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System Design of Electronic Products (Endsem)

Summary of how I approach the given Design problem:

Given a gas detection sensor (Honeywell EC-FX Ammonia gas sensor), I need to detect and alert when ammonia concentration exceeds 100 PPM in atmosphere.

→ Since as per datasheet, its a current output sensor, with the output current proportional to the ammonia gas concentration in PPM, and given that there are 3 variants of sensors, 0-100, 0-200, 0-250 PPM NH_3

My design choice would be to go with 0-200 PPM NH_3 sensor since the threshold we want to detect (100 PPM) lies in the midway of range 0-200 PPM.

→ And then ~~[struck]~~ I'll be converting this output current into voltage by ~~[struck]~~ connecting appropriate valued resistor in series with sensor output terminal and measure the output voltage across it.

⇒ As per the given datasheet, it says Baseline offset (for clean air) is 0.2 mA, and sensitivity is 100 ± 40 nA/ppm.

→ As I'll be using 0-200 PPM NH_3 range gas sensor, assuming output current is 0.2 mA at 0 PPM (clean air), considering the average sensitivity of 100 nA/ppm the output current at our required threshold of 100 ppm is

$$(0.2\,mA) + (100 \times 100)\,nA = 0.21\,mA$$

→ Considering the worst case sensitivities ($(100+40)$ nA/ppm and $(100-40)$ nA/ppm) we have sensitivities as 140 nA/ppm and 60 nA/ppm.

→ For 140 nA/ppm, output current at 100 PPM is $[(0.2 mA) + (100 \times 140) nA]$

$= (0.2 mA + 0.014 mA) = 0.214 mA$

→ For 60 nA/ppm, output current at 100 ppm NH_3 is $[(0.2 mA) + (100 \times 60) nA]$

$= (0.2 mA + 0.006 mA)$

$= ~~0.2006~~$ $0.206 mA$.

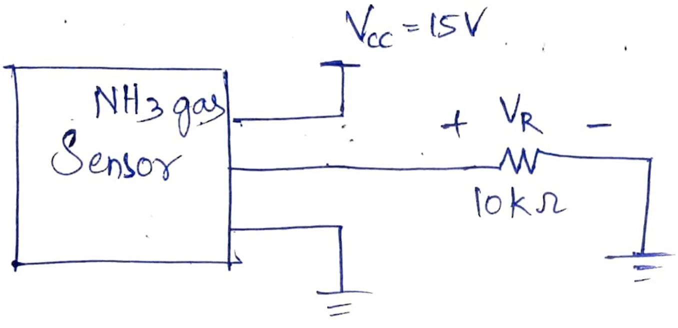
→ So, basically for our threshold at 100 ppm NH_3, output current is somewhere between (0.206 mA - 0.214 mA) depending on sensitivity. And since these are too small values, I'm choosing the resistance value as 10k Ω so that the voltage across the resistance ranges in

$((0.206 mA) \times (10k\Omega) - (0.214 mA) \times (10k\Omega))$

$= 2.06 V - 2.14 V$ for 100 PPM NH_3 conc.

→ But since safety is the first priority here, I'll be going with lowest value of 2.06 V for the ~~lower bound~~ threshold 100ppm NH_3 conc.

⇒ It implies that if the ~~output~~ voltage across that series resistor with sensor exceeds 2.06 V, it raises buzzer/alarm.

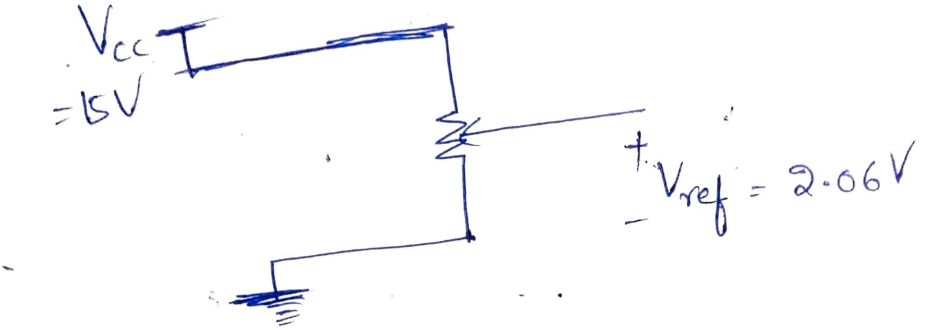


if $V_R > 2.06V$ ⇒ raise alarm / buzzer

else → do nothing and relax :)

→ For achieving this, I'll be using LM741 opamp as comparator ($V_{cc} = 15V$) with reference voltage given as 2.06 V.

→ For achieving the reference voltage 2.06V, I'll be using a simple voltage divider circuit ~~as below~~ ~~and~~ (a potentiometer)



→ And importantly, all the resistors I'll be choosing will be the ones with least tolerance values (±5%) so that our calculations won't go too wrong / bad in the worst case scenarios.

→ And finally.. the output of this comparator is connected to a red LED as well as a piezoelectric buzzer (which is a DC buzzer, works with DC voltage) for visual and audio alarms respectively to alert if NH_3 conc. is higher than 100 ppm in atmosphere.