EE230 : Analog Circuits Lab

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Experiment 7 : Instrumentation Amplifiers

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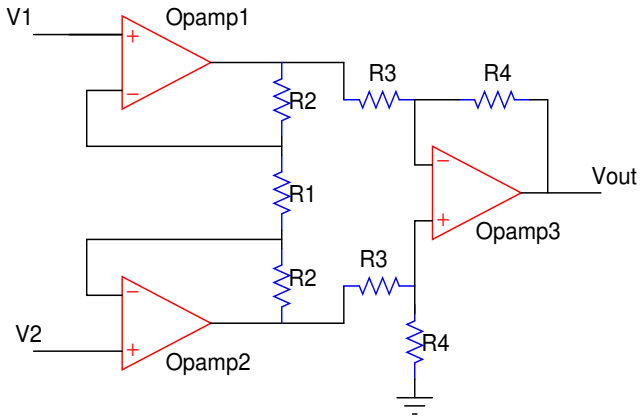
Three-Opamp Instrumentation Amplifier using TL084

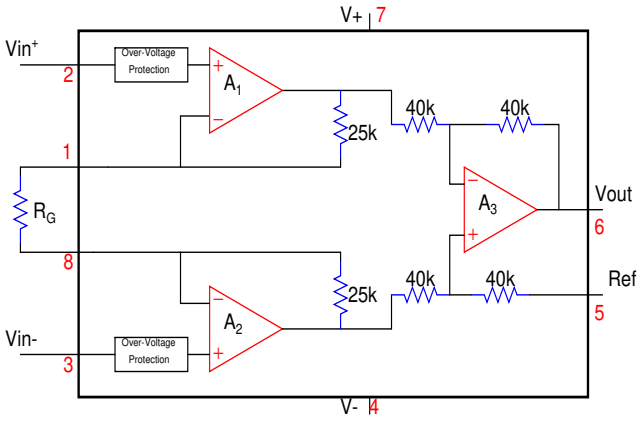


The differential voltage gain of the above amplifier,

$$A_d = \frac{V_{out}}{(V2 - V1)} = \frac{R4}{R3}(1 + \frac{2R2}{R1})$$

where the second term [1+ (2R2/R1)] is the Ad of the first difference amplifier, while (R4/R3) is the Ad of the second one.

INA128 Instrumentation Amplifier



The differential voltage gain of the above amplifier is also,

$$A_d = \frac{V_{out}}{(V2 - V1)} = \frac{R4}{R3}(1 + \frac{2R2}{R_G})$$

INA 128 is a low cost, general purpose instrumentation amplifier employing the standard three-Opamp instrumentation amplifier design

Learnings

1) INA128 Instrumentation Amplifier has a slight beneficial edge over Three-Opamp Instrumentation Amplifier using TL084 due to it's adjustability. One can have more control over the gain in INA128 Instrumentation Amplifier as compared to Three-Opamp Instrumentation Amplifier due to adjustable resistor R_G.
2) Over-Voltage Protector in INA128 Instrumentation Amplifier is also it's another benefit.
3) Three-Opamp Instrumentation Amplifier can be built on the bread board but not INA128 Instrumentation Amplifier.

Answer to the questions

Q1) In Sec 3.2 and 3.3, even under no-load conditions Vout was found to be non-zero. Give one or two reasons for this.
Answer :
1) V_{out} is non-zero due to the offset voltage even for no load condition.
2) There is more offset in the V_{out} in Instrumentation Amplifier using TL084 as compared to INA128 Instrumentation Amplifier because offset voltage in INA128 as compared to TL084.

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Q2) Give two or three major advantages of the three-Opamp instrumentation amplifier as compared to the single-Opamp difference amplifier of Experiment 6.
Answer :
1) Input resistance (R_{in}) for Three-Opamp Instrumentation Amplifier is ideally infinity which is very high as compared to Single-Opamp Instrumentation Amplifier.
2) It is easy to change the Differential Voltage Gain (A_d) in Three-Opamp Instrumentation Amplifier by only changing a single resistor and still having the Common-mode Voltage Gain (A_{cm}) equal to zero.
3) For practical purposes, Three-Opamp Instrumentation Amplifier has larger Common Mode Rejection Ratio (CMRR) than Single-Opamp Instrumentation Amplifier.

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Q3) Look at the data sheets of TL084 and INA 128. Identify the major differences between these two ICs – i.e. Opamp parameters crucial for difference amplifier applications, such as the Loadcell application discussed in this experiment.
Answer :
1) Drift is low for Three-Stage Instrumentation Amplifier.
2) Input bias current is low for Three-Stage Instrumentation Amplifier.
3) Low offset voltage for Three-Stage Instrumentation Amplifier.
4) High Common Mode Rejection Ratio (CMRR) for Three-Stage Instrumentation Amplifier.

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Q4) Identify one or two parameters of the INA128 that makes it superior to the TL084 based instrumentation amplifier.
1) INA128 has low input bias current and voltage offset as compared to TL084.
2) Common Mode Rejection Ratio (CMRR) for INA128 is very high as compared to TL084.

References

1) Lecture Slides
2) Sedra-Smith
3) WEL Resources for NGSpice