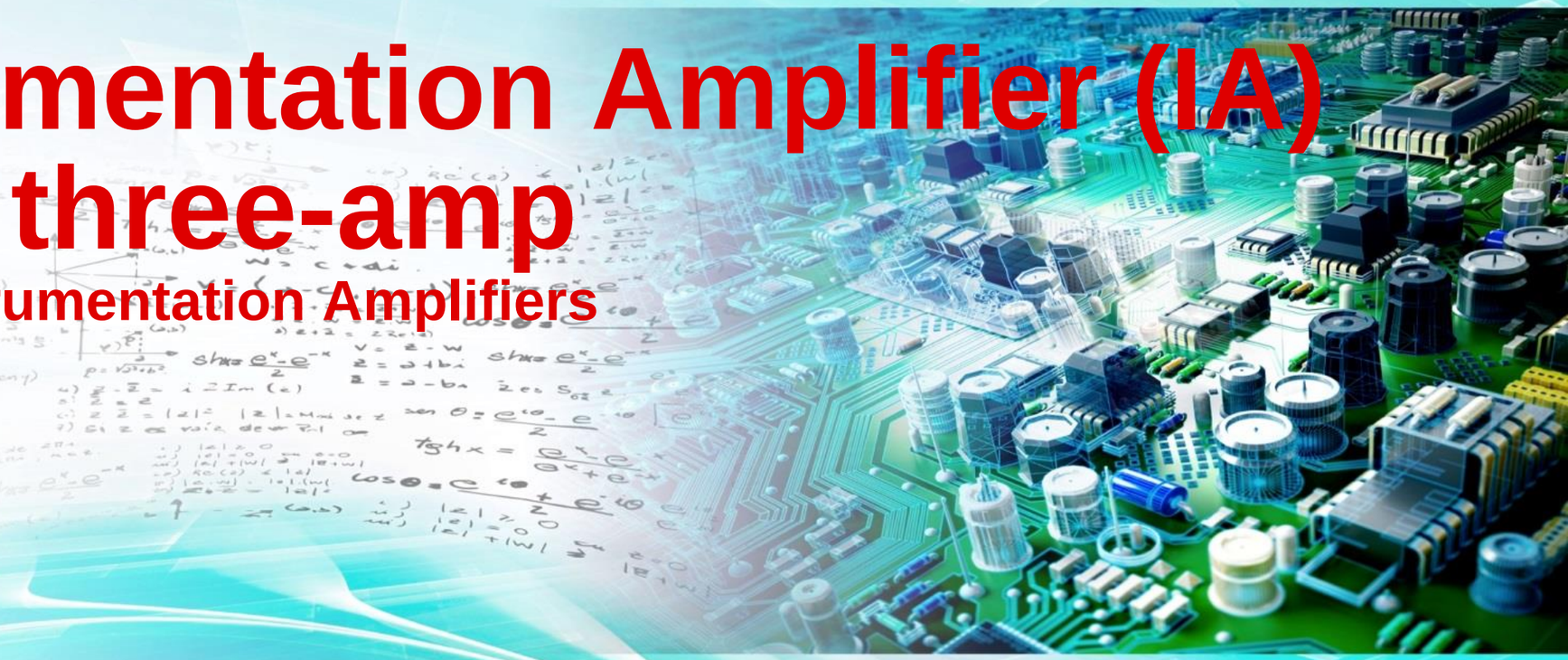
Quiz: Instrumentation Amplifier (IA) topologies: three-amp

TI Precision Labs – Instrumentation Amplifiers



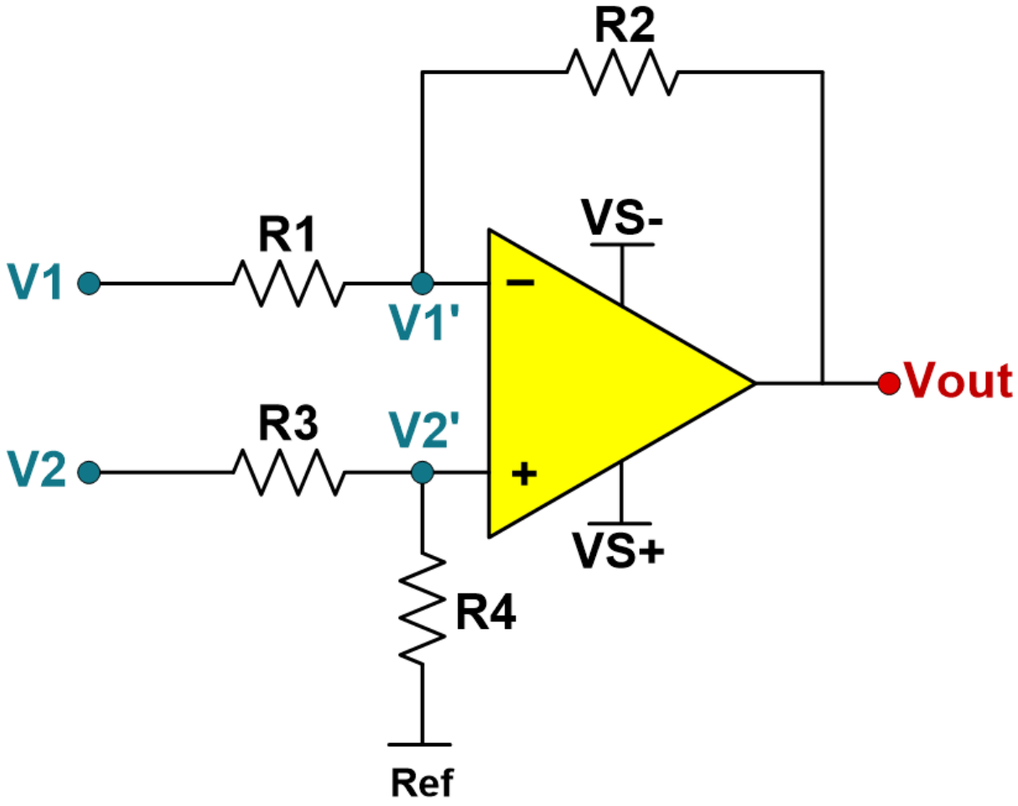
Presented by Tamara Alani

Prepared by Tamara Alani

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

1. What are two challenges associated with the discrete one-amp IA topology?

a) The one-amp IA consumes more power
b) The one-amp IA has low input impedance
c) The one-amp IA must have precision-matched resistors for high accuracy
d) The one-amp IA has fixed gain
e) The one-amp IA can only be used for mV-level input signals
f) b & e
g) c & a
h) b & c



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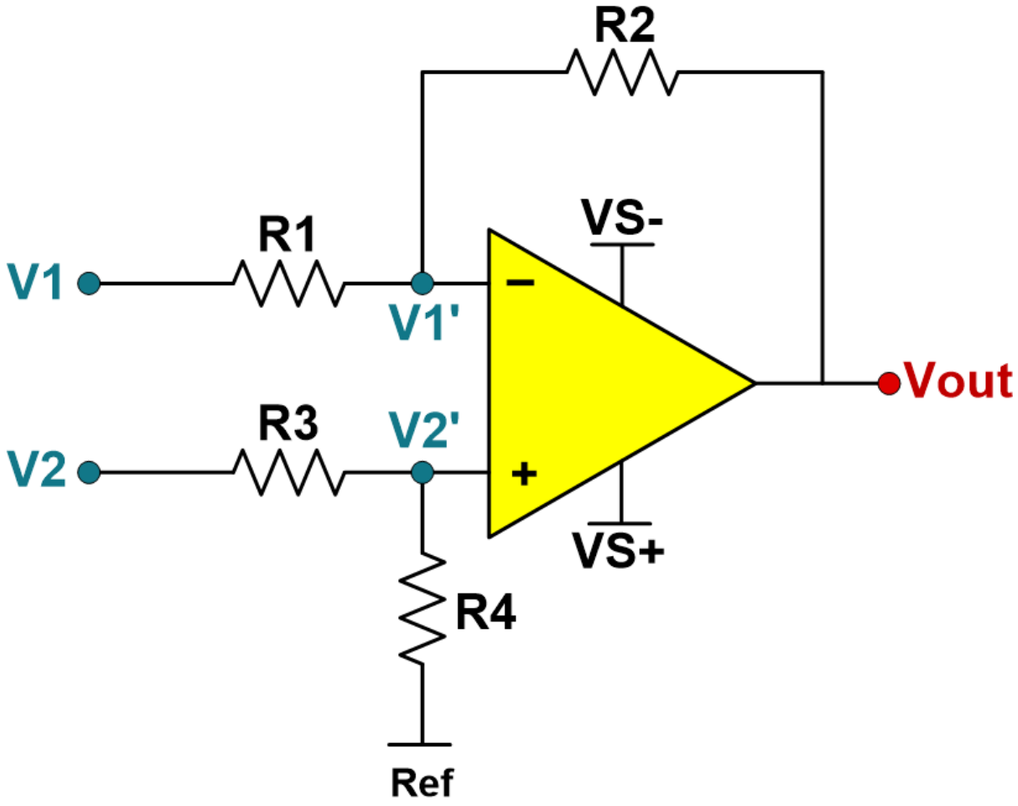

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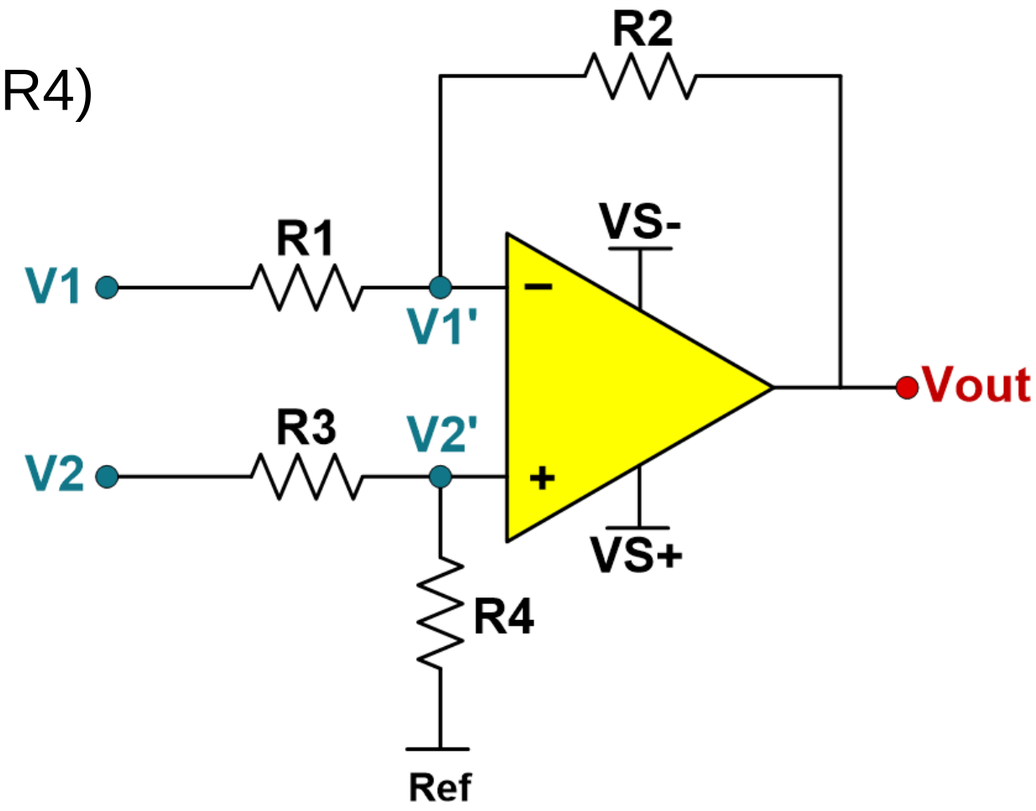
2. A one-amp IA has low input impedance. What is best way to resolve this?

a) Add really large input resistors (R1 through R4)
b) Put the amplifier in high gain
c) Add two buffers at the inputs (V1 and V2)
d) Find an amplifier with high input impedance



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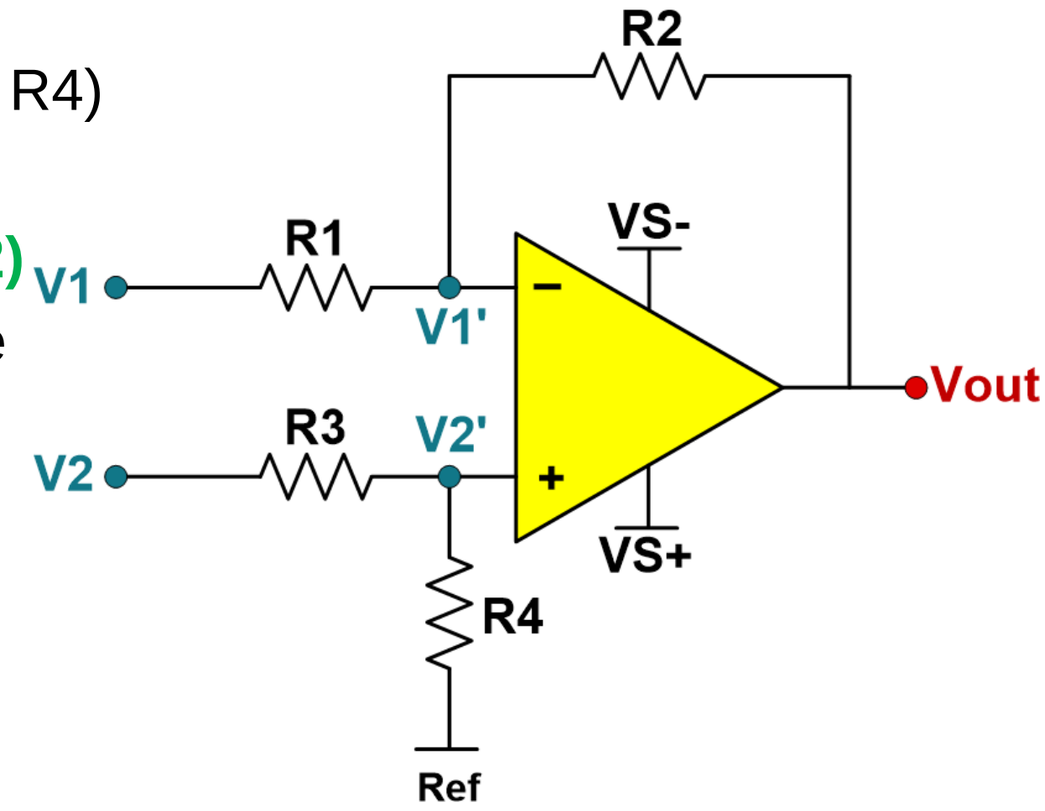

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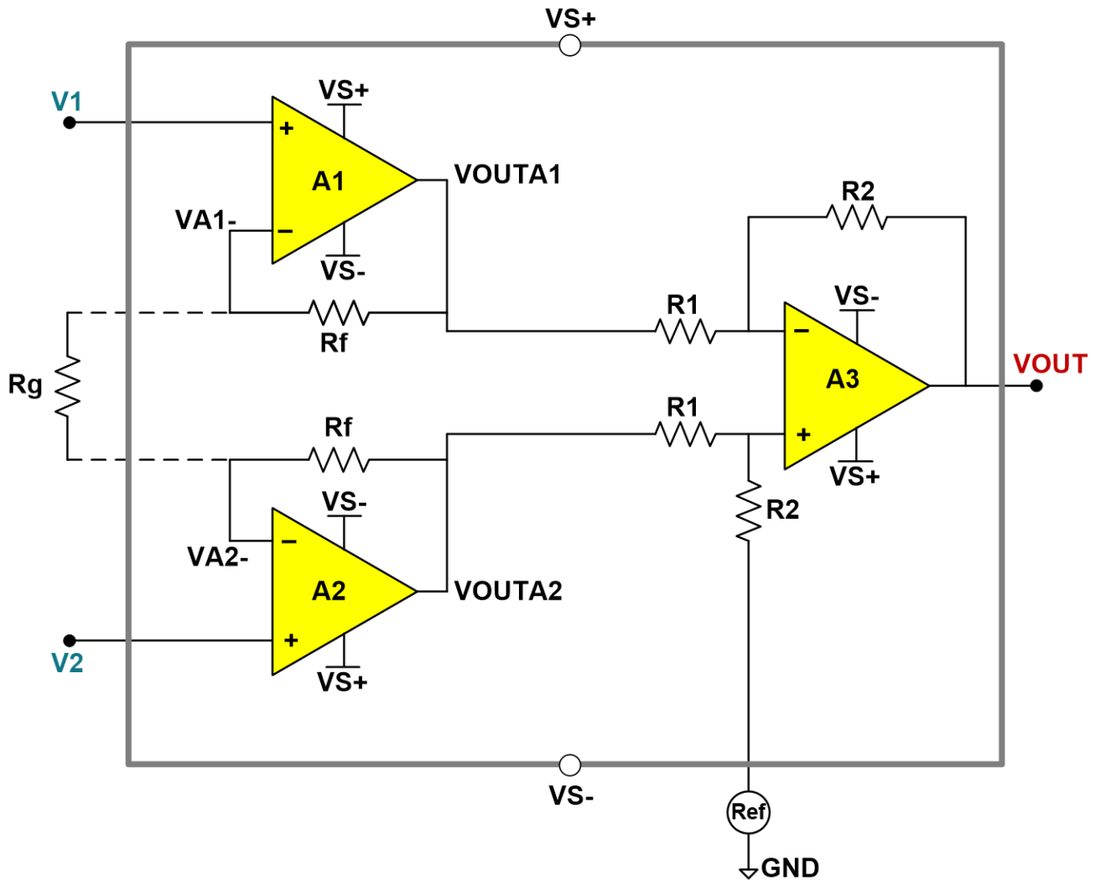
3. What is the gain equation for a three-amp IA?

a) $\text{Gain} = \frac{\text{R2}}{\text{R1}}$

b) $\text{Gain} = \text{Rg}$

c) $\text{Gain} = \frac{\text{R2}}{\text{R1}} \times (\text{Rg} + 2 \times \text{Rf})$

d) $\text{Gain} = \frac{\text{R2}}{\text{R1}} \times \left(1 + \frac{2 \times \text{Rf}}{\text{Rg}}\right)$



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c) $\text{Gain} = \frac{R2}{R1} \times (Rg + 2 \times Rf)$

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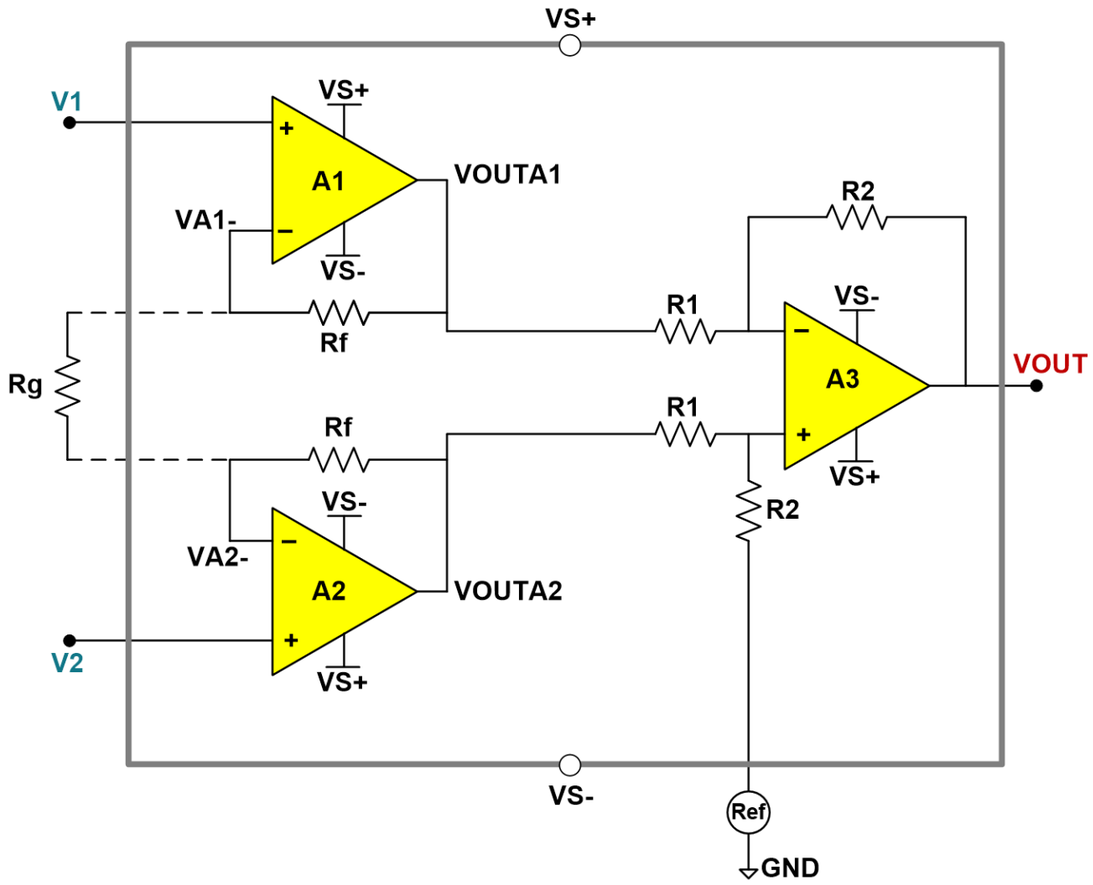

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4. Using the INA333-Q1 (TI's Automotive, Zero-drift, low power IA), what value of Rg do you need to achieve a signal gain of 501V/V?

a) Rg = 100Ω
b) Rg = 200Ω
c) Rg = 200kΩ
d) Rg = 501Ω

HINT:

Go to the product datasheet:
https://www.ti.com/lit/ds/symlink/ina333-q1.pdf

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$$\text{Gain} = \left(1 + \frac{100\text{k}\Omega}{\text{Rg}}\right)$$

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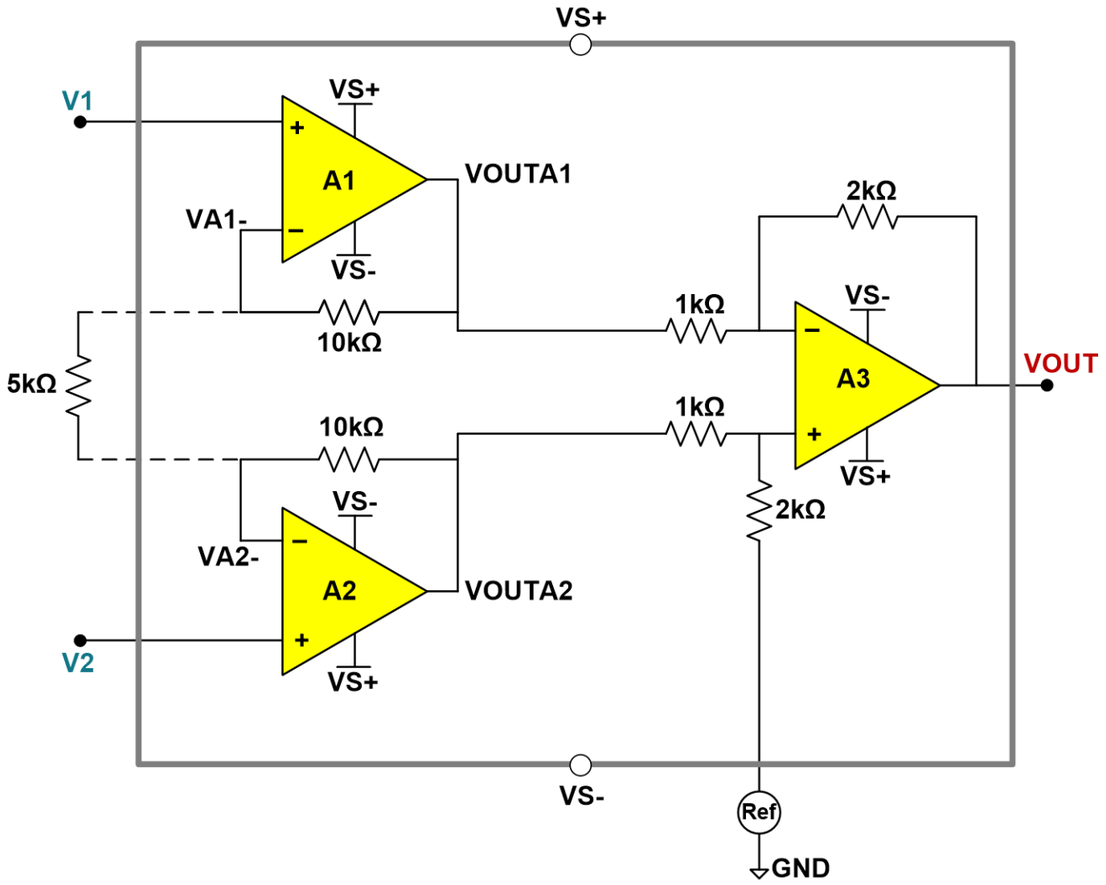
5. What is the differential gain of the following circuit?

a) Gain = 5V/V

b) Gain = 2V/V

c) Gain = 4V/V

d) Gain = 10V/V



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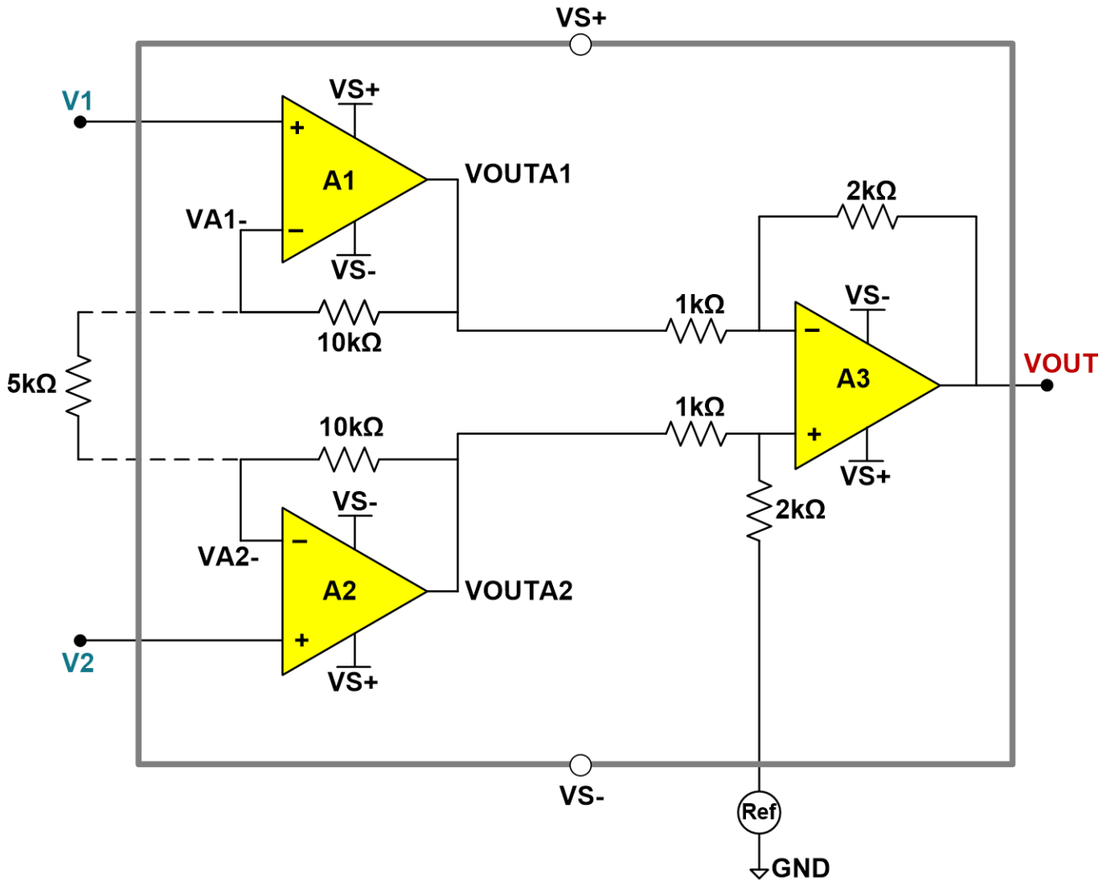

HINT:

$$Ad = \frac{R2}{R1} \times \left(1 + \frac{2Rf}{Rg}\right)$$

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6. Using the INA818 (TI's high-precision, low-power IA with over-voltage protection), create a boundary plot for the following conditions:
   - Voltage supply = ±15V
   - Gain = 100V/V
   - Reference = 0V
   - Common mode voltage = 8V

HINT:

Use the INA Boundary Plot calculator in the **Analog Engineer's Calculator**: https://www.ti.com/tool/ANALOG-ENGINEER-CALC

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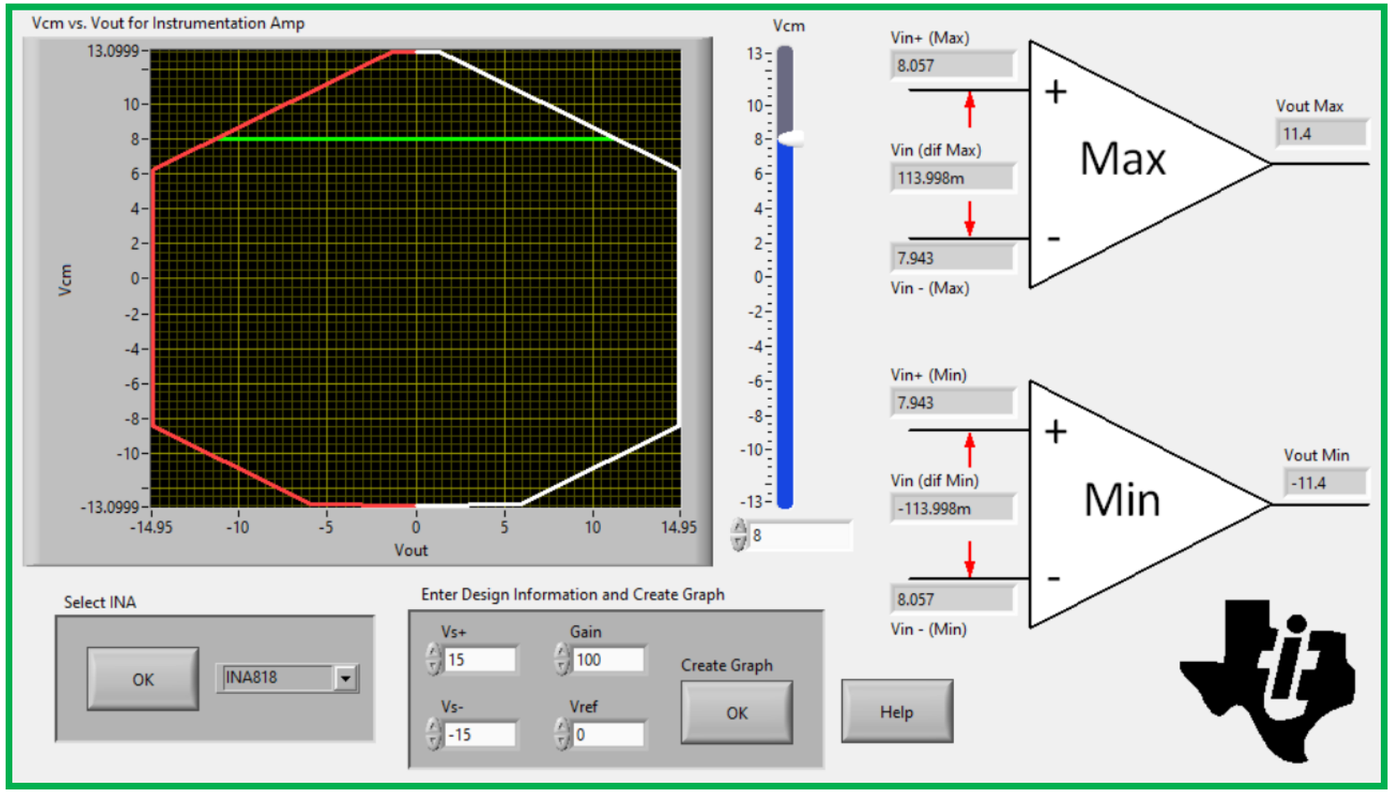

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7. In theory, how does CMRR change with signal differential gain

   a) When signal gain is increased, ACM / Ad will increase so CMRR will double
   b) When signal gain is decreased, ACM / Ad will increase so CMRR will increase in direct proportion to gain
   c) When signal gain is increased, Ad / ACM will increase so CMRR will increase by a factor of 1/2
   d) When signal gain is increased, Ad / ACM will increase so CMRR will increase in direction proportion to gain

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HINT:

$$CMRR\left(\frac{V}{V}\right) = \frac{differential\ gain}{common\ mode\ gain} = \frac{A_d}{A_{CM}}$$

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8. What are the typical magnitudes of input impedance for a 3 op amp IA?

   a) 1 Ω to 1k Ω
   b) 1k Ω to 100k Ω
   c) 100k Ω to 10M Ω
   d) 10^9 Ω to 10^{12} Ω

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9. How do you determine the total current consumption of a 3 op amp IA?

   a) Look for the quiescent current specified in the datasheet and multiply it by 3
   b) (Load currents (i1, I2, and i3) + quiescent current) multiplied by 3
   c) Load currents (i1, I2, and i3) + quiescent current + any loading on Vout
   d) (Load currents (i1, I2, and i3) + quiescent current

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