How to Design Inverting Amplifier with T-Network Feedback Circuit

General Purpose Amplifiers

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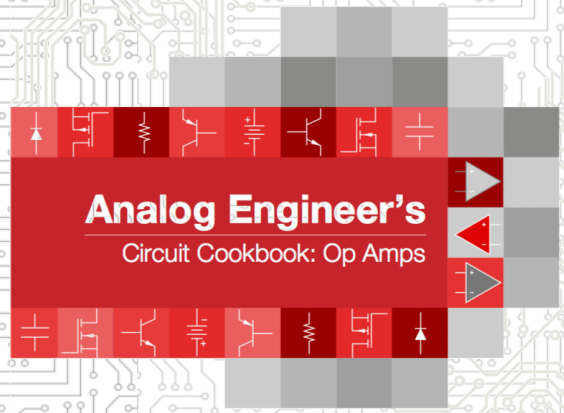
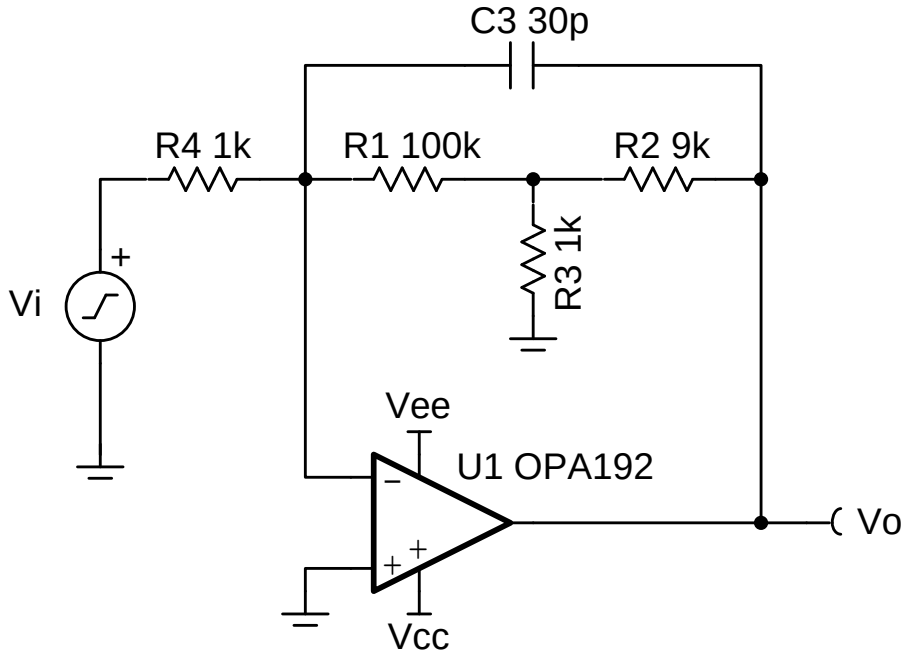


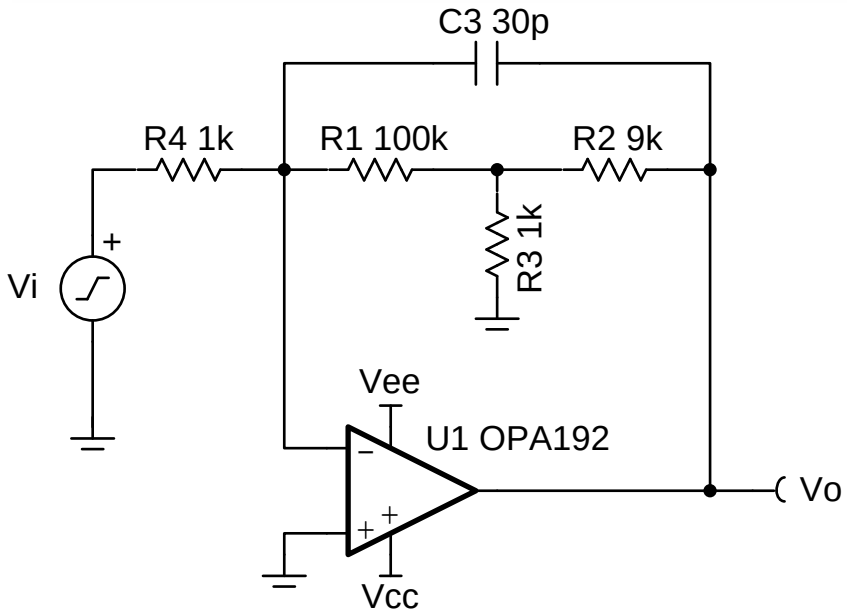
Circuit Description



$$V_o = V_i \times \frac{R_1 + R_2 + \frac{R_1 \times R_2}{R_3}}{R_4}$$

Design Steps

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
-2.5mV	2.5mV	-2.5V	2.5V	5V	-5V	5kHz



Inverting Gain

$$\frac{V_o}{V_i} = \frac{R_1 + R_2||R_3}{R_4} \times \frac{R_2 + R_3}{R_3}$$

Equivalent Resistance

Inverse Voltage Divider

$$\frac{V_o}{V_i} = \frac{R_1 + R_2 + \frac{R_1 \times R_2}{R_3}}{R_4}$$

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Design Steps

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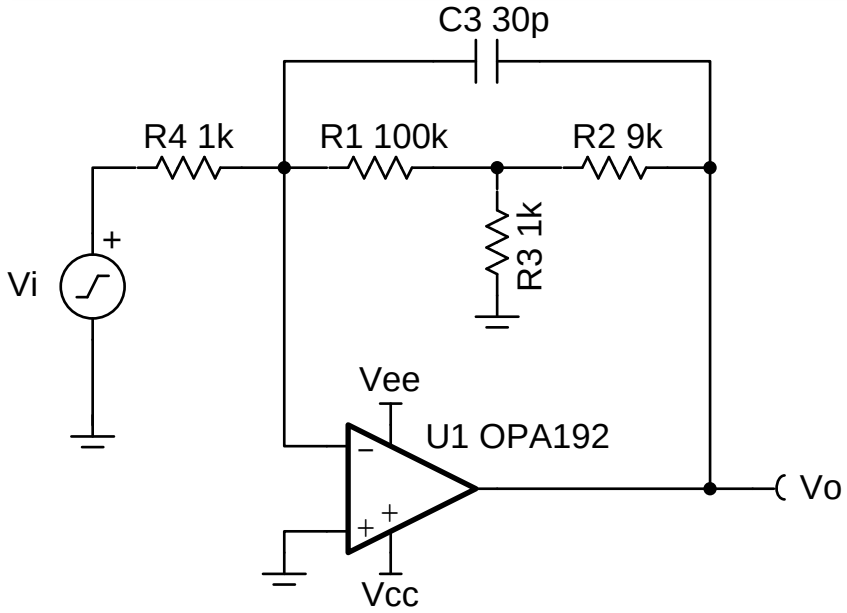
-2.5mV	2.5mV	-2.5V	2.5V	5V	-5V	5kHz



$$Gain = \frac{V_{oMax} - V_{oMin}}{V_{iMax} - V_{iMin}}$$

$$Gain = \frac{2.5V - (-2.5V)}{2.5mV - (-2.5mV)} = 1000V/V$$

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Design Steps

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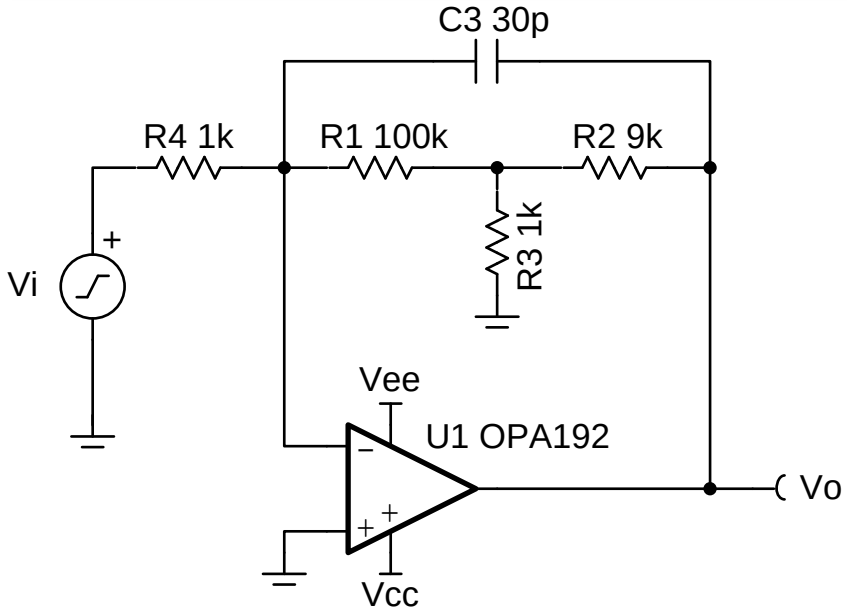


$$Gain = \frac{R_1 + R_2 + \frac{R_1 \times R_2}{R_3}}{R_4}$$

$$R_1 = 100k\Omega$$

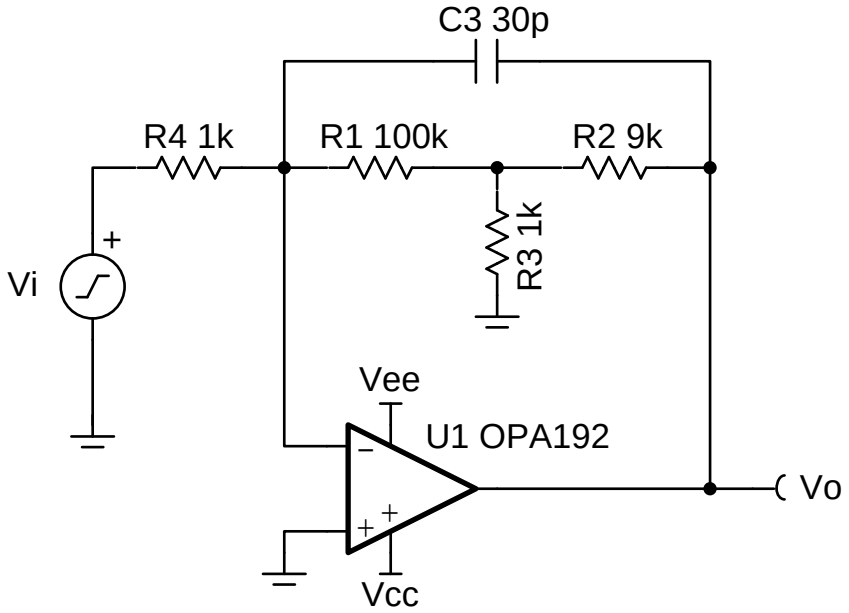
$$R_2 = 9k\Omega$$

$$R_4 = 1k\Omega$$

$$R_3 = \frac{R_2 \times R_1}{(Gain \times R_4) - R_1 - R_2} = 1k\Omega$$

Design Steps

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
-2.5mV	2.5mV	-2.5V	2.5V	5V	-5V	5kHz



$$R_{eq} = R_1 + R_2 + \frac{R_1 \times R_2}{R_3} = 1.009M\Omega$$

$$C_3 = \frac{1}{2\pi \times R_{eq} \times f_p}$$

$$C_3 = \frac{1}{2\pi \times 1.009M\Omega \times 5kHz} = 31.55pF$$

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Design Steps

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
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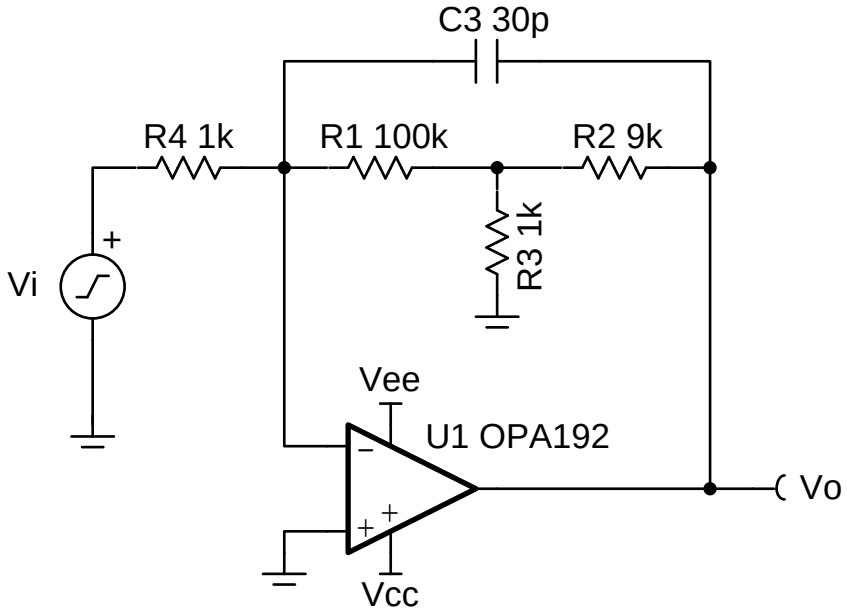


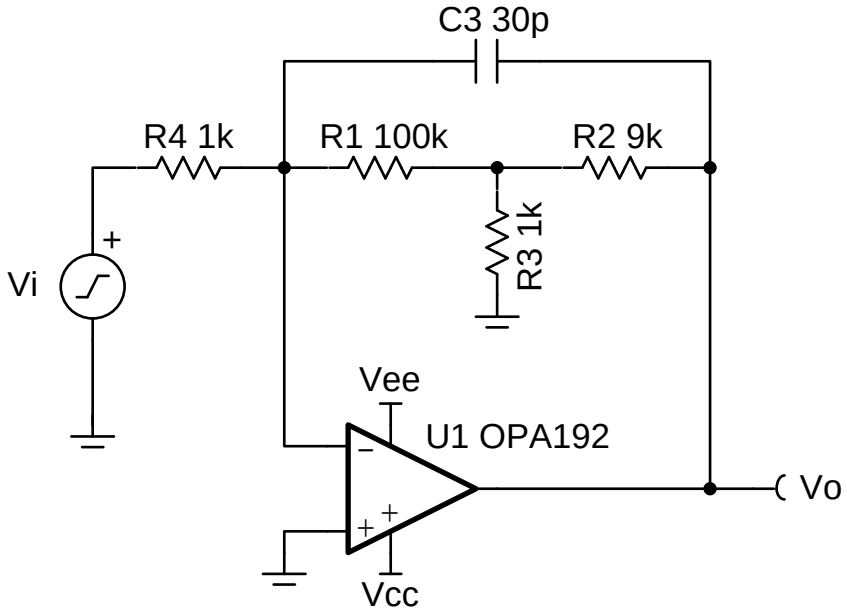
$$NG = 1 + \frac{R_{eq}}{R_4} = 1 + \frac{1.009M\Omega}{1k\Omega} = 1010\ V/V$$

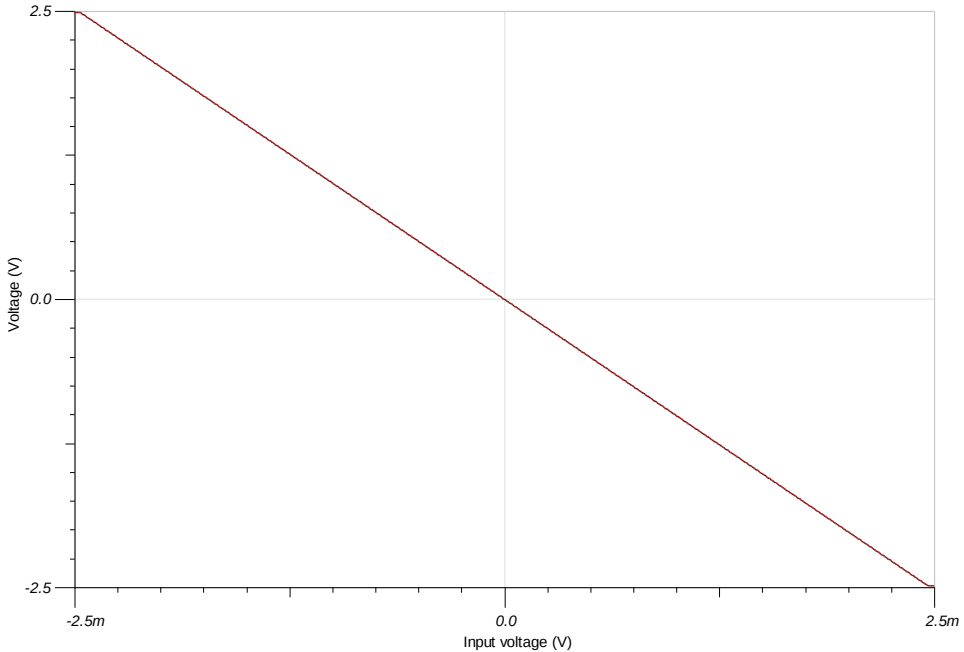
$$NG \times f_p < BW_{OPA192}$$

$$5.05\text{MHz} < 10MHz$$

DC Results

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
-2.5mV	2.5mV	-2.5V	2.5V	5V	-5V	5kHz





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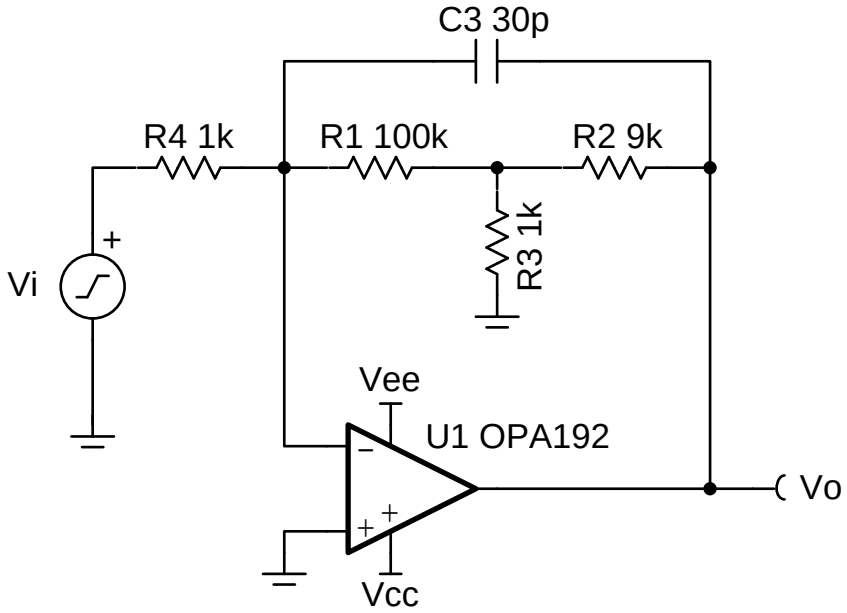
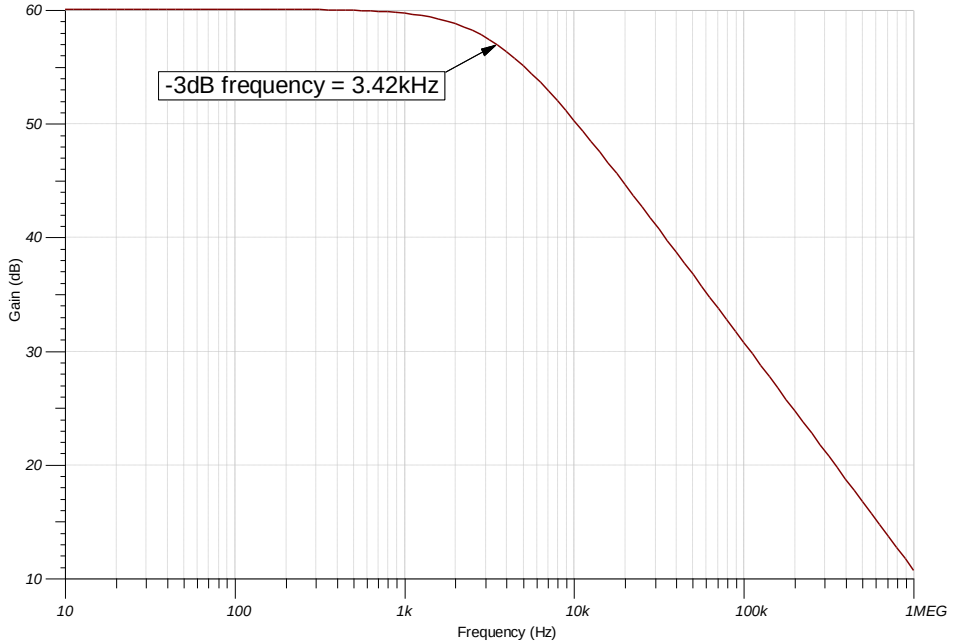
AC Results

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
-2.5mV	2.5mV	-2.5V	2.5V	5V	-5V	5kHz





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Design Notes

Input		Output		Supply		BW
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	f_p
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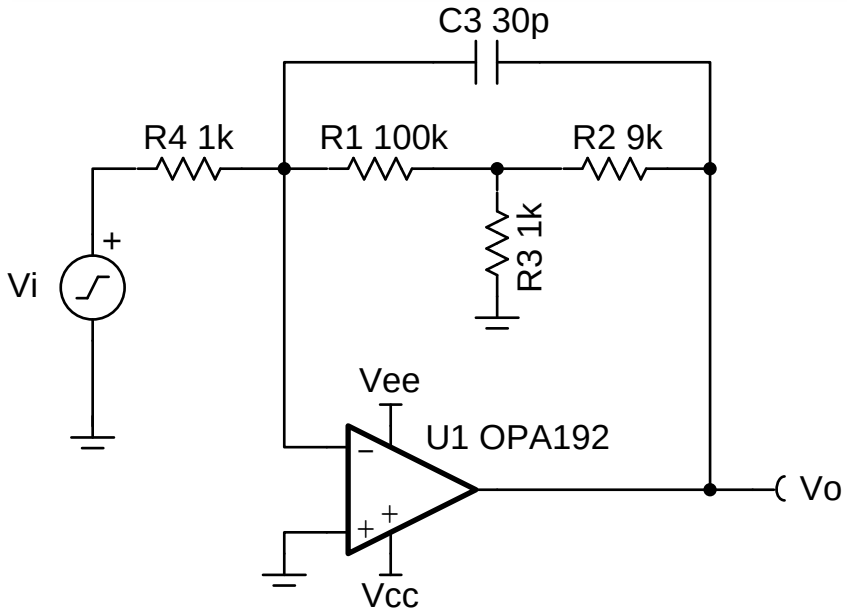

Design Notes:

1. Use low offset devices due to the high gain of the circuit.
2. C3 and the equivalent resistance of feedback resistors set the inverting amplifier's cutoff frequency, f_p.
3. The common-mode voltage in this circuit does not vary with input voltage.

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
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