

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 | R00 |
| SOFTWARE VERSION | - |
| SOFTWARE CHECKSUM | - |

Features

- Electrochemical type CO₂ gas sensor
- Solid state sensor
- 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

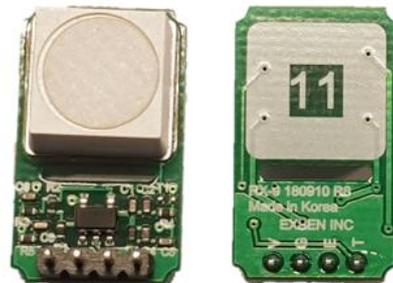
- Carbon dioxide gas

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

Application

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



CO₂ Sensor Module

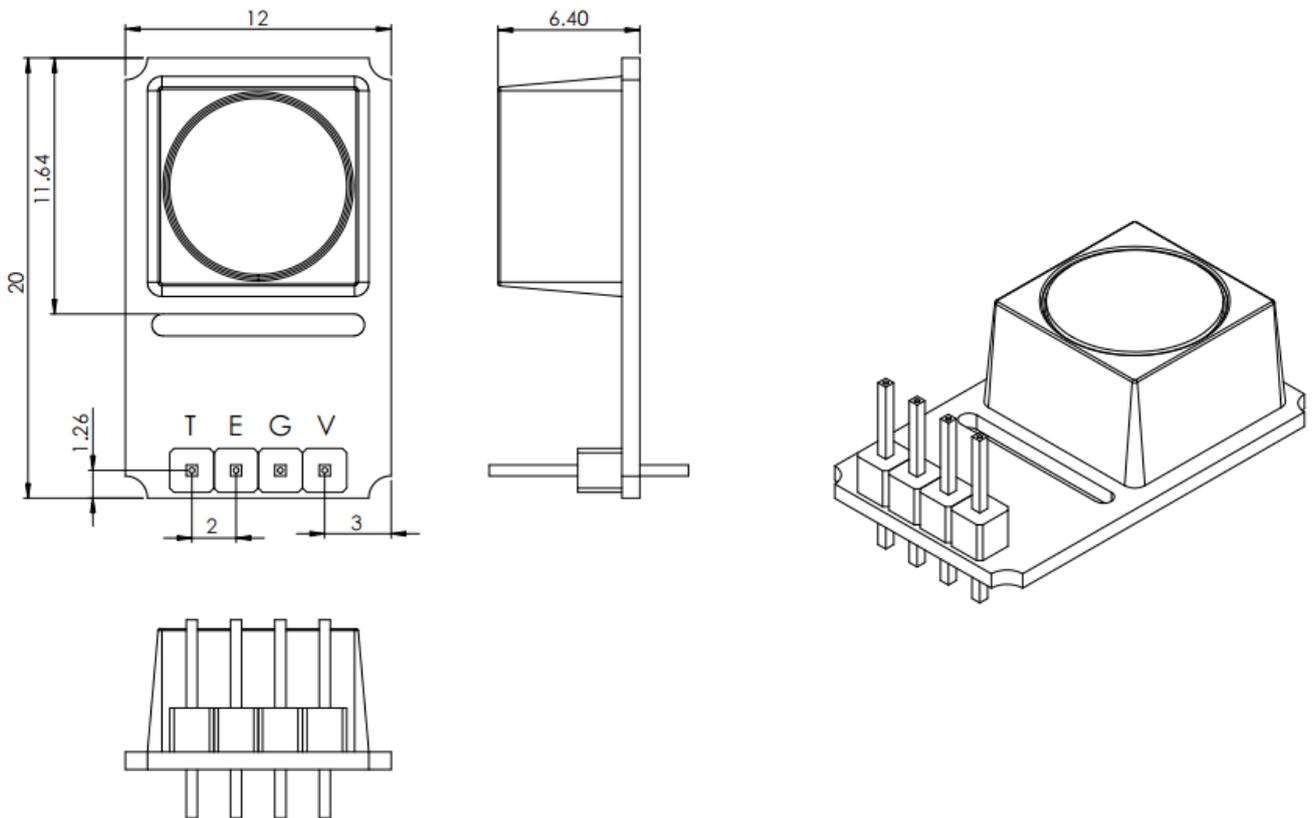
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1. DATA SHEET

| | |
|-------------------------------------|---|
| MODEL NAME | CO ₂ SENSOR (RX-9) |
| PART NUMBER | EX-NN-20123VN5KA (Various) |
| DIMENSION | 20 x 12 (mm ²) , |
| CO ₂ GAS DETECTION RANGE | 400~5,000 (ppm range could be changed by client's need) |
| 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 | 400-4,000 | | | ppm |
| | Resolution | - | D _R | 1 | | | ppm |
| | Accuracy ¹⁾ | 25°C 50%RH After warm-up | RX-9 Simple | -20 | - | 20 | % |
| | RX-9 | | -10 | - | 10 | | |
| Time | Response | 25°C 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 | | | - |
| Power | Input | RX-9 Simple | V _{IN} | 3.2 | 3.3 | 3.4 | V |
| | | RX-9 | | 3.2 | 3.3 | 3.4 | V |
| | Current Consumption | - | P _A | - | 0.12 | 0.15 | A |
| | Warm-up consumption | - | P _W | - | 0.5 | 0.8 | W |
| Output | Interface connections | RX-9 Simple | O _C | Analog output, 2CH or 1CH available | | | V |
| | | RX-9 | | Analog output, 2CH | | | V |
| | AVO-ppm | - | I2C_ppm | 400~4,000 (Various ppm is available) | | | ppm |
| | Sampling interval | - | T _{SPL} | | 1 | | Hz |
| | Connector | - | CNT (| 2.0 mm pin header | | | - |
| Ambient | Operating Temp | - | O _T | -40 | 25 | 60 | °C |
| | Operating Humidity | No condensing | O _H | 0 | - | 95 | % |
| | Storage Temp | - | S _T | -40 | 25 | 85 | °C |
| | Storage Humidity | Pack in moisture proof bag | S _H | 5 | - | 90 | % |
| Calibration | | - | CAL | Not required and Self mode is ready. Self mode algorithm is provided by manufacturer. User must code the algorithm as instruction. | | | - |

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

CO₂ Sensor Module

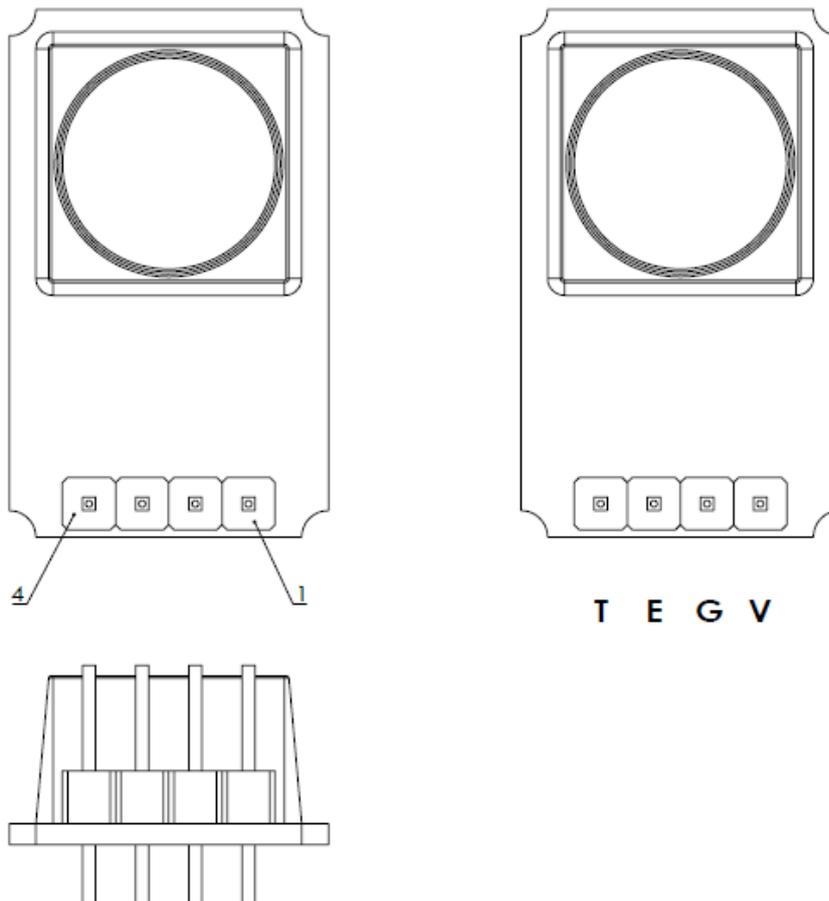
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2. Terminal descriptions

- 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 | RX-9 Simple | Vin, 3.3V, Voltage Input |
| | | RX-9 | 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 by another documents. RX-9 needs 2 ADC CH to transfer sensor data. Please check the master system it has spare 2 ADC CH.

4. QR Code information for RX-9



1054 4 C

CO2

EXSEN

RX-9 have QR code on the back side of sensor. It has calibration coefficient number and serial number

It comprised with 20 digits. For example, it is 157022167K0544CAB07A.

157 is calibration factor A

022 is calibration factor B

167 is Temperature compensation factor.

K0544CAB07A is serial number.

To use rx-9 sensor to your system, you should have QR-code reader and writing system to write the calibration factor to master

CO₂ Sensor Module

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5. Reliability Test Result for RX-9

1. Thermal Shock Test

- Ambient Condition: -40°C 30 min, 85°C 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°C, 1000 hr
- Electric Condition: 3.3V (<±0.1V)
- Sample No: 30 ea
- Pass Condition: CO₂ Gas exposure test (ppm Tolerance: <±10%, @1000 ppm of CO₂ 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% |

CO₂ Sensor Module

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3. High Temperature High Humidity Life Test

- Ambient Condition: 85°C, 85%, 500 hr
- Electric Condition: Operation
- Sample No: 30 ea
- Pass Condition: After Test, apply 400 ppm CO₂ gas with Air balance for 5 days to recover.

Then measure the CO₂ gas concentration under 1000 ppm of CO₂ (ppm tolerance: $\pm 10\%$)
@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°C
- 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 |

CO₂ Sensor Module

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5. Gas Exposure Test

- Ambient Condition: 25°C, 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 CO₂ concentration

| 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 |

6. 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°C 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.

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- 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 $\pm 25\%$ deviation at 5 min after starting and $\pm 15\%$ 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

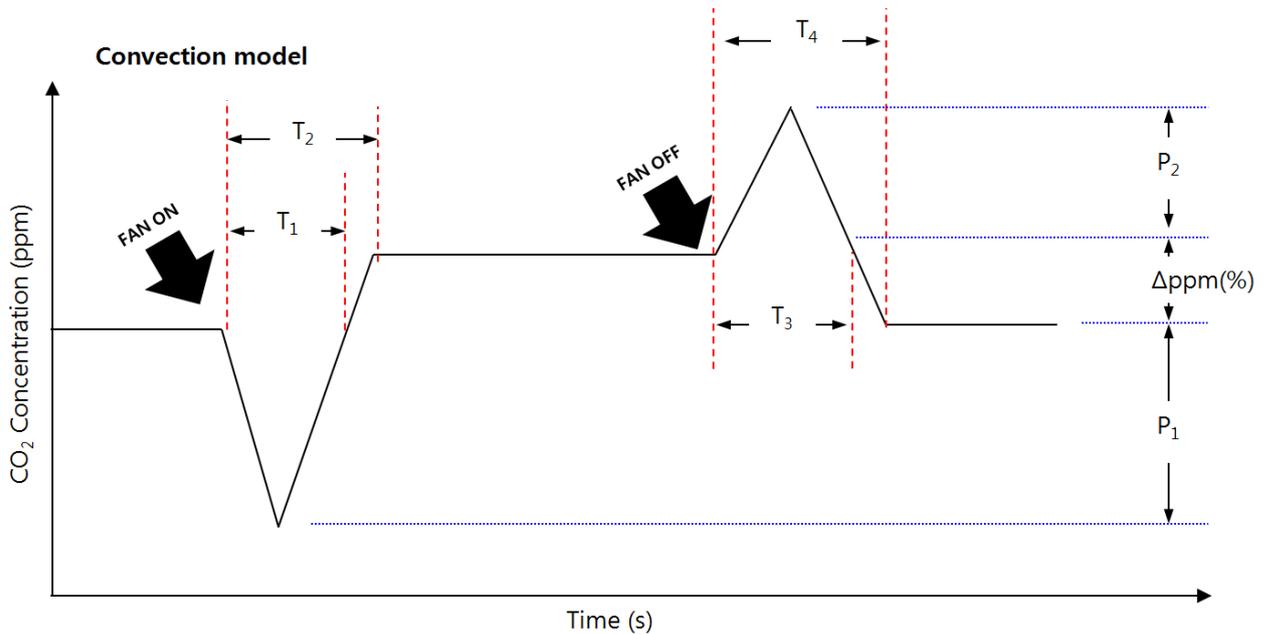


FIG. The convection model of temperature changing for sensor

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

| 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 |

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