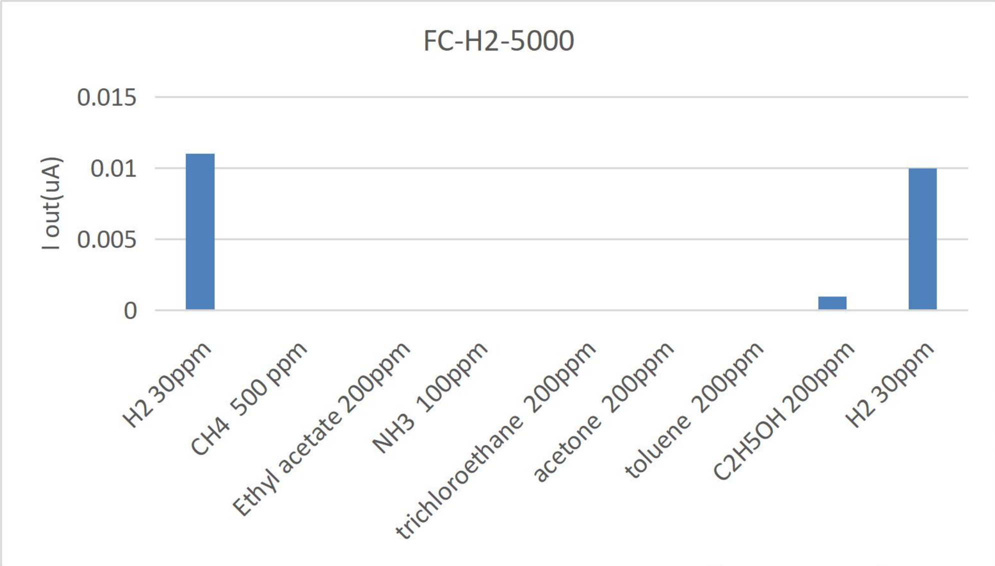


Figure 9 Interference gas test

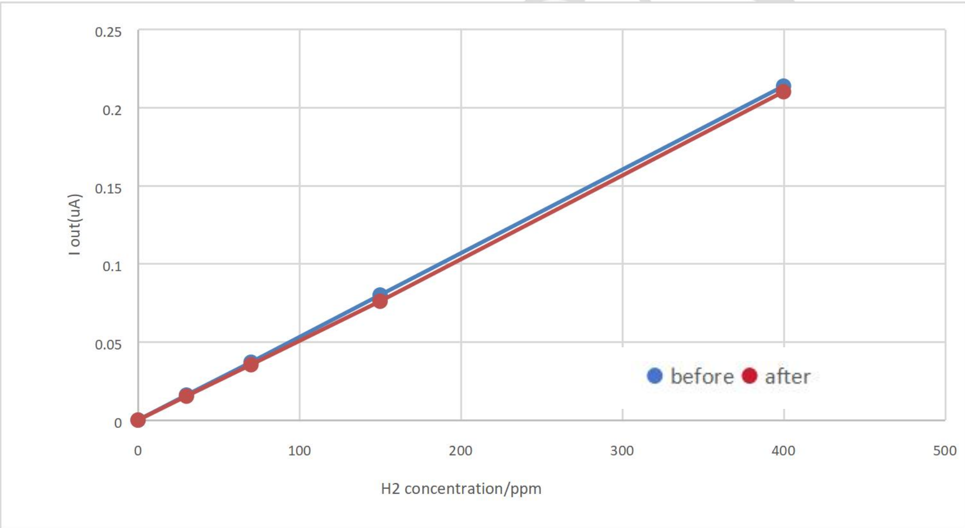


Figure 10 Effect of durability test on sensitivity

1.9.2 Corrosion test

Figure 12 shows the sensitivity of the sensor before and after the corrosion test. The sensor is exposed to 1ppm H_2S 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 11 shows the sensitivity is not affected by H_2S, either.

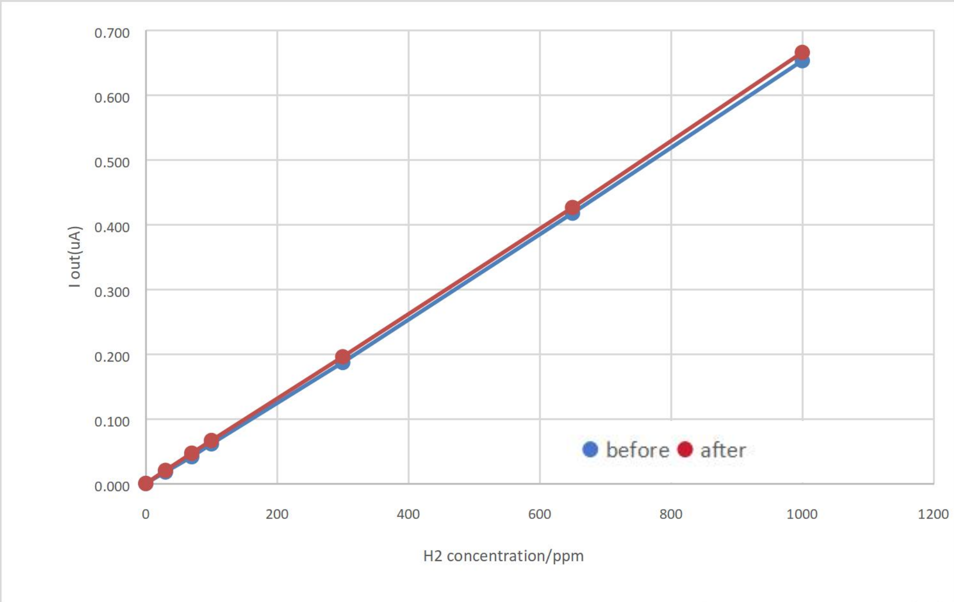


Figure 11 Corrosion test

1.9.3 Long term stability test

Figure 12 &13 show the long-term stability data for FC-H_2-XXXX. The samples were short-circuited stored in the kitchen and tested from time to time. The Y-axis in figure 12 shows the output current of the sensor in normal air while the Y-axis in figure 13 shows the output current of the sensor in 500ppm H_2 . These charts demonstrate that the sensor is very stable within 1500 days.

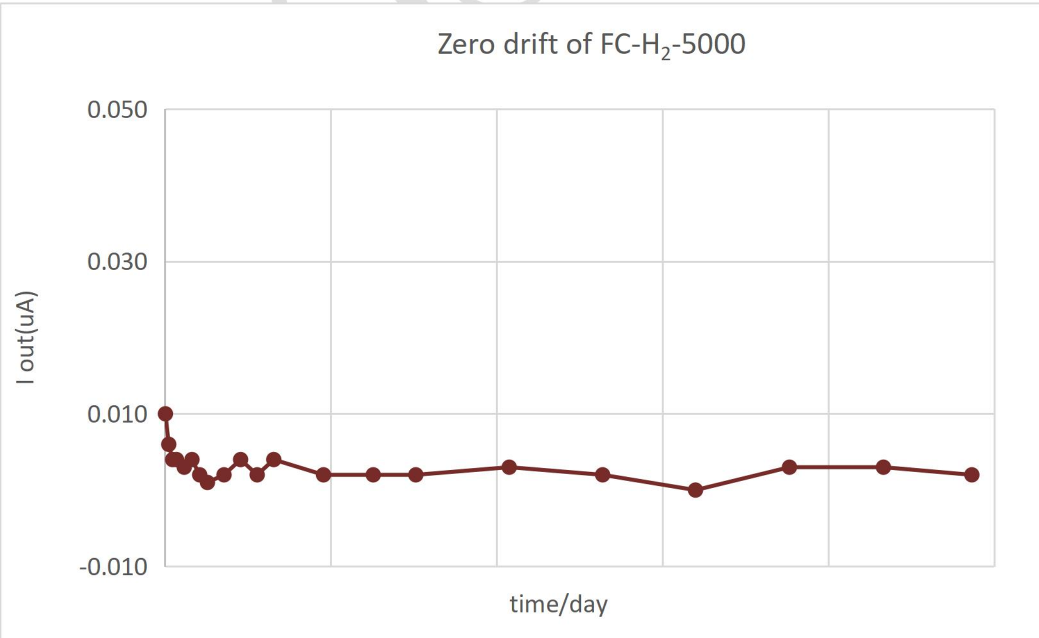


Figure 12 Zero output

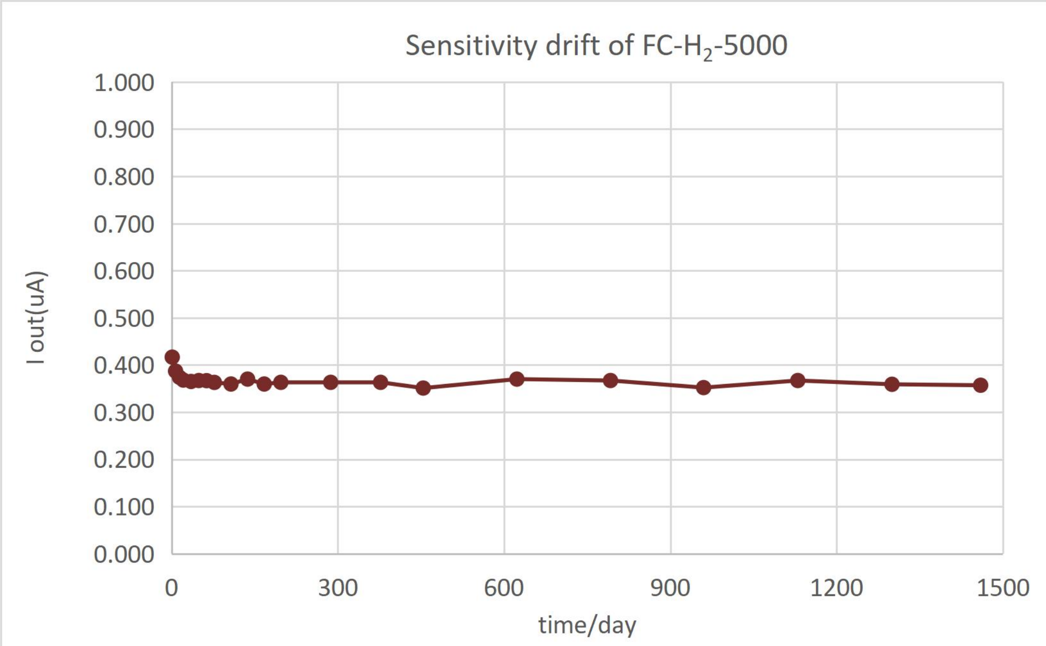


Figure 13 Output in 500ppm H_2

1.9.4 False alarm test

Figure 14 shows the sensitivity of the sensor before and after the false alarm test specified by UL2034. The tested samples were continually exposed to 30ppm H_2 for 30 days during the period the sensor didn't give alarm. The sensitivity before and after the test showed in figure15 demonstrates that the sensitivity is negligibly affected by the long term exposure to 30ppm H_2.

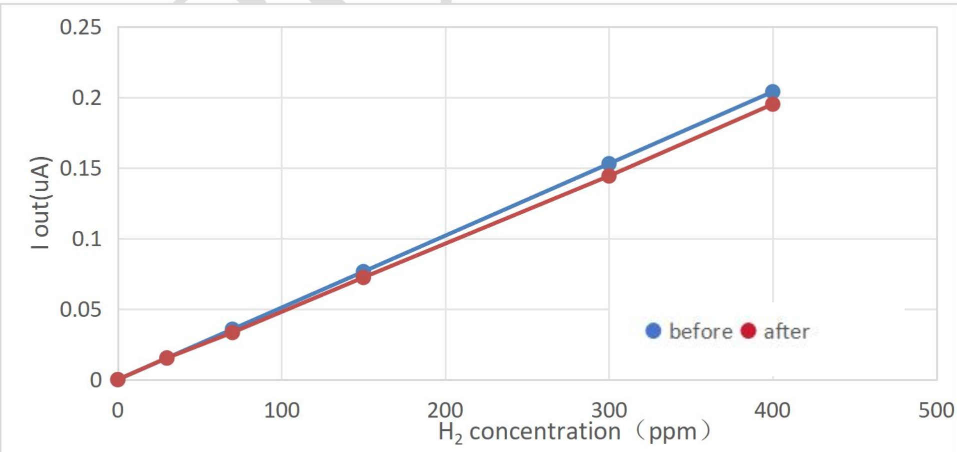


Figure 14 False alarm test

1.10 Environmental test

1.10.1 Temperature dependency

Figure15 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 500ppm H_2 once every 5℃ from -40 to 70℃.

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 500ppm H_2 at different temperature & 50%RH;

I_0:the output current in 500ppm H_2 at 20℃ & 50%RH;

Table7 Compensation coefficient

t（℃）	-40	-35	-30	-25	-20	-15	-10	-5
I/I0	25%	26%	28%	33%	38%	45%	53%	59%
t（℃）	0	5	10	15	20	25	30	35
I/I0	68%	75%	83%	92%	100%	104%	108%	111%
t（℃）	40	45	50	55	60	65	70	
I/I0	114%	117%	120%	122%	124%	126%	128%	

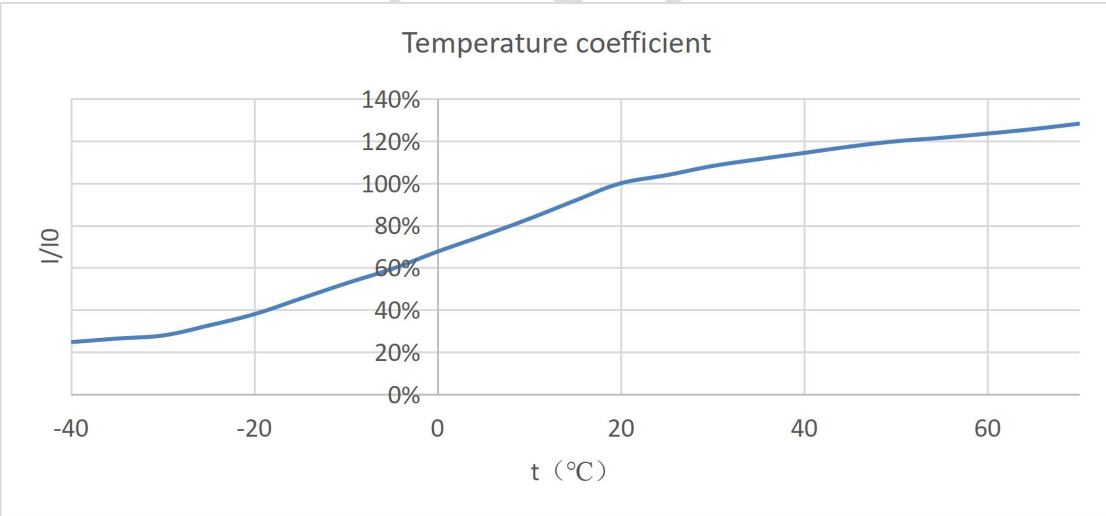


Figure15 Temperature influence test

1.10.2 Humidity dependency

Figure16 demonstrates the humidity dependency of FC-H_2-XXXX under constant temperatures of 20℃ and 50℃. During this test, the samples are placed in the testing system the temperature in which is constant at 20℃ and 50℃ separately and record the output of the sensor to 500ppm H_2 under different humidity as shown in table 8.This data demonstrate that humidity dependency is negligible as temperature varies.

Table 8 Experimental factors

temperature/℃	Humidity	temperature/℃	Humidity
20	10%RH	50	10%RH
	50%RH		50%RH
	95%RH		95%RH

I:the output current in 500ppm H_2 at different temperature & humidity;

I_0:the output current in 500ppm H_2 at 20℃ & 50%RH;

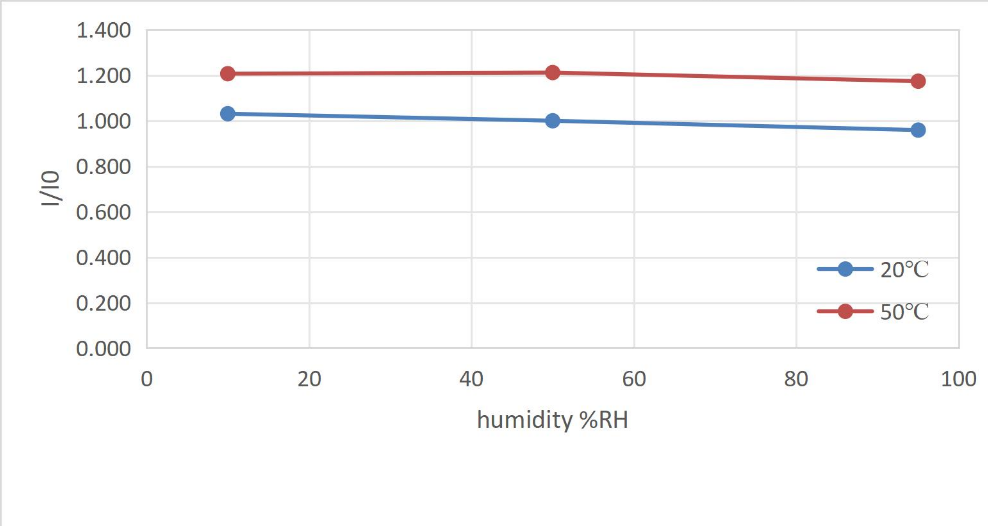


Figure 16 Humidity influence

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 9 and exposure for at least 3 hours in a certain environment. The output of the samples to 30, 70, 150, 400ppm H_2 recorded and is shown in Figure17 from which we can see that the sensor’s performance will not be influenced by humidity.

Table 9 Environment factors

temperature/℃	humidity%RH

-10	50
0	15
20	50
35	50
49	40

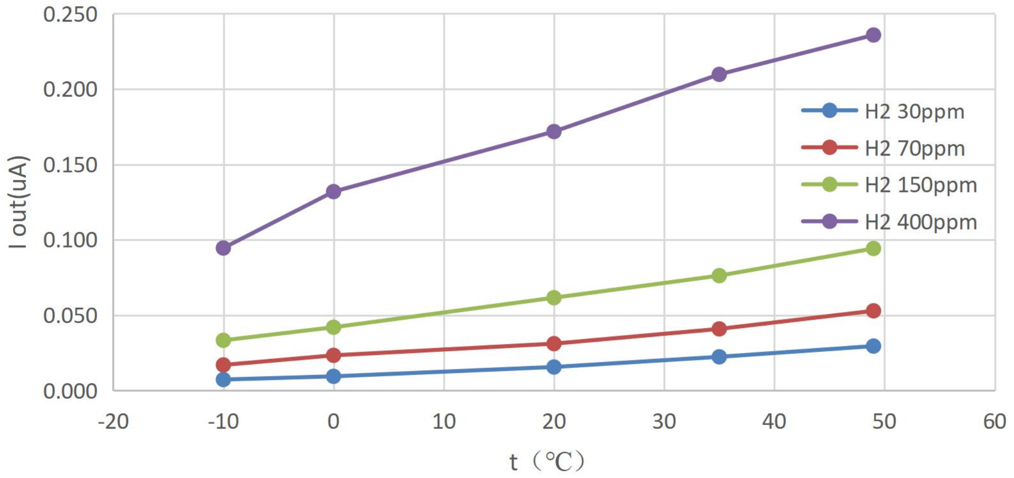


Figure 17 Operation in high and low temperature test

1.10.3.2 Effect of shipping and storage

Figure 18 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℃ for 24 hours followed by one hour at room temperature and then 3 hours at -40℃. After the exposure to extreme environment the samples were stabilized at room temperature for 3 hours, then the sensitivity performance was check once more. The comparison of the sensitivity before and after the test is shown in Figure 18 which demonstrates the sensor can meet the requirement of UL 2034.

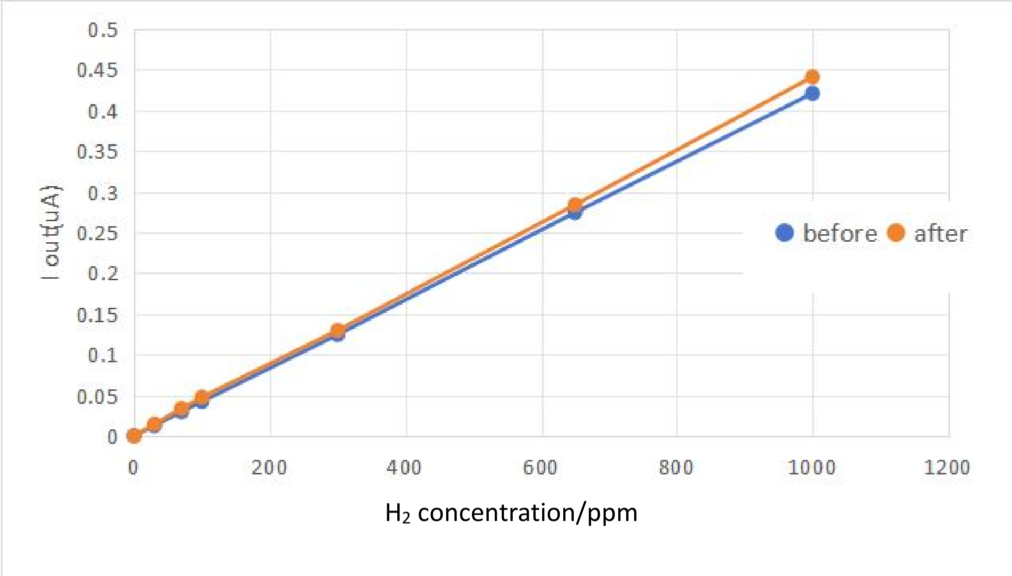


Figure 18 Effect of shipping and storage

1.10.3.3 Temperature cycle test

As required by UL2034--stability Test, the samples were exposed to ten cycles (<1 hour and >15 minutes) of temperature from 0℃ & 100%RH to 49℃ & 40%RH. Figure 19 shows H_2 sensitivity performance before and after the cycle test, which demonstrates that the influence of the extreme conditions on FC-H_2-XXXX is negligible.

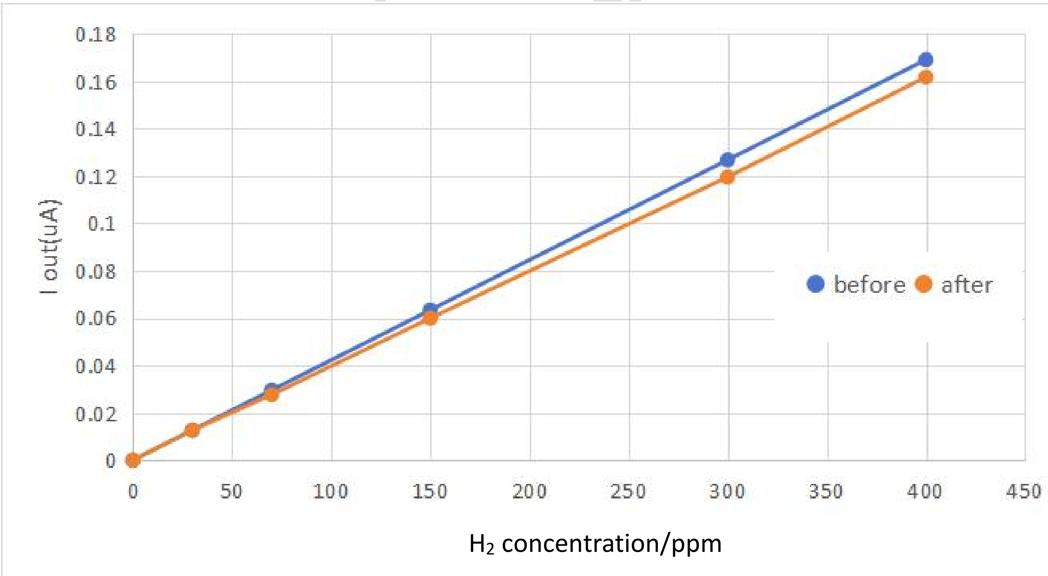


Figure 19 Temperature cycle test

2.Circuit design

2.1 Circuit diagram

FC-H_2-XXXX, based on the proven fuel cell technology, generates a current signal which is proportional to the concentration of H_2. To use the sensor for H_2 detection, the output current is usually converted to voltage for measurement .Figure 20 is an example circuit. In this circuit the output voltage(Vout) is measured to get the exact H_2 concentration. If the circuit is powered by 3.3V, the Vout without sensor connected should be 0.148V(Vref), Vout increases with the H_2 Concentration. By measuring the Vout increase can H_2 concentration be calculated.

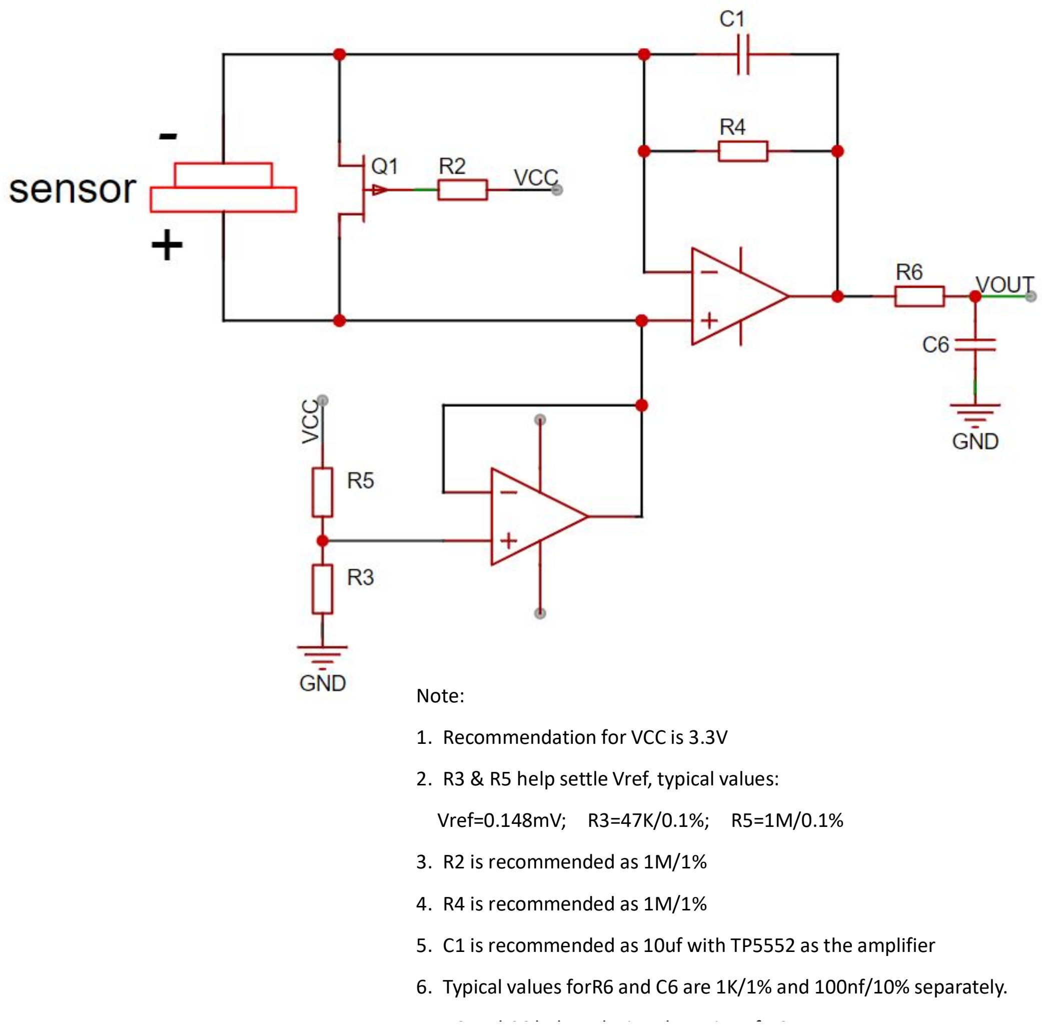


Figure 20 Sample circuit diagram

2.2 Setting reference voltage（Vref）

There is a certain ratio that the Vout in 0ppm H_2 would be less than zero and the circuit able to detect negative voltage is very complicated. For easier detection the Vout without sensor connected is set a little higher than 0 which is 0.148V in the example circuit. If Vref is set too high the resolution will be decreased while too low Vref is set there's the possibility that the Vout 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 Figure 8. An anti-polarization circuit is necessary for quick stabilization of Vout. As shown in Figure 20, a JFET is recommended for this purpose.

2.4 Current/Voltage conversion circuit

The sensor current output is converted into voltage as shown in Figure 20. Vout is expressed by the following formula:

Vout =(S*C+I_0)/1000000000*R+Vref

Vout：output voltage in V

S：sensor sensitivity in nA/ppm

C：H_2 concentration in ppm

I_0：output current in 0ppm H_2 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 Vret can be calculated as follows for circuit with other working power

Vref=VCC2*(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 H_2 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 =（Vmax -Vref）/（Smax×T× Cmax）

where：Vmax：Voltage at Cmax

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

Smax ：the biggest possible sensitivity（nA/ppm）which is 0.6 for FC-H_2-5000

T：temperature coefficiency 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 1000ppm, the amplification gain is:

R=（3.3-0.148）/（0.6/1000000000*1.24*5000）= 847K

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.

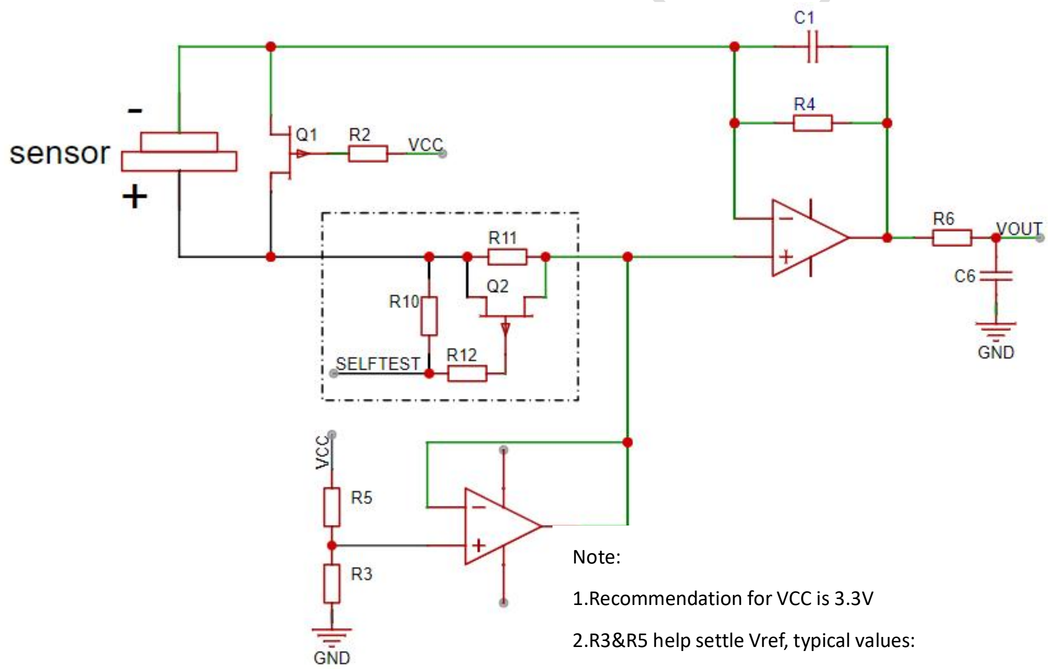
2.7 Electrical noise prevention

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 C_1 are two effective ways. The example circuit in Figure 20 adopts voltage follower design. For a certain amplification gain increasing the value of C_1 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, R_4 in the range from 100K to 1M & C_1 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 H_2 sensors based on fuel cell technology are exposed to high H_2 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 undershoot is that it takes a long time for the counter electrode to consume H_2 reaching there in high concentration which leads to a long recovery time. Chapter 5.3.6 in EN50291requires the sensor to settle down after one hour in fresh air after 15 minutes in 5000ppm H_2. The electrodes and structure in FC-H_2-XXXX are designed specially to eliminate undershoot without adjust of circuit. So detectors with FC-H_2-XXXX integrated can easily pass the 5000ppm test specified in EN50291 without modification of circuit.

2.9 Self-diagnosis



Note:

1.Recommendation for VCC is 3.3V

2.R3&R5 help settle Vref, typical values:

Vref=0.148mV; R3=47K/0.1%;R5=1M/0.1%

3.R2 is recommended as 1M/1%

4.R4 is recommended as 1M/1%

5.C1 is recommended as 10uf with TP5552 as the amplifier

6.Typical values forR6 and C6 are 1K/1% and 100nf/10% separately.

Figure 21 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 Q_1 to disconnect the sensor temporarily from the circuit

3)Self-test port is set to 3.3V for a certain period(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

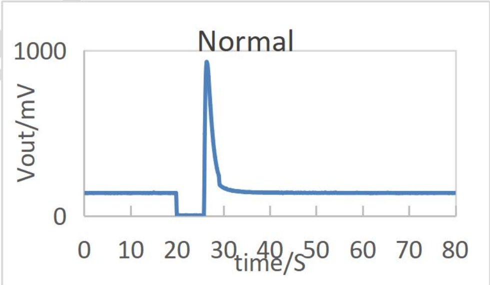
5) By recording the output data after the sensor is connected back to the circuit can we distinguish sensors with malfunction from normal ones

Self-diagnosis test result：

The sample is a sensor carried out the test at room temperature with amplification gain set at 460K.

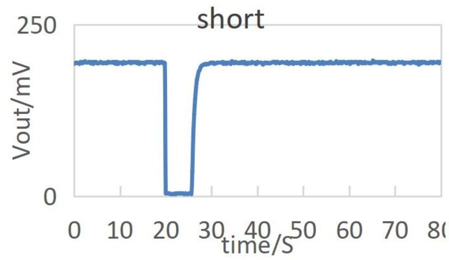
Normal sensor：

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.



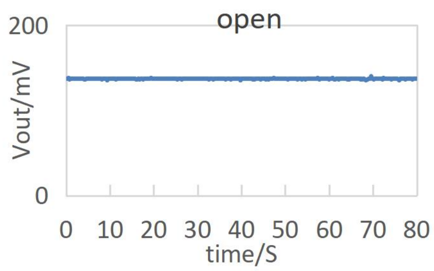
Short sensors：

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 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 H_2 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-polorization

3）Inject H_2 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

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

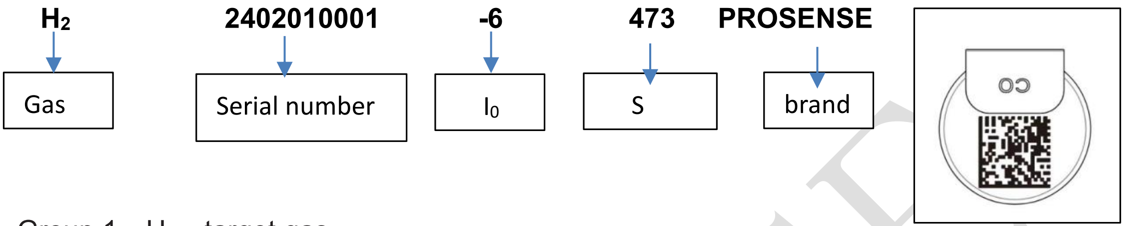
In the above formula, C refers to the H_2 concentration in ppm

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, but the accuracy can not be as good as calibrated with H_2.

3.2.1 Rules for barcode on sensor：



Group 1：H_2：target gas

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

Group 3：-6：one byte for symbol(be deleted if it is positive)，one or two numbers，output current in 0 PPM H_2 in nA.To get the exact number the data in the barcode should be divided by 10，for the above example, I_0 is: -6/10=-0.6nA

Group 4：473：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 is: 473/1000=0.473nA/ppm

Group 5：PROSENSE，brand

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 7 & figure 15.

3.4 Calculation of H_2 concentration

H_2 concentration can be calculated according to the following equation：

$$C=((Vout-Vref）*1000000000/R-I_0)/S_1$$

C：H_2 concentration in ppm

Vout：output voltage in V

Vref：offset of the circuit in V

R：amplification gain in Ohm

I_0: output in fresh air in nA

S_1：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℃/30~80%RH. Dew condensation should be avoided.

5.Soldering of PCB

Please pay attention to the following points for soldering：

1)Flux should be sufficiently dried before sensors are soldered onto a PCB 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 figure 22 for details.

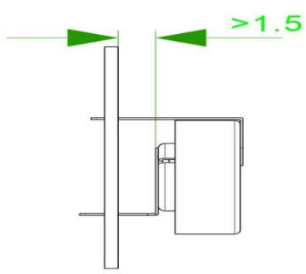


Figure 22 Example of soldering

4)Recommended conditions for manual soldering:

Temperature of soldering copper head: 360℃

Period: < 5 sec.

6.Gas test

Gas mixture of H_2 and O_2 should be used instead of mixture of H_2 and N_2 since O_2 is necessary for the detection. If N_2 is used instead of O_2 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 0ppm H_2
- 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 H2 is recommended for accuracy detection
- Any disassemble of the sensor is forbidden which will make the guarantee invalid

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