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CA3a

Question

Please analysis this force sensing application and design the amplifier gain and the the gain registor(R_G) of the instrumentation amplifier as shown in below Figure 1(where R_1=R_2=25 KΩ)

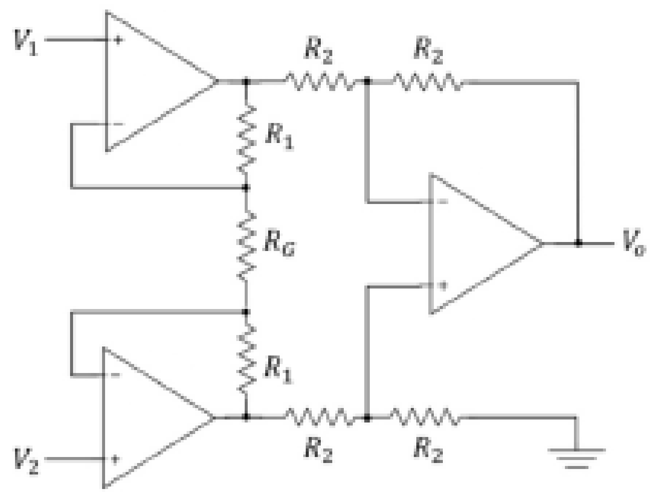

Figure 1: ADC structure

Analysing

Firstly, we know that the force sensor is used to measure a contact force which range is from 0 to 2 N. After seeing the key metric of this force sensor specifications, the sensitivity(60 mv/N) of this force sensor is crucial to calculate the output range of force sensor. Here are the results:

$$V_{force} = 60 * 2 = 120mv = 0.12V \tag{1}$$

Then, we focus on the ADC(Analog-to-digital converter) part. At the same time, we know that the requirement of output of this ADC is range from -10V to 10 V, so we can get the output range of ADC.

$$V_{ADC} = 10 - (-10) = 20v \tag{2}$$

Based on the requirement of this question, we should know that the amplifier gain in Figure 2 is at least $\frac{V_{ADC}}{V_{force}}$.

$$A_V = \frac{V_{ADC}}{V_{force}} \approx 167 \tag{3}$$

Following the definition of Amplfier gain in lecture notes, we can use the calculation equation of amplifier to get the result of R_{gain}

$$A_V = \frac{V_{ADC}}{V_{force}} = (1 + \frac{2R_1}{R_{gain}})\frac{R_3}{R_2} \tag{4}$$

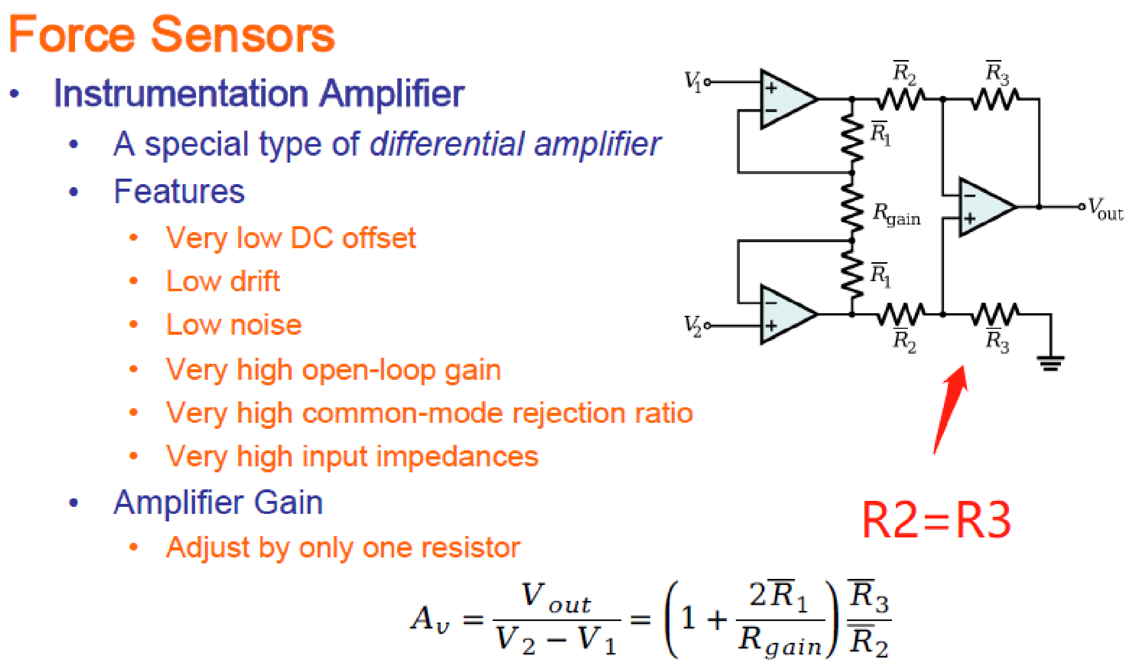

Figure 2: Definitions in the lecture notes

Finally, through the specification of this ADC($R_2 = R_3$), as a result, we can get the R_{gain} from this below equation.

$$R_{gain} = \frac{2R_1}{A_v - 1} \approx 301\Omega \tag{5}$$

Conclusions

Force sensing application

This force sensing application: The system use the force sensor to sense the range of force, and then amplify this signal by using this amplifier. As a result, ADC get the correct signal from a special filter.In a word, through this process in Figure 3 and calculating transformation, the user can know the variety of the initial force.

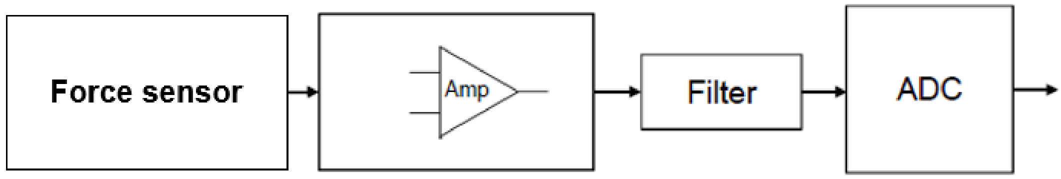

Figure 3: The total process of force sensing application

Amplifier gain

From the result in Analysing part, the Amplifier gain is about 167.

Gain resistor

Through the calculation in Analysing part, the gain resistor is about 301Ω.