Quiz: Instrumentation Amplifier (IA) topologies: one-amp

TI Precision Labs – Instrumentation Amplifiers

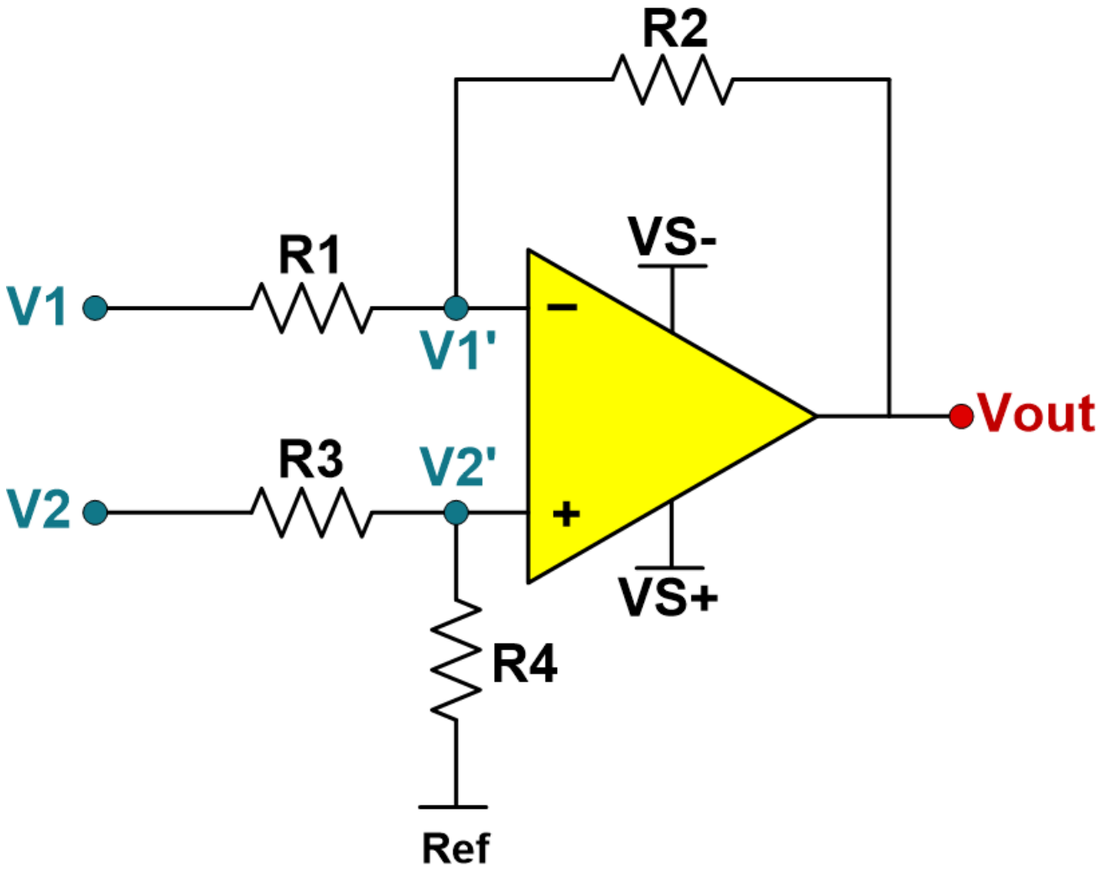
Presented by Tamara Alani

Prepared by Tamara Alani

Quiz: (IA) topologies: one-amp || Question

1. What is the simplified output equation of a one-amp IA assuming R2 = R4 and R1 = R3?

   a) Vout = V2 × V1
   b) Vout = R2/R1 × (V2 – V1) + Ref
   c) Vout = Ref × (V2 – V1)
   d) Vout = V1 × V2 × Ref



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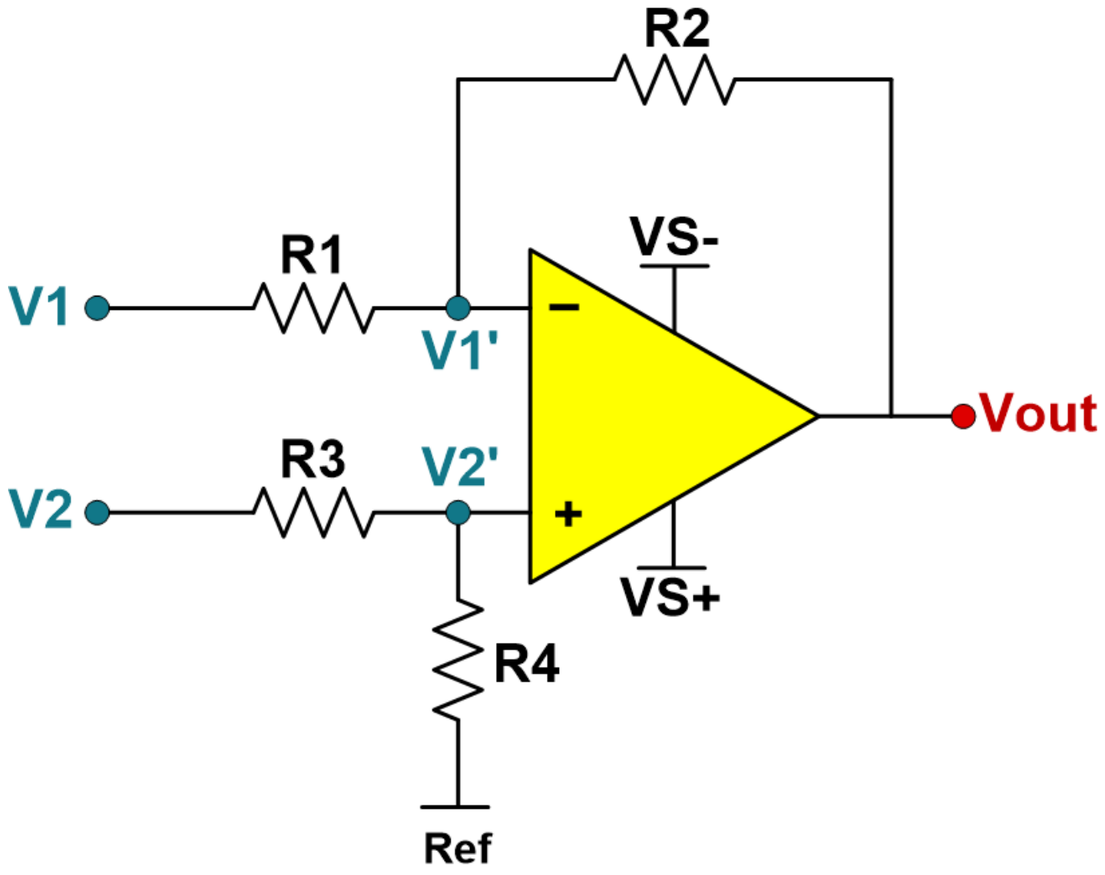

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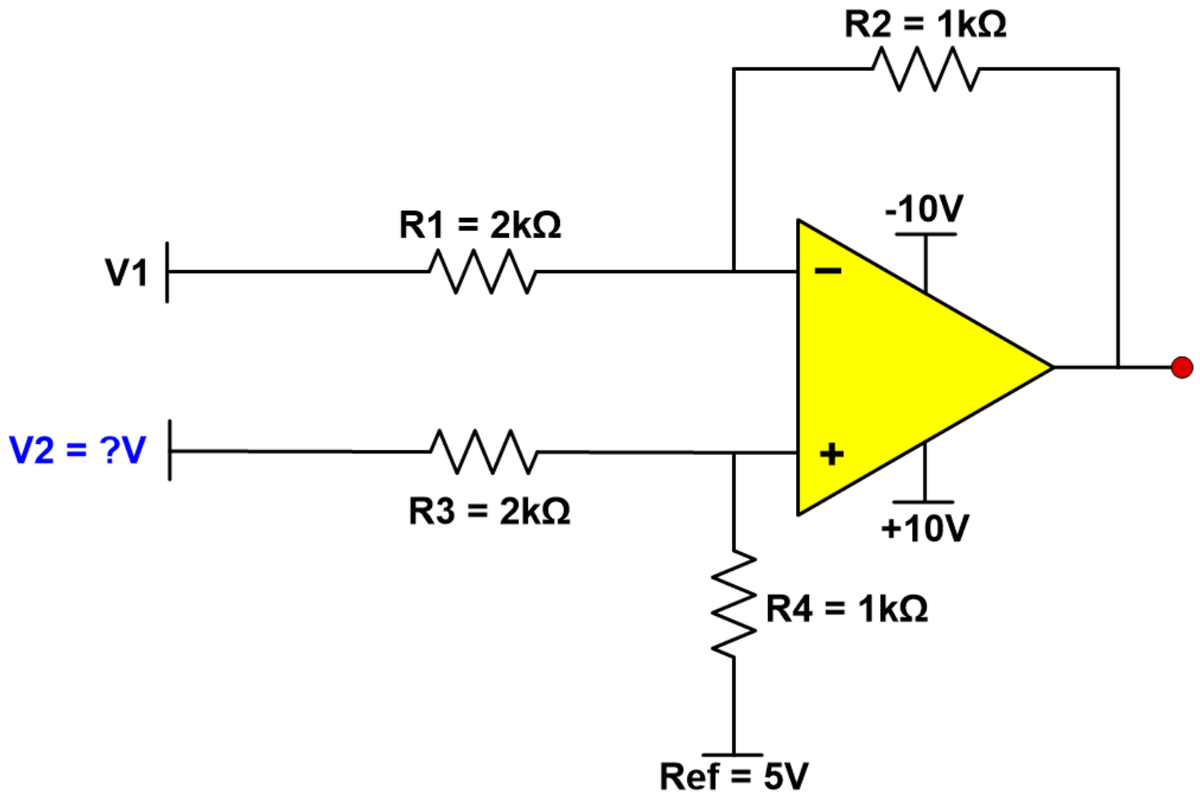
2. In the circuit shown below, what is the maximum voltage you are able to place on V2 and still maintain linear input operation, assuming rail-to-rail input operation?

   a) V2 = 10V
   b) V2 = 15V
   c) V2 = 5V
   d) V2 = 20V



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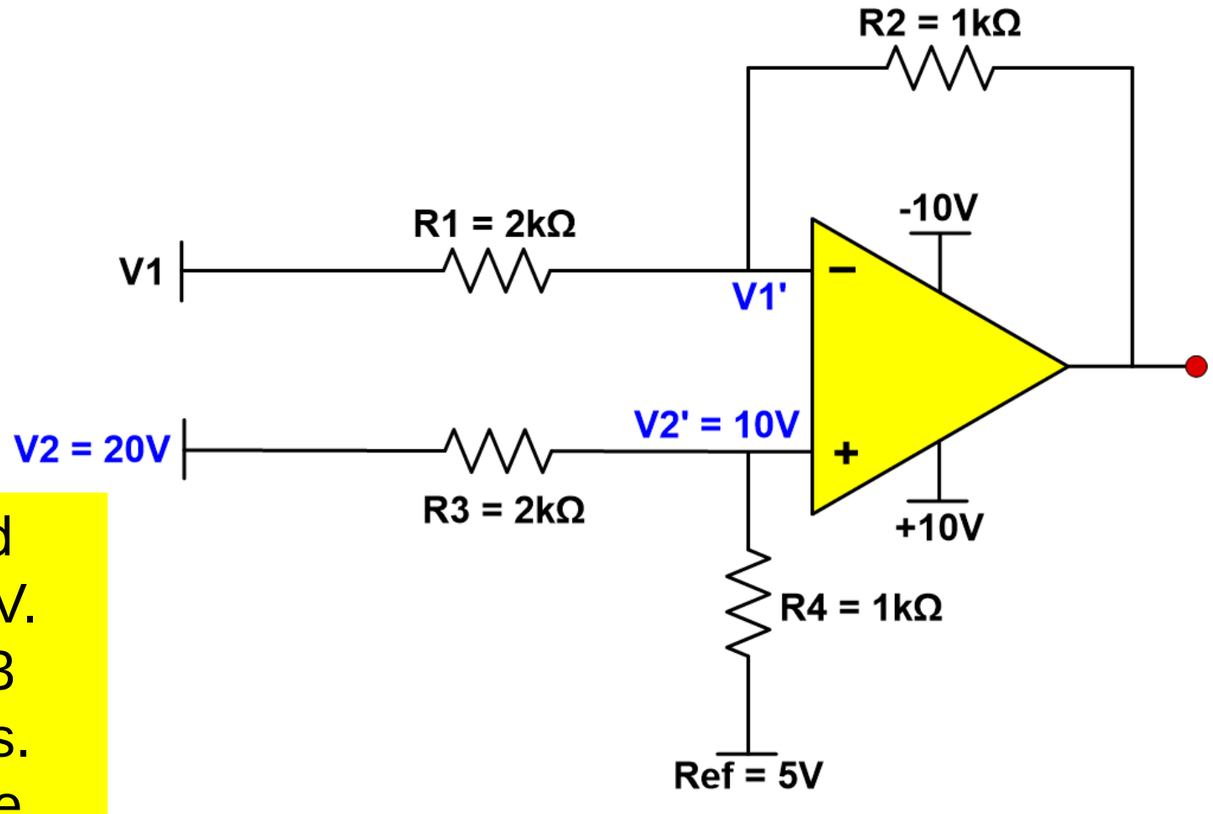

Rail-to-rail input: the voltage seen at V2' and V1' need to be at most 10V and at least -10V. Because of the voltage divider formed by R3 and R4, V2 can be beyond than the supplies. Take caution, there is a 5V reference voltage.

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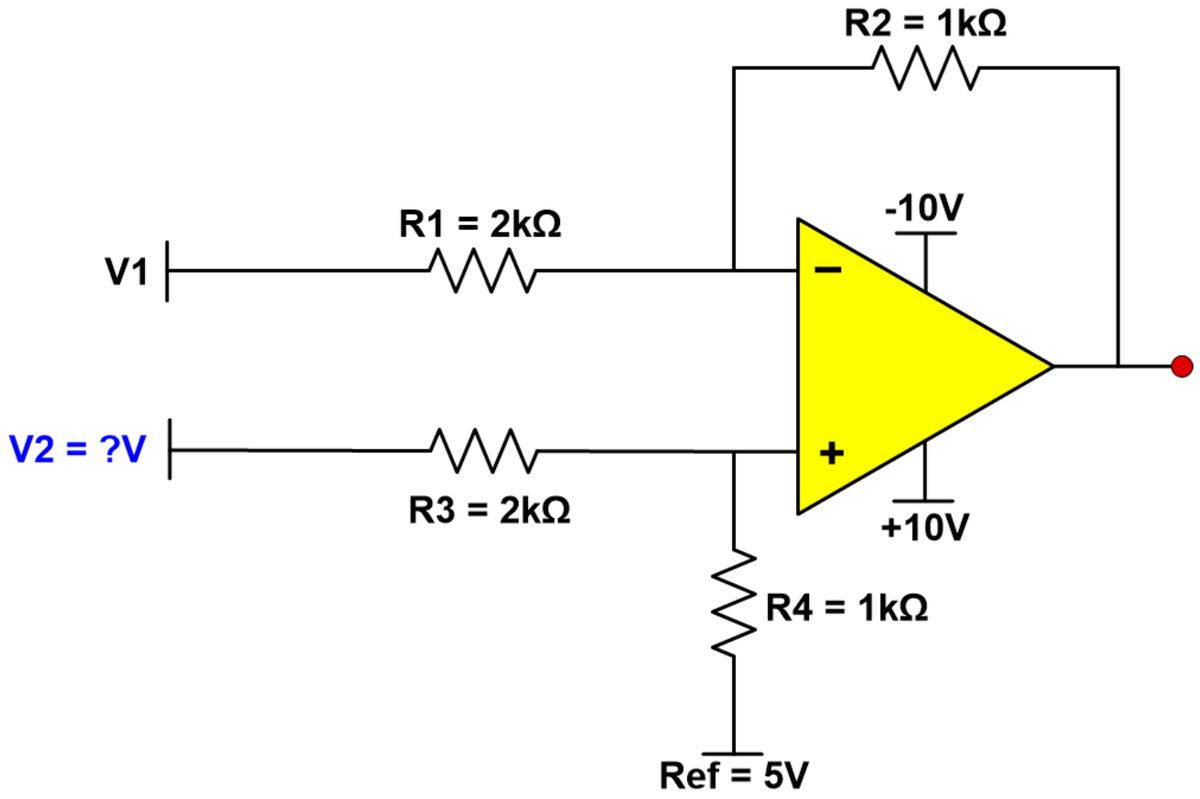
3. In the circuit shown below, what is the minimum voltage you are able to place on V2 and still maintain linear input operation, assuming rail-to-rail input operation?

a) V2 = -10V

b) V2 = -40V

c) V2 = 0V

d) V2 = -20V



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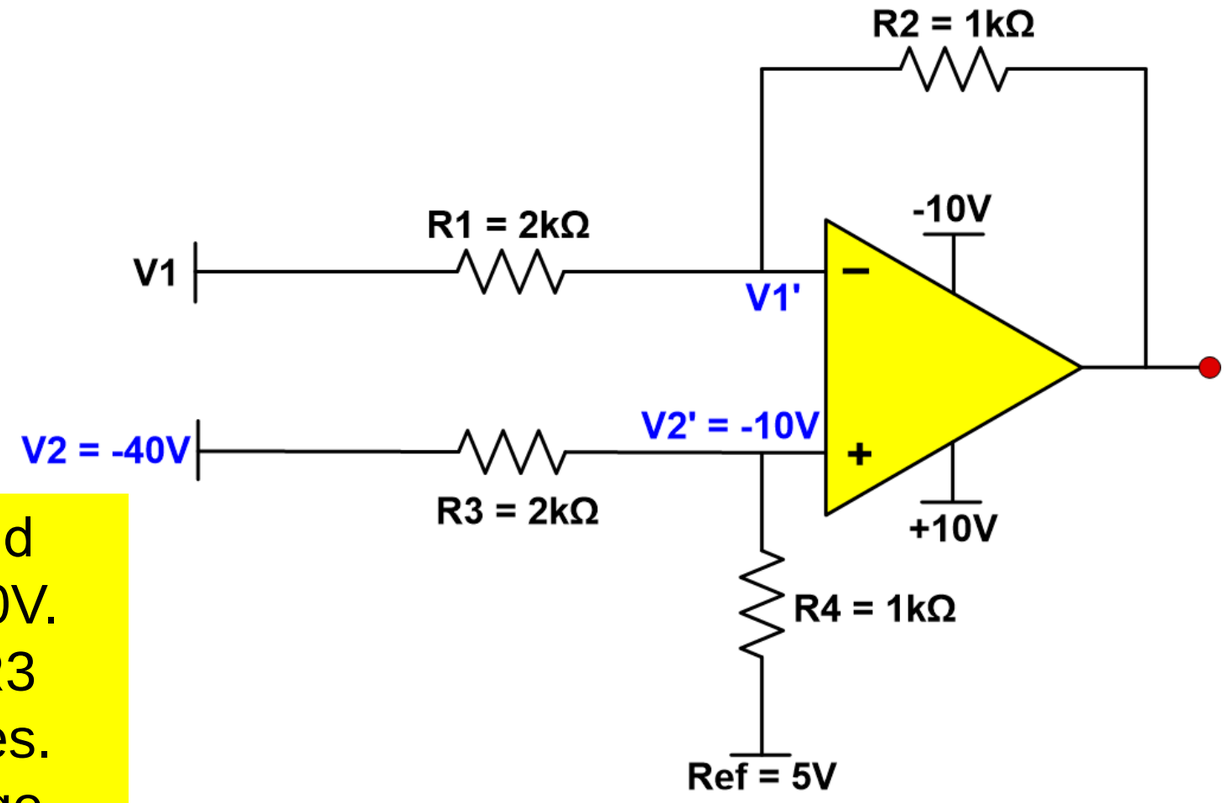

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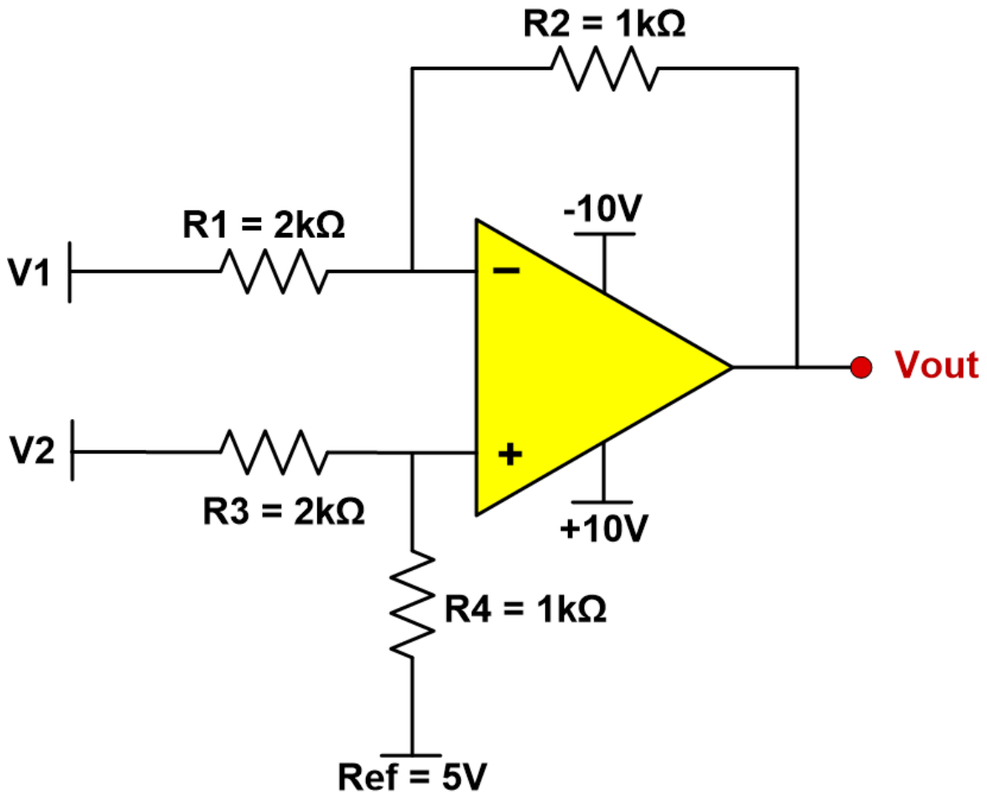
4. Create a boundary plot to graphically show the usable range of this IA given that the supplies are ±10V and the reference voltage is set to 5V.



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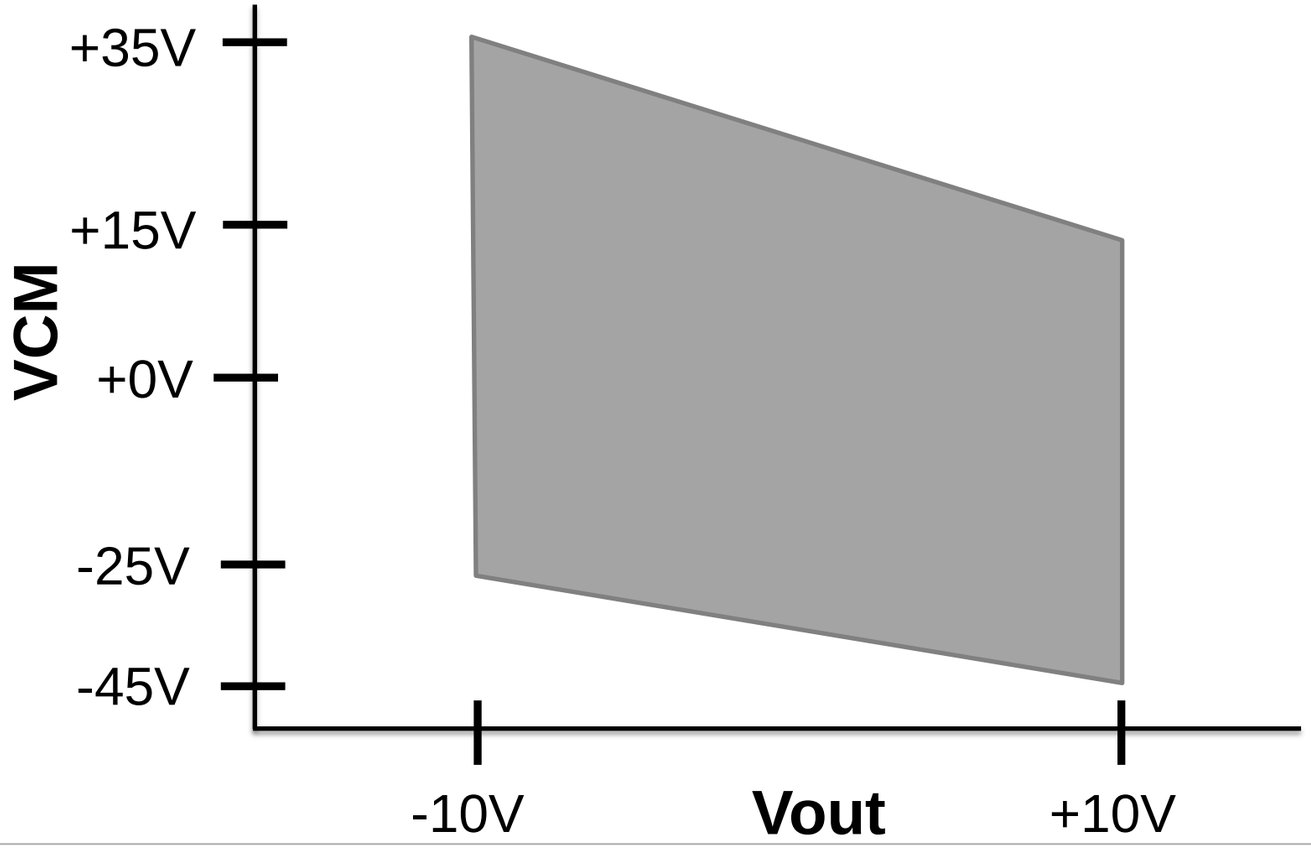

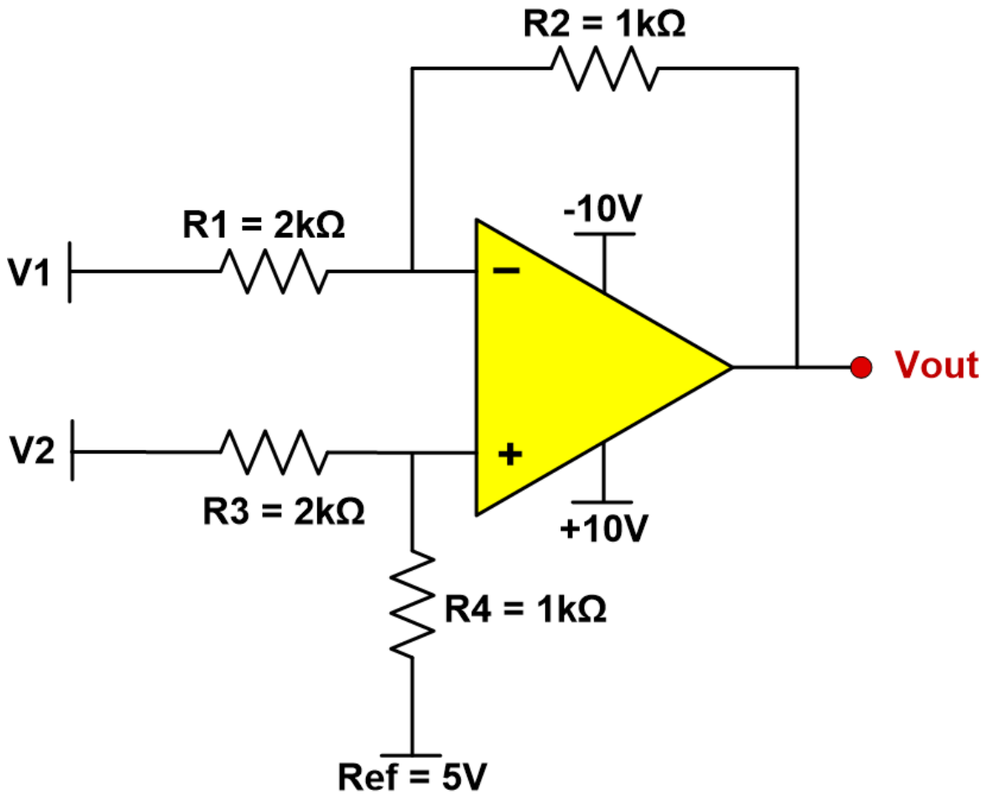

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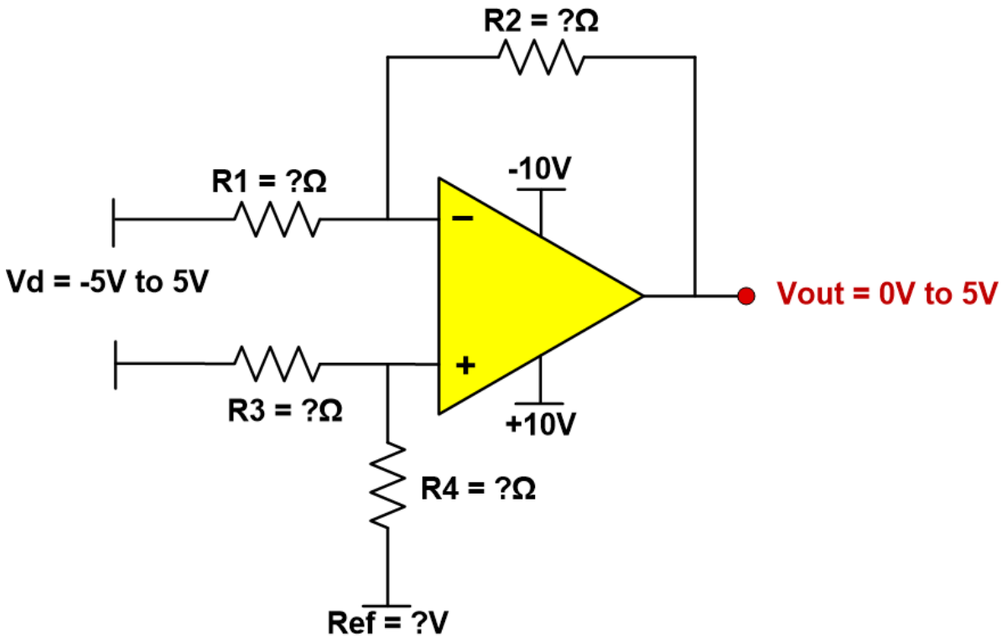
5. Assume we have an input signal of -5V to +5V. We would like to process this with a 5V ADC. So when Vin equals -5V, we want to see 0V at the output. And when the input is +5V, we want to see +5V at the output. Determine the gain and reference voltage required to achieve this.



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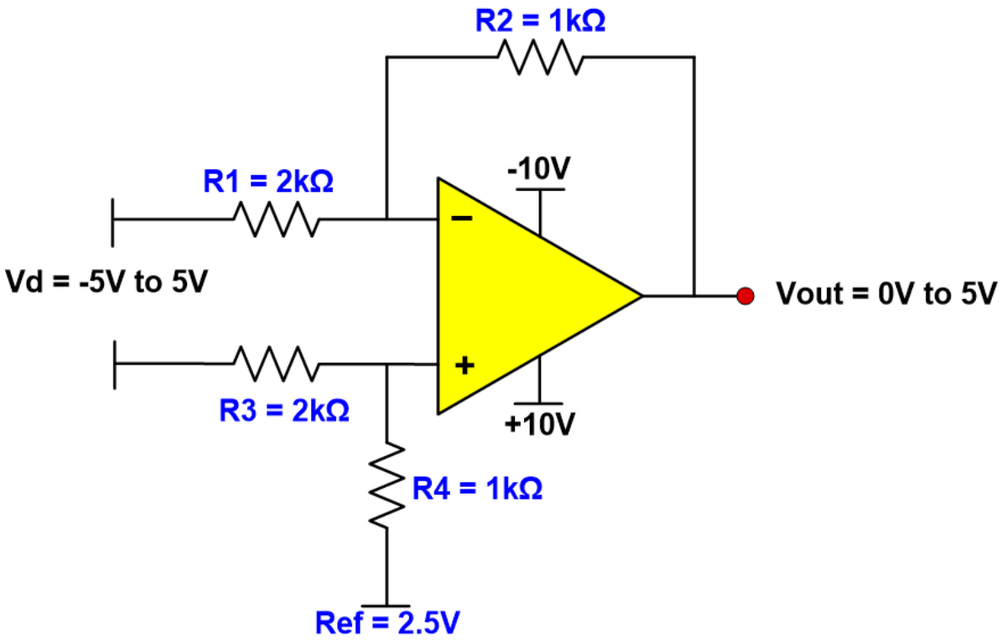

- Solve for Gain:

$$\text{Gain} = \frac{\Delta\text{Vout}}{\Delta\text{Vd}} = \frac{5}{10} = \frac{1}{2} = \frac{Voutmax - Voutmin}{Vinmax - Vinmin}$$

$$\text{Choose R2}=\text{R4}=1\text{k}\Omega,\ \text{R1}=\text{R3}=2\text{k}\Omega$$

- Solve for Ref:

$$\text{Vout} = \text{Ad} \times \text{Vd} + \text{Ref}$$

$$0 = \frac{1}{2} \times (-5) + \text{Ref} \rightarrow \text{Ref} = 2.5\text{V}$$

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