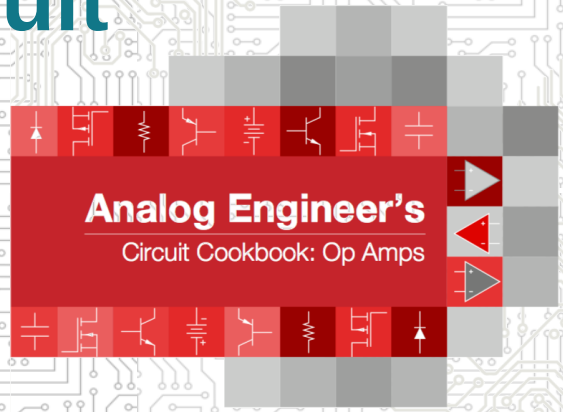
How to Design
High-side current-sensing circuit



General Purpose Amplifiers

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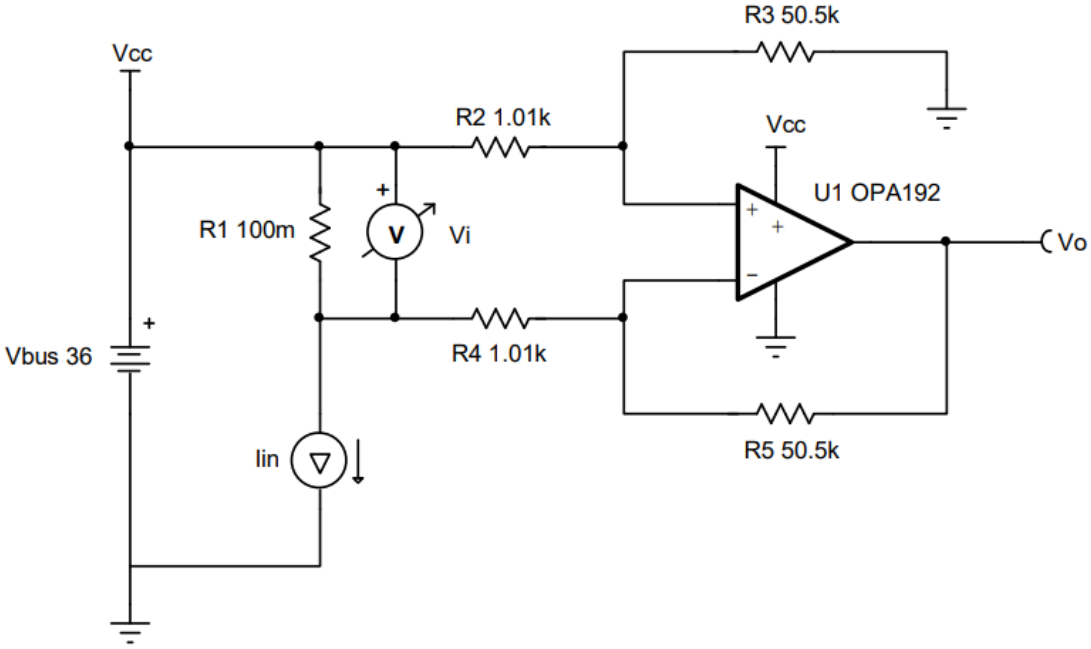
Circuit Description



$$Vo = Iin \times R1 \times \frac{R5}{R4}$$

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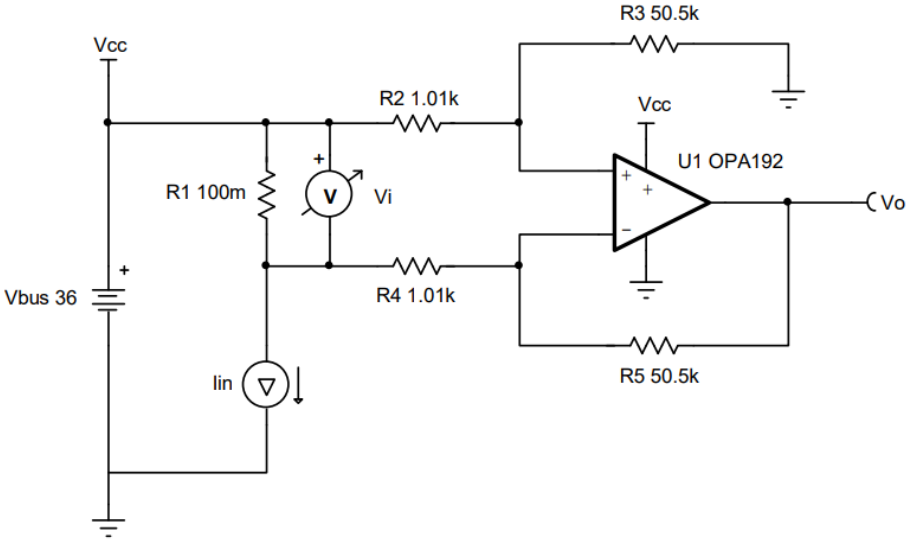
Design Goals

Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V



$$Vo = Iin \times R1 \times \frac{R5}{R4}$$

$$Given\ R2 = R4\ and\ R3 = R5$$

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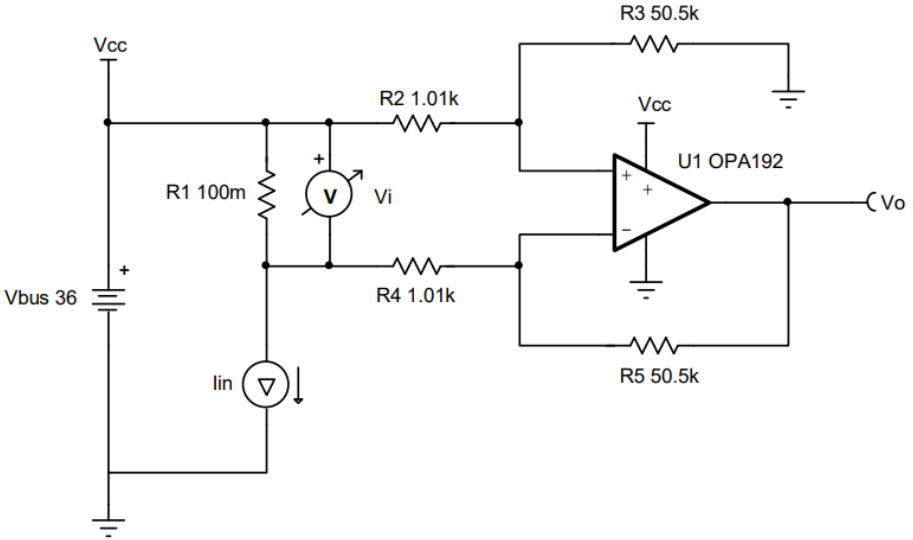
Design Steps

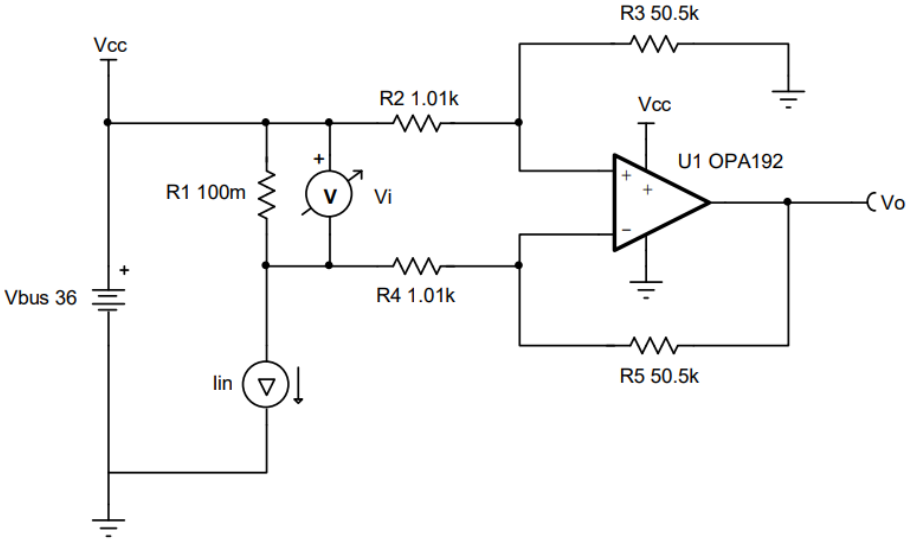
Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V



$$R1 = \frac{ViMax}{IiMax} = \frac{100mV}{1A} = 100m\Omega$$

Design Steps

Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V



$$Gain = \frac{VoMax - VoMin}{(IiMax - IiMin) \times R1} = 50V/V$$

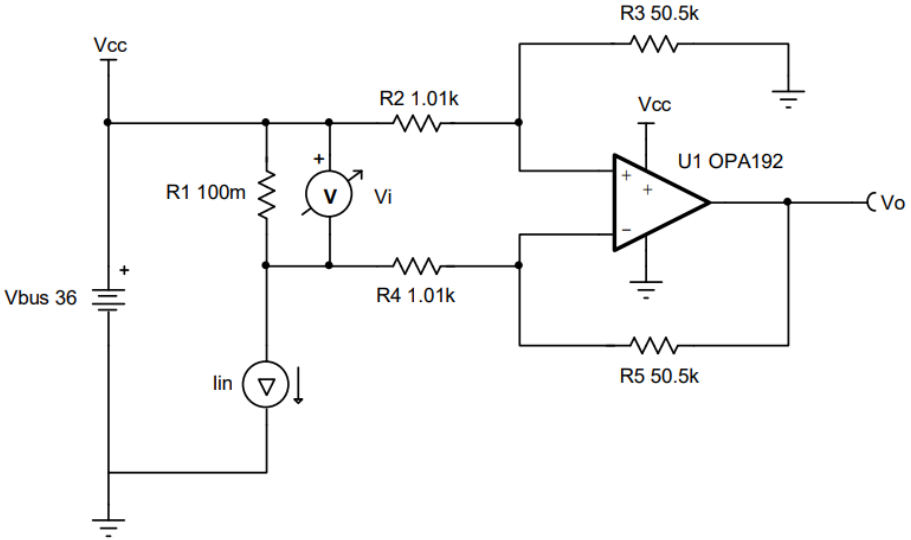
$$Gain = \frac{R5}{R4}$$

$$R2 = R4 = 1.01\ \Omega$$

$$R3 = R5 = \mathrm{R2} \times Gain = 1.01\ k\Omega \times 50\frac{V}{V} = 50.5\ k\Omega$$

Design Steps

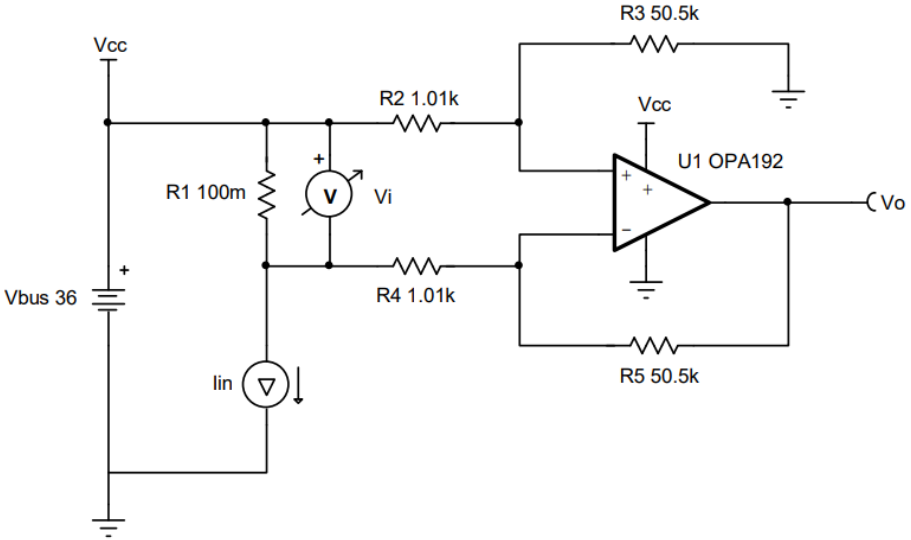
Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V

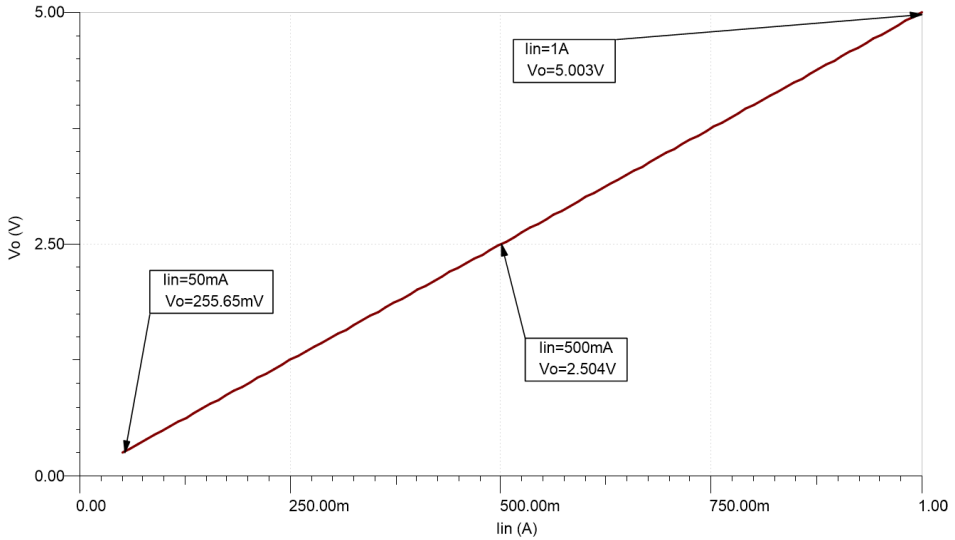


$$Vcm = Vcc \times \frac{R3}{R2 + R3} = 35.294\ V$$

DC Results

Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V





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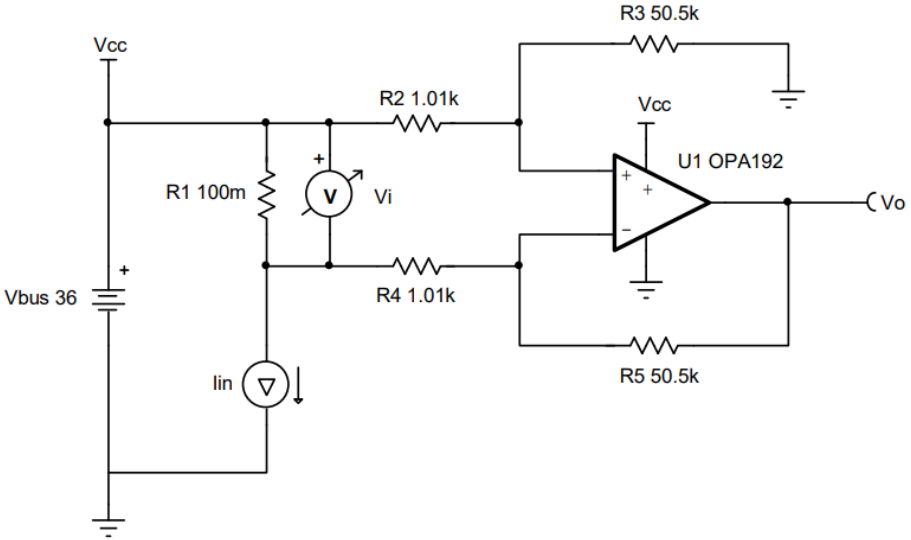
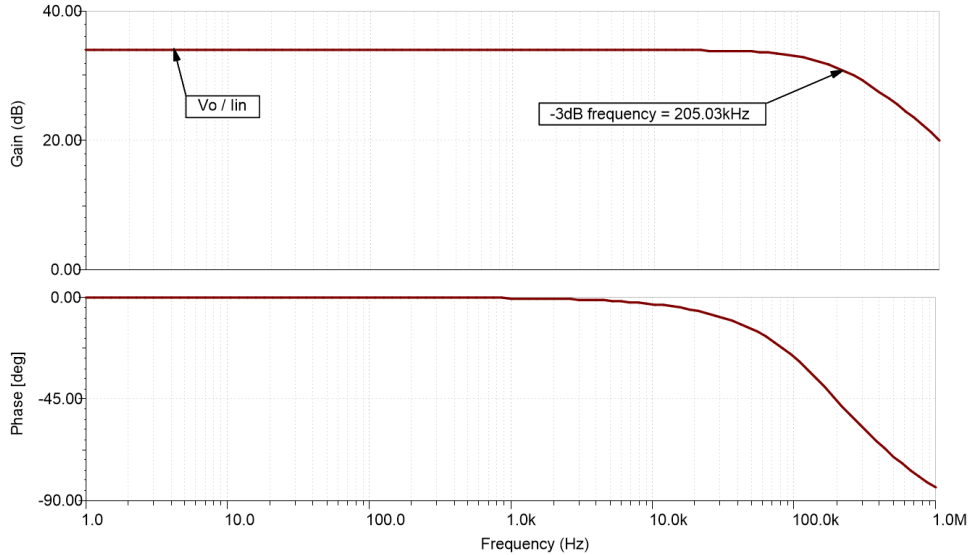
AC Results

Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V





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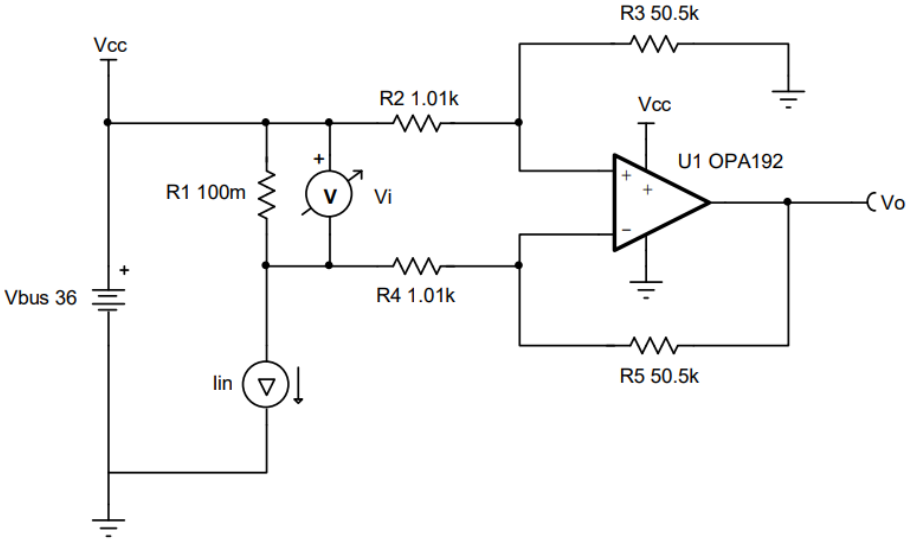
Design Notes

Input		Output		Supply	
I_{iMin}	I_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}
50mA	1A	250mV	5V	36V	0V



Design Notes:

1. For high-side current sensing, ensure the common-mode voltage is within the linear input operating region of the amplifier.
2. Increasing the shunt resistor increases power dissipation.
3. DC common mode rejection ration (CMRR) performance is dependent on the matching of the gain setting resistors, R2 – R5.

Design Resources

EE Cookbook: Op Amp
www.ti.com/circuitcookbooks
Step-by-step circuit design of common op amp building block circuits.

TI Designs
www.TI.com/tidesigns
Ready-to-use reference designs with
theory, calculations, simulations
schematics, PCB files, bench test results

Analog Engineer's Pocket Reference
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A compendium of blog posts on op amp design topics including offset voltage, input bias current, stability, noise and more

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