CO_2 Sensor Module – RX-9_BIN

EXSEN EXSEN Inc.

SPECIFICATION SHEET

MODEL NAME	CO2 SENSOR (RX-9, RX-9 Simple)
PART NUMBER	EX-NN-20123VN5KA (Various)
CUSTOMER NAME	-
CUSTOMER PART NUMBER	-
DATE	2018.11.30
REMARK	R07(23.07.26)
SOFTWARE VERSION	-
SOFTWARE CHECKSUM	-

Features

- **Electrochemical type CO_2 gas sensor**
- Solid state sensor
- **Very High price competitiveness**
- Temperature compensate sensor
- High selectivity
- High reliability
- Fast response
- Super compact size
- Suitable to indoor environment
- 4 Pin, 2.0 mm pitch pin header

Detecting Gas

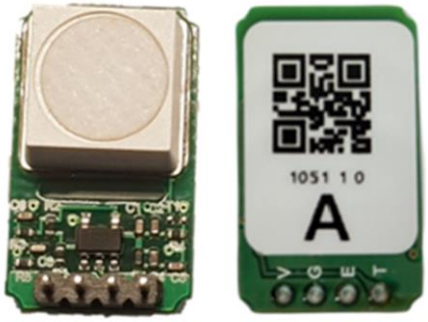
- Carbon dioxide gas

Sensor Series

- RX-9 Simple: 2CH Analog output, sensor, to sense freshness state of indoor
- RX-9: 2CH Analog output, sensor with QR code, QR code contains factory calibration information, user can use this data to calibrate the sensor.
- RX-9_BIN: bin classified RX-9

Application

- Air cleaner
- Air conditioner
- Diffuser
- Climate control system
- Total heat exchanger
- Security
- Home automation
- Set-top box
- Lighting
- Dash-Cam
- Portable sensor box



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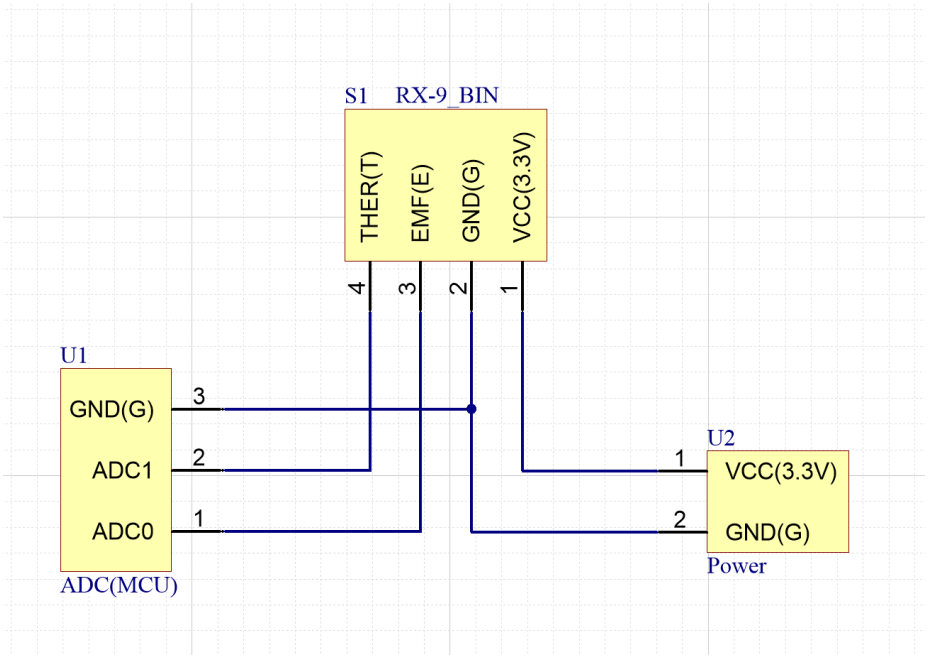
Overview



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A

Manufacturing Information for Q.C

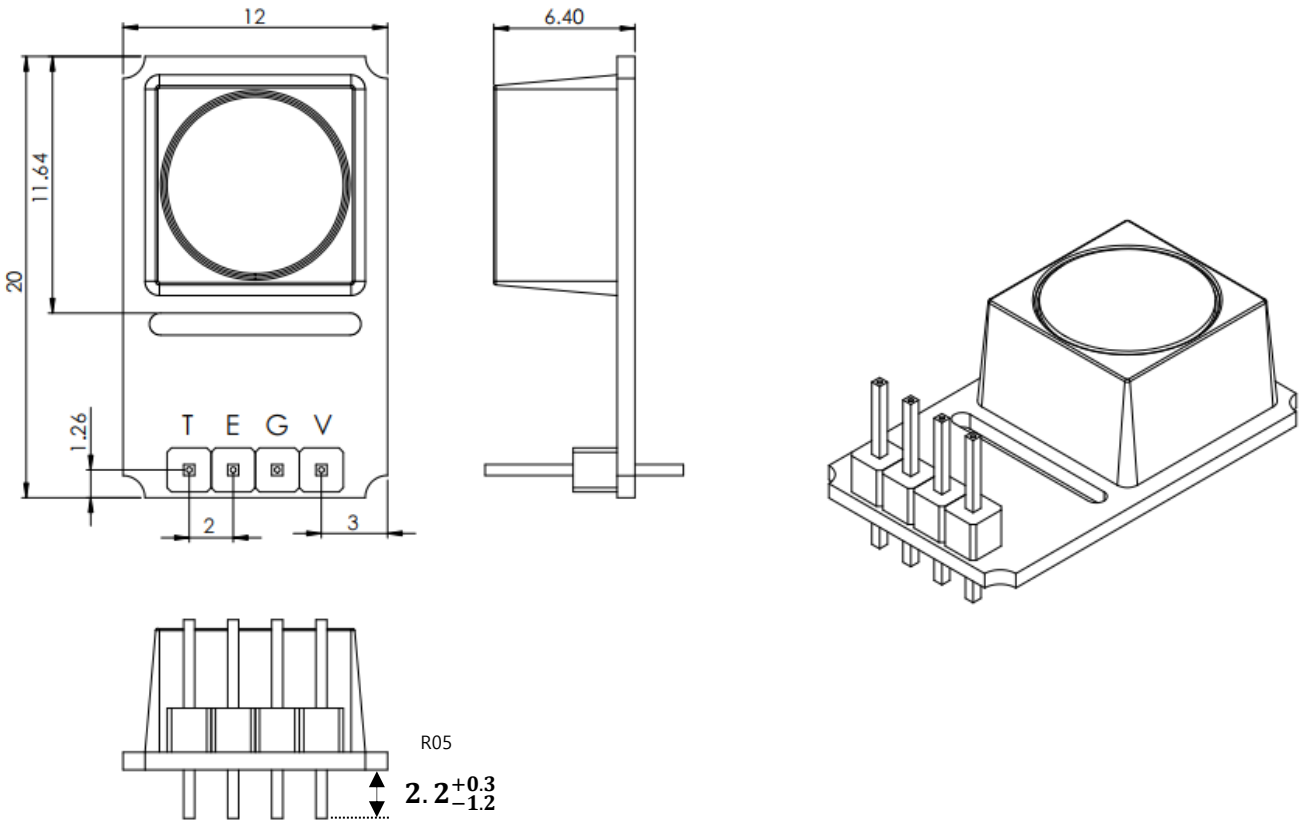
Factory Cal information (A~E Bin, 5 Bins)
Same bin have same Cal information.
Same bins are classified and supplied.

1. DATA SHEET

MODEL NAME	CO_2 SENSOR (RX-9_BIN)
PART NUMBER	EX-NN-20123VN5KA (Various)
DIMENSION	20 x 12 (mm^2)
CO_2 GAS DETECTION RANGE	400~5,000 ppm (400 ~ 2000: Accuracy ±10%)
COMMUNICATION	Analog voltage output (Default: 2CH, Simple mode: 1CH)
APPLICATION	Carbon dioxide concentration display General Purpose

(1) Dimension

- **Small Sensor Module, 20 x 12 x 6.45 (L x W x H, mm)**



- **Connector: 2.0 mm pin header 4 pin**

General Tolerance (mm)	
Linear	±0.3
Radius	±0.5

(2) Sensor & electrical performance specification (T_a = 25°C)

Parameters		Condition	Symbol	Min	Typ	Max	Unit
Gas	**Target gas**	-	T_{Gas}		CO_2		-
Data	**Sensor type**	-	EC		Electrochemical		
	Detection range	-	DD_R		400-5,000 (400~2000: accuracy ±10%)		ppm
	Resolution	-	D_R		1		ppm
	Accuracy[1)]	25℃ 50%RH After warm-up	RX-9_BIN	-10	-	10	%
Time	**Response**	25℃ 50%RH In 1 m^3 Chamber with circulation	T_{Res}		1 min		
	Warm-up	-	T_{WU}		3	30	min
	Life-time	-	T_{LT}		10 years		-
Electric	**Operating Voltage**	RX-9_BIN		3.25	3.3	3.35	V
	Current Consumption	-	P_A	-	0.12	0.15	A
	Warm-up consumption	-	P_W	-	0.5	0.8	W
Output	**Output**	RX-9_BIN			Analog output, 2CH		V
		EMF	E (pin 3)	0	1.8	3.3	V
		THER	T (pin 4)	0	2	3.3	V
	Connector	-	CNT (		2.0 mm x 4 pin header		-
Ambient	**Operating Temp**	-	O_T	-40	25	60	ºC
	Operating Humidity	No condensing	O_H	0	-	95	%
	Storage Temp	-	S_T	-40	25	85	ºC
	Storage Humidity	Pack in moisture proof bag	S_H	5	-	90	%
Calibration		-	CAL		Use Factory calibration information Self-calibration mode is ready.		-
Warranty					1 year		

1) Accuracy: Accuracy can be measured after 24 ~ 48 hours with auto calibration.

(3) Sensor characteristic graph

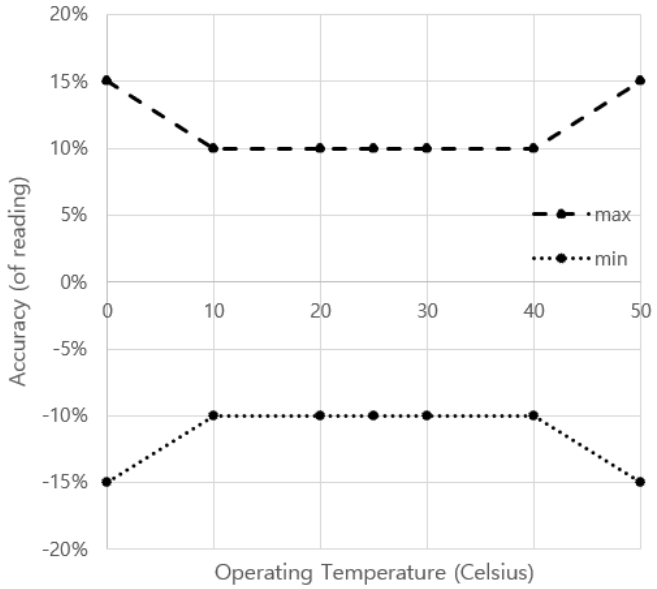


Fig. 1 Accuracy by temperature

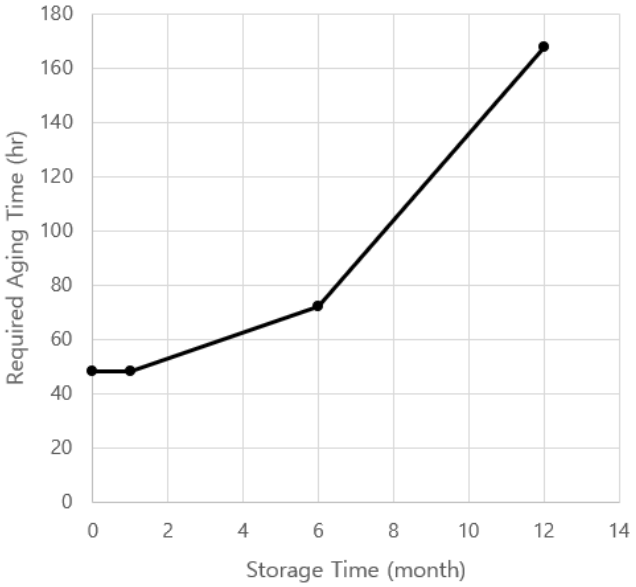


Fig. 2 Required aging time by storage time

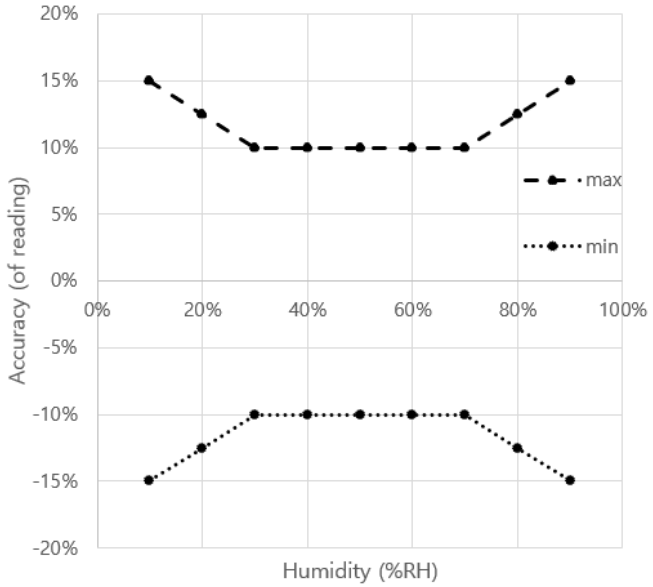


Fig. 3 Accuracy by Humidity

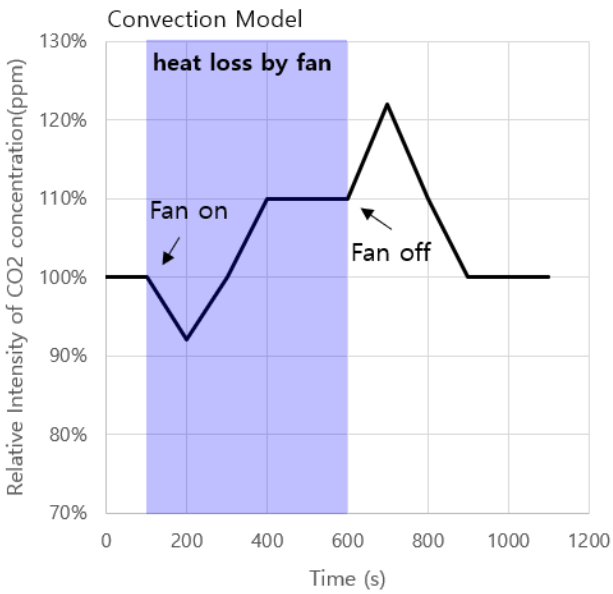


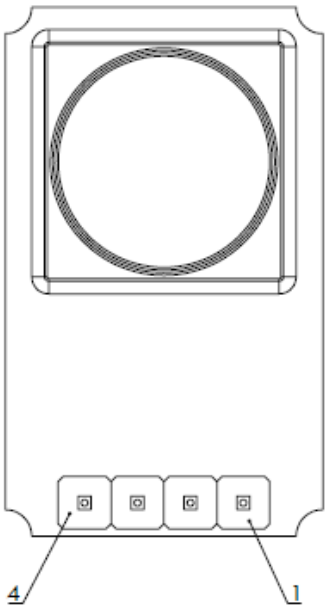
Fig. 4 Fluctuation by temperature changing

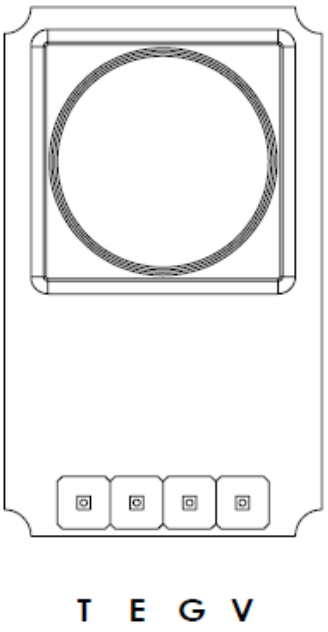
2. Terminal descriptions

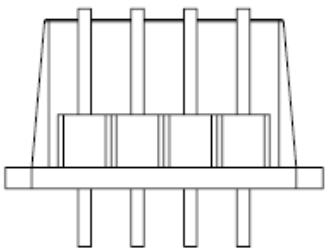
- Connector

Model name	Maker	Type	Pin no	Pin to Pin
2.0 mm pitch pin header	Various	Male	4	1~4

Pin No.	Symbol	Description
1	V	Vin, 3.3V, Voltage Input
2	G	Ground
3	E	Voltage output, Sensor raw signal, Electromotive Force
4	T	Voltage output, NTC Thermistor signal for temperature compensation







3. Communication descriptions

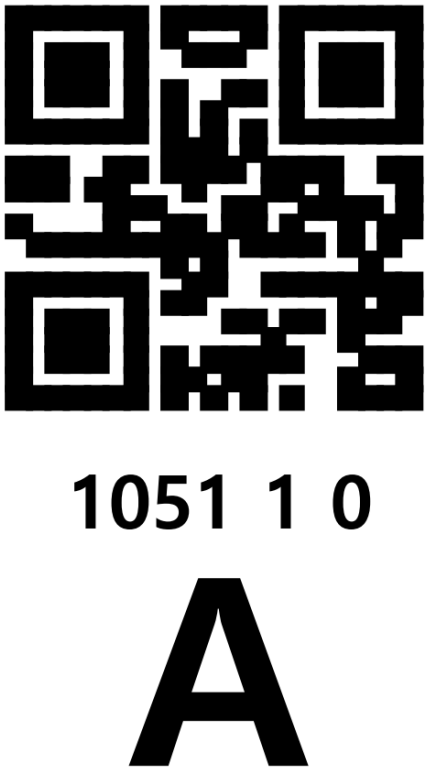
*** Please Contact to EXSEN or local distributor.**

*** Protocol and Algorithm is provided on https://github.com/EXSEN/RX-9_BIN**

*** RX-9_BIN needs 2 ADC CH to transfer sensor data.**

*** Please check the master system it has spare 2 ADC CH.**

4. BIN information



RX-9_BIN have five bins. It provides factory calibration information. User can use this value to calibrate the sensor easily.

Under 1kea, EXSEN provides the product in one bin. so, when you are downloading firmware to mcu, use the bin value to calibrate once.

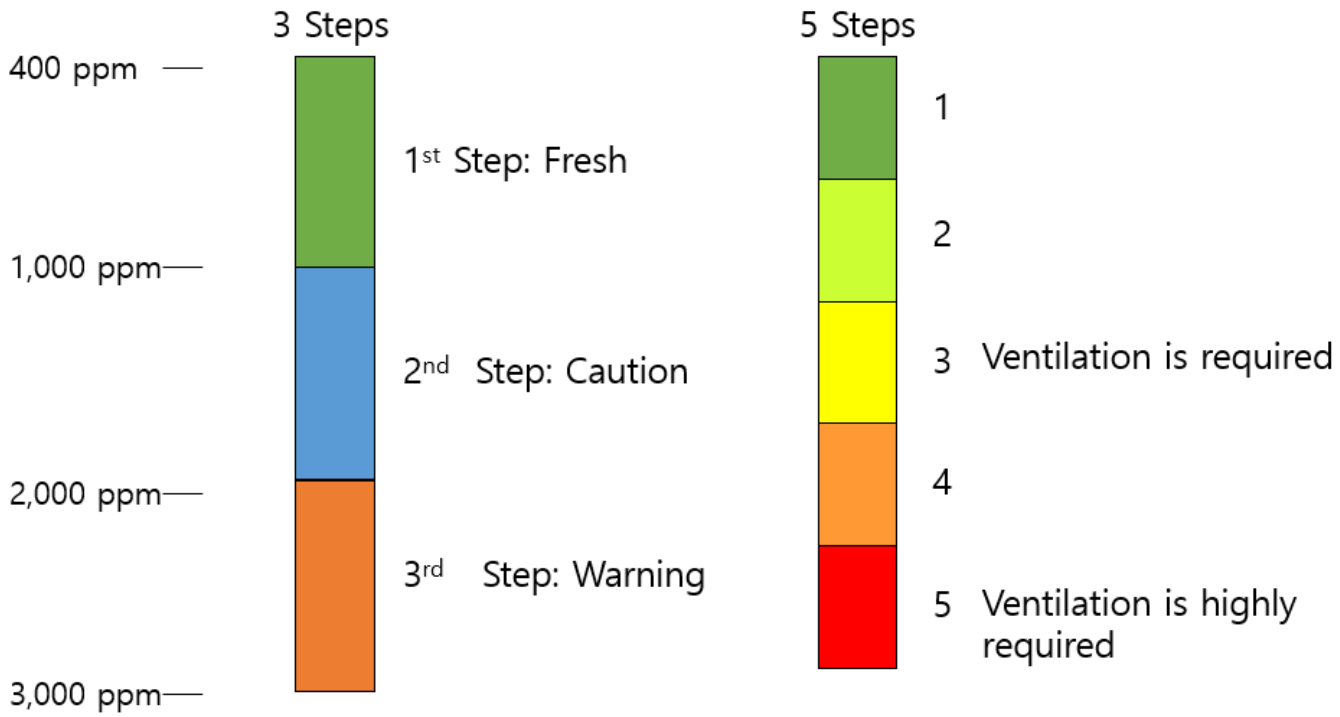
It is simple and accurate.

All bins are equal. It only has production process variance, so it is classified A ~ E bins. and there is no difference in performance. just use bin value to the firmware code. Factory calibration is done simiply by using the representative value of bin. additional calibration is not required for the same bin product supplied. Of course, it is difficult to supply a large amount in the same bin at once, so EXSEN can supply several bins. But normally only one type if bin will be packed in one box. The number of products in 1 box is 960 pcs.

The bin information is clearly marked on the back of each sensor, with A ~ E, so there is no confusion.

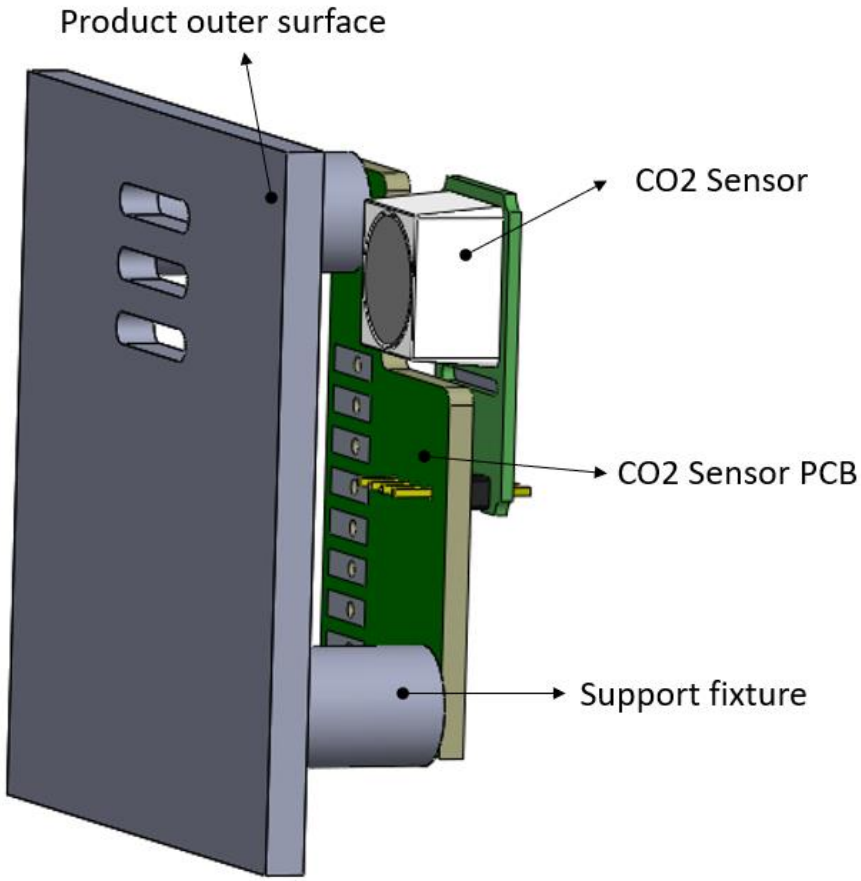
Bin	Value
A	48
B	52
C	58
D	66
E	74

5. Freshness output of RX-9 series.

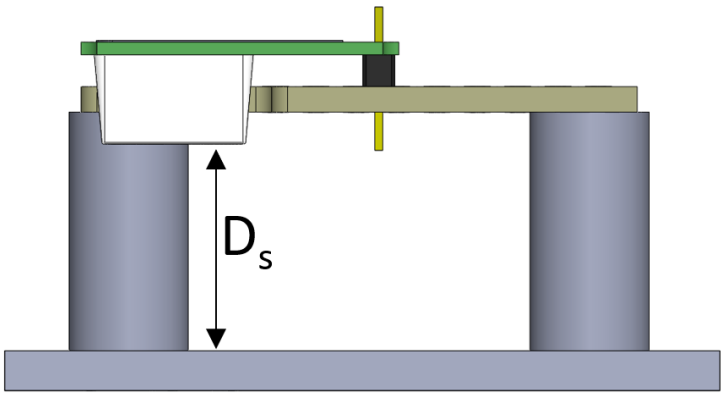


RX-9 series module can be used for output of freshness. The number of steps is calculated by user and EXSEN provide the algorithm to calculate it. Normally EXSEN recommend 3 to 5 steps. Very simple algorithm is used for this.

6. Assembly Guide



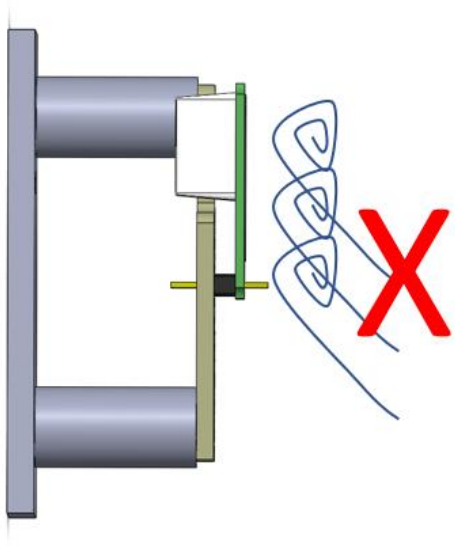
1. sensor and inner surface



Ds is required distance between sensor and inner surface. Avoiding ESD from outer surface, Ds is needed. Ds is required over 10 mm from inner surface.

$$D_s \geq 10 \text{ mm}$$

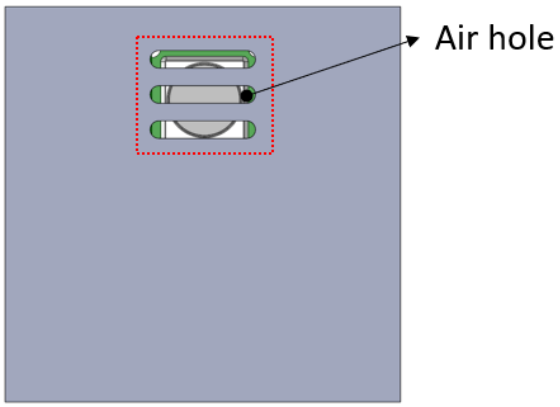
2. Preventing rapid air flow



>0.5 m/s wind can take a heat from the sensor. Heat loss can make transition on sensing. So the sensor should be installed in separated space from rapid air flow of fan. At same reason, another heat source should be separated from sensor. (Ex: Power source or heating type sensor).

X Air flow: > 0.5 m/s

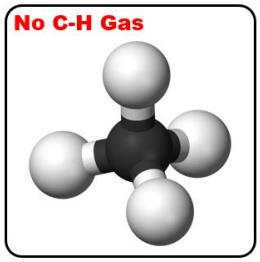
3. Air hole guide



Carbon dioxide gas can be diffused easily. So, air hole is needed but it is not important.

- Air hole size, location is not important. If the product has another hole on outer surface, don't make more holes for this.
- Don't seal the product fully. Make sensor can breathe.

7. Handling Guide



Avoid exposure to high concentrations of **C-H** gases!

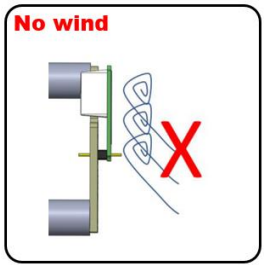
- Ethanol, Toluene, PCB detergent (TC), IPA, Bond, Paint, Silocone

No Solder Fume : solder fume can prevent air from entering the sensor.

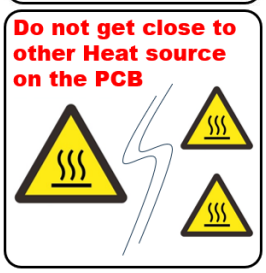
No Chemical Spray : spray fillers and gases can reduce the sensitivity.

No PCB Cleaning : during PCB cleaning, the cleaning detergent can penetrate. into the sensor

No Condensation : Beware of condensation during storage or use. It may cause malfunction.



No Wind : Avoid exposure to strong winds during use. The sensor value fluctuates.



Caution : Heat

Do not place heat generating elements or heat sensitive components close to the sensor on PCB.

Heat generating elements: LDO, Resistors, heat generating sensors, etc.

Heat sensitive components: Temp/Humi sensors, low temperature LCD, etc.

8. Reliability Test Result for RX-9 Series

1. Thermal Shock Test

- Ambient Condition: -40℃ 30 min, 85℃ 30 min, 150 cycles
- Electric Condition: No Operation
- Sample No: 30 ea
- Pass Condition: Operation-able, No Crack on device

Sample no.	Result	Sample no.	Result	Sample no.	Result
1	Pass	11	Pass	21	Pass
2	Pass	12	Pass	22	Pass
3	Pass	13	Pass	23	Pass
4	Pass	14	Pass	24	Pass
5	Pass	15	Pass	25	Pass
6	Pass	16	Pass	26	Pass
7	Pass	17	Pass	27	Pass
8	Pass	18	Pass	28	Pass
9	Pass	19	Pass	29	Pass
10	Pass	20	Pass	30	Pass

2. Operating Endurance Test

- Ambient Condition: 25℃, 1000 hr
- Electric Condition: 3.3V (< ±0.1V)
- Sample No: 30 ea
- Pass Condition: CO_2 Gas exposure test (ppm Tolerance: < ±10%, @1000 ppm of CO_2 gas)

@1020 ppm

Sample no.	Result		Sample no.	Result	
	ppm	%		ppm	%
1	999	-2.1%	16	982	-3.7%
2	981	-3.8%	17	970	-4.9%
3	1009	-1.1%	18	951	-6.8%
4	951	-6.8%	19	1028	0.8%
5	1000	-2.0%	20	967	-5.2%
6	1011	-0.9%	21	959	-6.0%
7	1024	0.4%	22	1028	0.8%
8	984	-3.5%	23	1030	1.0%
9	958	-6.1%	24	988	-3.1%
10	967	-5.2%	25	1018	-0.2%
11	1025	0.5%	26	1041	2.1%
12	1022	0.2%	27	992	-2.7%
13	967	-5.2%	28	999	-2.1%
14	1022	0.2%	29	963	-5.6%
15	993	-2.6%	30	963	-5.6%

3. High Temperature High Humidity Life Test

- Ambient Condition: 85℃, 85%, 500 hr
- Electric Condition: Operation
- Sample No: 30 ea
- Pass Condition: After Test, apply 400 ppm CO_2 gas with Air balance for 5 days to recover.
  Then measure the CO_2 gas concentration under 1000 ppm of CO_2 (ppm tolerance: < ±10%)

@995 ppm

Sample no.	Result		Sample no.	Result	
	ppm	%		ppm	%
1	978	-1.7%	16	1062	6.7%
2	1039	4.4%	17	971	-2.4%
3	957	-3.8%	18	1067	7.2%
4	903	-9.2%	19	972	-2.3%
5	977	-1.8%	20	933	-6.2%
6	1066	7.1%	21	1035	4.0%
7	928	-6.7%	22	1036	4.1%
8	1057	6.2%	23	1028	3.3%
9	984	-1.1%	24	1078	8.3%
10	973	-2.2%	25	1054	5.9%
11	968	-2.7%	26	992	-0.3%
12	976	-1.9%	27	1020	2.5%
13	971	-2.4%	28	1047	5.2%
14	1006	1.1%	29	1054	5.9%
15	967	-2.8%	30	943	-5.2%

4. ESD(HBM)

- Ambient Condition: 25℃
- Electric Condition: No Operation, HBM: 2 kV, 3 times each pin
- Sample No: 30ea
- Pass Condition: Operation-able

Sample no.	Result	Sample no.	Result	Sample no.	Result
1	Pass	11	Pass	21	Pass
2	Pass	12	Pass	22	Pass
3	Pass	13	Pass	23	Pass
4	Pass	14	Pass	24	Pass
5	Pass	15	Pass	25	Pass
6	Pass	16	Pass	26	Pass
7	Pass	17	Pass	27	Pass
8	Pass	18	Pass	28	Pass
9	Pass	19	Pass	29	Pass
10	Pass	20	Pass	30	Pass

5. Gas Exposure Test

- Ambient Condition: 25℃, 50%RH
- Electric Condition: Operation
- Sample No: 150 ea
- Pass Condition: @500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000 ppm
  ppm Tolerance: ±10% at each CO_2 concentration

Sample No.	Result	Sample No.	Result	Sample No.	Result	Sample No.	Result	Sample No.	Result
1	PASS	31	PASS	61	PASS	91	PASS	121	PASS
2	PASS	32	PASS	62	PASS	92	PASS	122	PASS
3	PASS	33	PASS	63	PASS	93	PASS	123	PASS
4	PASS	34	PASS	64	PASS	94	PASS	124	PASS
5	PASS	35	PASS	65	PASS	95	PASS	125	PASS
6	PASS	36	PASS	66	PASS	96	PASS	126	PASS
7	PASS	37	PASS	67	PASS	97	PASS	127	PASS
8	PASS	38	PASS	68	PASS	98	PASS	128	PASS
9	PASS	39	PASS	69	PASS	99	PASS	129	PASS
10	PASS	40	PASS	70	PASS	100	PASS	130	PASS
11	PASS	41	PASS	71	PASS	101	PASS	131	PASS
12	PASS	42	PASS	72	PASS	102	PASS	132	PASS
13	PASS	43	PASS	73	PASS	103	PASS	133	PASS
14	PASS	44	PASS	74	PASS	104	PASS	134	PASS
15	PASS	45	PASS	75	PASS	105	PASS	135	PASS
16	PASS	46	PASS	76	PASS	106	PASS	136	PASS
17	PASS	47	PASS	77	PASS	107	PASS	137	PASS
18	PASS	48	PASS	78	PASS	108	PASS	138	PASS
19	PASS	49	PASS	79	PASS	109	PASS	139	PASS
20	PASS	50	PASS	80	PASS	110	PASS	140	PASS
21	PASS	51	PASS	81	PASS	111	PASS	141	PASS
22	PASS	52	PASS	82	PASS	112	PASS	142	PASS
23	PASS	53	PASS	83	PASS	113	PASS	143	PASS
24	PASS	54	PASS	84	PASS	114	PASS	144	PASS
25	PASS	55	PASS	85	PASS	115	PASS	145	PASS
26	PASS	56	PASS	86	PASS	116	PASS	146	PASS
27	PASS	57	PASS	87	PASS	117	PASS	147	PASS
28	PASS	58	PASS	88	PASS	118	PASS	148	PASS
29	PASS	59	PASS	89	PASS	119	PASS	149	PASS
30	PASS	60	PASS	90	PASS	120	PASS	150	PASS

9. Cautions

1. Moisture, Gas-Proof Package

1.1 When moisture or interfering gas is absorbed into the sensor module it may cause malfunction. There is a possibility that may cause broad ppm tolerance of sensor. but normally sensor module can self-calibrated after 1 day. For this reason, the sensor module is used to keep moisture or interfering gas to minimum

2. Storage Conditions

2.1 Before/After opening the packing: The sensor module should be kept at 30℃ or less and 60%RH or less. The sensor module should be used within 3 months. When storing the sensor module, the cap sealing tape is should be attached.

2.2 EXSEN sensor is sensitive to ambient condition while storing, if the sensor module exposed to air direct w/o cap sealing tape, the sensor module should be operated for 4 days after that the sensor self-calibrated at clean air.

2.3 Please avoid rapid transition in ambient temperature, humidity, interfering gas, especially in high humidity environments where condensation can occur.

3. Handling

3.1 The sensor module is very sensitive to human touching. Don't touch the sensor pin w/o glove. it may occur the sensor malfunction.

3.2 The sensor module is temperature compensation device, so don't apply rapid transition in temperature by conduction, convection, radiation. rapid temperature transition can make sensor output ppm fluctuation.

3.3 The sensor could be damaged from high concentrated interfering gas. For example, ethanol Isopropyl alcohol or solvent to clean the PCB could be harm to sensor.

3.4 PCB coating solution or resin is harm to sensor. While curing to PCB coating, the resin outgasses the interfering gas to sensor. It damages to sensor sensitivity. Occasionally, the damage works permanently. If the coating is required to use the sensor, seal the top of sensor firmly.

4. Initializing of sensor (warm-up)

4.1 The sensor takes 5 minutes to initialize their internal components. The sensor is basically heating device. so, the initializing means warming up the device to sense the carbon dioxide.

4.2 The accuracy depends on the warming-up time. The sensor shows ±25% deviation at 5 min after starting and ±15% at 10 min.

5. Auto Calibration

5.1 The sensor is monitored their output by program of MCU. the MCU calibrate the baseline of sensor output by 1 day.

5.2 It is required to auto-calibrate, the sensor should be exposed to clean atmosphere at least 5 min/day. because the sensor learns the baseline of clean air.

5.3 The sensor shows reliable sensing data after 1 auto-calibration. Because storage condition of sensor could change the baseline of sensor at first. But this symptom is calibrated after 1 day by auto calibration

5.4 After reliability test, the sensor should be exposed to clean air at least 3 days. The harmful environment changes the sensor baseline. So, give enough time to sensor to calibrate.

6. Temperature changing

6.1 Rapid temperature changing makes signal fluctuation to sensor output. The fluctuation is stabilized soon when the temperature is stabilized.

6.2 The temperature changing is caused by convection, heat conduction, and thermal radiation.

6.3

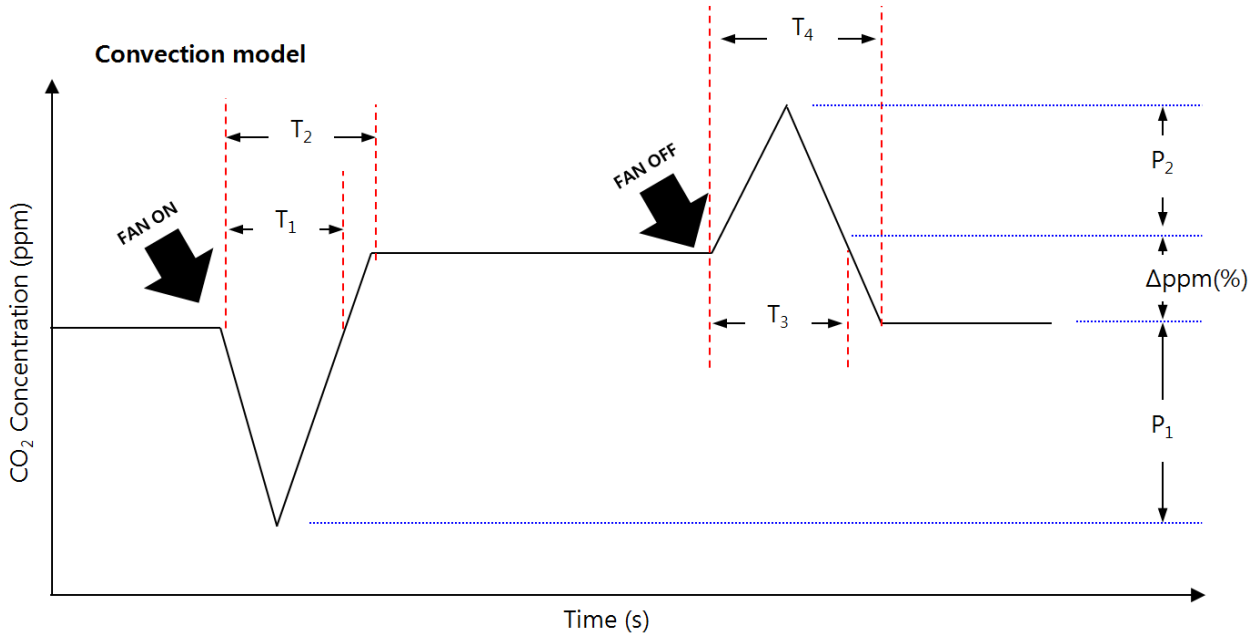


FIG. The convection model of temperature changing for sensor

RX-9 output data, @400 ppm, Ambient Temp = 25℃

FAN speed	T1 (s)	T2 (s)	T3 (s)	T4 (s)	Δppm (%)	P1 (%)	P2 (%)
High	200	400	200	300	10	12	10
Low	175	300	200	300	8	10	8

10. Revision history

Revision No.	Date (yy.mm.dd)	Description	Page	Note
00	18.11.30	Initiate the documents	All	Yk
01	19.02.15	Add QR code and reliability test result	All	Yk
02	19.06.27	Add sensor characteristic graph	4	Yk
03	19.07.03	Add RX-9 simple step description, assembly guide	7,8,9	Yk
04	19.09.30	Modify QR code structure, Add revision history	6,14	Yk
05	23.05.05	Add Pin length limit, To prevent the pin from touching other	2	Yk
06	23.07.19	Add sensor distinguish BIN for RX_9 Simple	-	Yk
07	23.07.26	Add RX-9_BIN spec and remove some RX-9 Simple description	All	Yk

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