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SDEP Final Exam

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(2) **Design Summary**

To design a Nitrogen Dioxide (NO_2) sensor which will detect NO_2 Concentration when it exceeds 10 PPM. Furthermore any Leakage in NO_2 must stop or repair the plant.

To achieve the above objective we need to design an electronic ~~Sensor~~ Product which contain an Industrial Nitrogen Dioxide sensor (EC4-20-NO2).

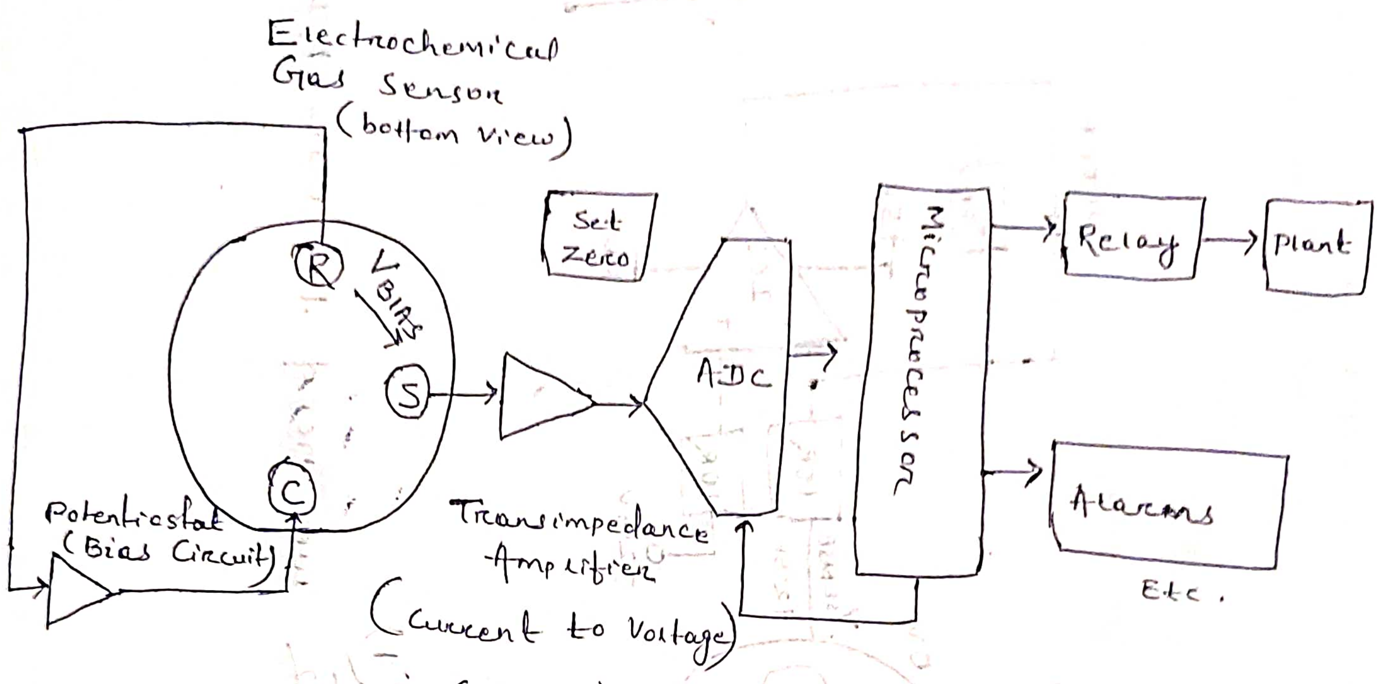
The above mentioned gas sensor is a 3 electrode ~~circuit~~ sensor for detecting toxic gases known as potentiostatic circuit. The electrochemical gas sensor requires a bias circuit known as potentiostat to maintain Correct bias potential between the sensing and reference electrodes. In many cases this will be 0V but some devices require either positive or negative bias potential. In our case $V_{BIAS} = 0V$.

→ The gas sensor produces an output current propotional to the gas Concentration. A current to voltage converter, also known as trans-impedance amplifier, is required to convert the small currents from the electrochemical cell into a useful voltage for measurement.

→ The analog to digital converter (ADC) samples the output of the trans-impedance amplifier and produce a digital reading of the voltage level. This is used by the microprocessor to calculate the actual gas concentration.

→ The microprocessor then will drive an Alaram to detect NO_2 concentration when ~~exceeds~~ exceeds 10 PPM & a Relay to stop or repair the plant in case of any leakage.

At some point in the system there will need to be a zero setting adjustment. This could be implemented in the hardware at the trans-impedance amplifier, or in Software within the microprocessor. The block diagram of the above mentioned Gas sensor is shown below.



(Fig-1)

(Block diagram of Typical Gas Detection system using an Electrochemical Gas Sensor)

R: Reference Electrode.

C: Counter Electrode.

S: Sensing Electrode.

Assumptions

→ The transmitted signal that is going from the sensor to to the transducer ~~short~~ are ~~is also~~ in EMI/EMC Free environment.

→ The amplification from micro volt to higher voltage for the Op-Amp comparator is done using transimpedance Amplifier.

Tradeoff

In the transimpedance amplifier we are using a resistor for current to voltage conversion. There will be a unnecessary power loss in the circuit due to the resistor

~~the~~

Transimpedance Amplifier.

R_{GAIN} defines the gain of the amplifier in V/A.

Taking $R_{GAIN} = 100k$, then

Transimpedance gain $= 10^5$ V/A.

From the Sensor datasheet (EC4 − 20 − NO2)

Sensor Sensitivity $= 600$ nA/PPM.

$= 6 \times 10^{-7}$ A/PPM

Then the system sensitivity is Calculated as :-

System sensitivity $= 6 \times 10^{-7} \times 10^{5}$ V/PPM.

$= 6 \times 10^{-2}$ V/PPM

$= 60$ mV /PPM

So 1 PPM = 60mV.

10 PPM = 600 mV = 0.6 V

In the given block diagram for 0 PPM ~~0PPM~~ we are getting 2.5 V as the output.

From the application note it is fond that for EC4 − 20 − NO2, the applied bias is 0V and the Vout polarity is −ve.

For 10 PPM = −0.6V. So, the $V_{Ref} = 2.5 - 0.6 = 1.9$ V

→ In the block diagram (2), the IC3 comparator is having reference 1.9V. , $V_{ref} = 1.9$ V.

By doing voltage division we got.

$$V_{act} = 5 \times \frac{3.3k}{5.6k + 3.3k} = 1.8539 \text{ V}$$

$$\text{Error} = V_{ref} - V_{act} = 0.046 \text{ V}.$$

But we know in our design 1 PPM = 0.06V. The error is less than 1 PPM. So, the design is efficient in nature.