CO_2 Sensor Module – RX-9

USER GUIDE – CO2 Concentration Calculation

This document explains "how to convert EMF to CO2 ppm". You can see the method of calibration.
The representative equation is like below.

$$CO_2(ppm) = 10^{\frac{cal\_A - EMF}{cal\_B}}$$

Equation 1. CO2 calculation

- CO_2(ppm) is real co2 gas concentration, you can measure or make condition the way you want. Unit: ppm
- cal_A is calibration variable
- cal_B is calibration constant.
- cal_A and cal_B is calculated from equation 1 like below

if lowest CO_2 concentration is 400 ppm and then EMF is 200 mV and
highest CO_2 concentration is 4000 ppm and then EMF is 150 mV.

$$\log_{10} 400 = \frac{cal\_A - 200}{cal\_B}$$

Equation 2-1 lowest CO_2 concentration equation

$$\log_{10} 4000 = \frac{cal_A - 150}{cal\_B}$$

Equation 2-2 highest CO_2 concentration equation

If you set the ambient CO2 concentration as 400 ppm and know the EMF value you can make the equation 2-1. At same way, you can make equation 2-2 too.
Now you have 2 equation and you did not know cal_A and cal_B yet. To get the cal_A and cal_B you can solve equation 2-1 and 2-2.

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$\log_{10} 400 = 2.60206$

$\log_{10} 4000 = 3.60206$

To solve equation 2-1 and 2-2, substitute numbers to equation 2-1 and 2-2

$$2.60206 = \frac{cal\_A - 200}{cal\_B}$$

Equation 3-1 log 400 calculation

$$3.60206 = \frac{cal\_A - 150}{cal\_B}$$

Equation 3-2 log 4000 calculation

From equation 3-1,

$$cal_A = 2.60206 \cdot cal\_B + 200$$

Equation 4-1 cal_A calculation

Substitute equation 4-1 to equation 3-2

$$cal\_B = 50$$

Equation 4-2 cal_B result

You can get cal_A as same way

$$cal\_A = 330.103$$

Equation 4-3 cal_A result

You can check the value again with equation 1

If EMF is 175 mV,

$$CO_2(ppm) = 10^{\frac{330.103 - 175}{50}} = 1264.911$$

Equation 4-4 CO_2 concentration check

Equation 1 is bone of equation. To compensate temperate, you can add some value to equation 1 like below

$$CO_2(ppm) = 10^{\frac{cal\_A-(EMF-DEDT(THER\_ini-THER))}{cal\_B}}$$

Equation 5 Temperature compensation equation

- DEDT is delta EMF / delta THER value. Unit: mV/Celsius
- THER_ini is the thermistor value when cal_A calculation. Unit: Celsius
- THER is current thermistor value. Unit: Celsius

DEDT is usually depends on finished structure. But normally set the DEDT as 1.

You can measure the DEDT at 1000 ppm of CO2 concentration, change the temperature from 20℃ to 30 ℃.

If EMF is changed 10 mV, you can solve it as 10 mV/(30℃-20℃) = 1 mV/℃

Now you can compensate temperature, but this is not end.

At RX-9 producing process, there is difference between sensor production and finished production. So add some offset value to enhance accuracy to equation 5.

$$CO_2(ppm) = 10^{\frac{cal\_A-(EMF-DEDT(THER\_ini-THER))}{cal\_B \times cal\_B\_offset}}$$

Equation 6 Add cal_B_offset value to equation 5

- Cal_B_offset value is 0.000 ~ 2.000
- You can measure cal_B_offset at finished product.
- Normally it shows 0.8~1.1 value. If you did not measure cal_B_offset value yet, you must set cal_B_offset value to 1.000.

Okay, this is the end of equation. You can find whole processing code at

https://github.com/EXSEN/RX-9

if you want to ask something, contact ykkim@exsen.co.kr, any time.