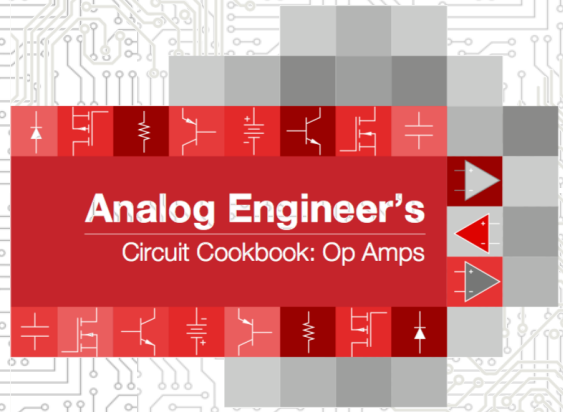
How to Design
Low-noise and long-range PIR sensor conditioner circuit



General Purpose Amplifiers

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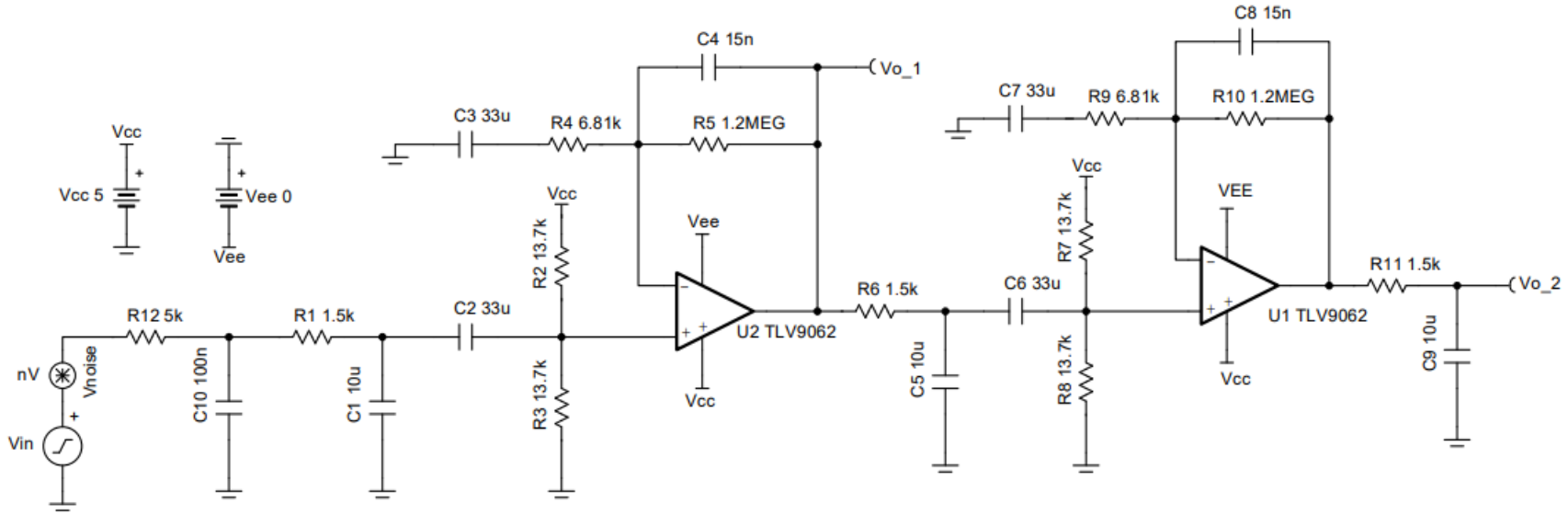
Circuit Description



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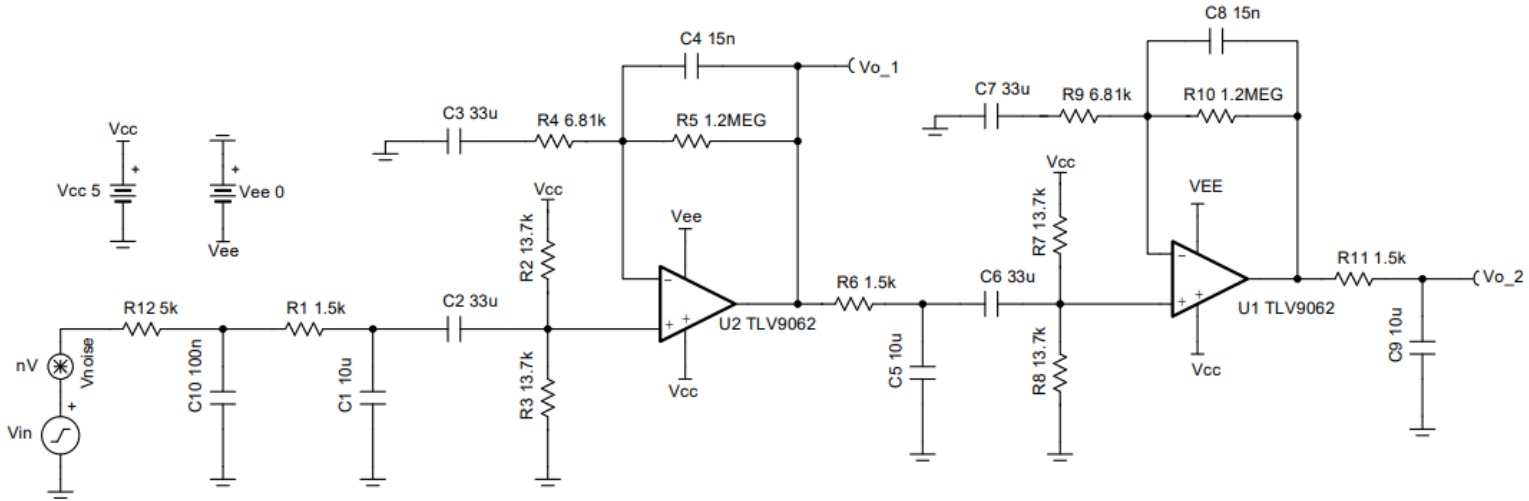
Design Steps

AC Gain	Filter Cutoff Frequency		Supply	
90 dB	f_L	f_H	V_{cc}	V_{ee}
	0.7 Hz	10 Hz	5V	0V



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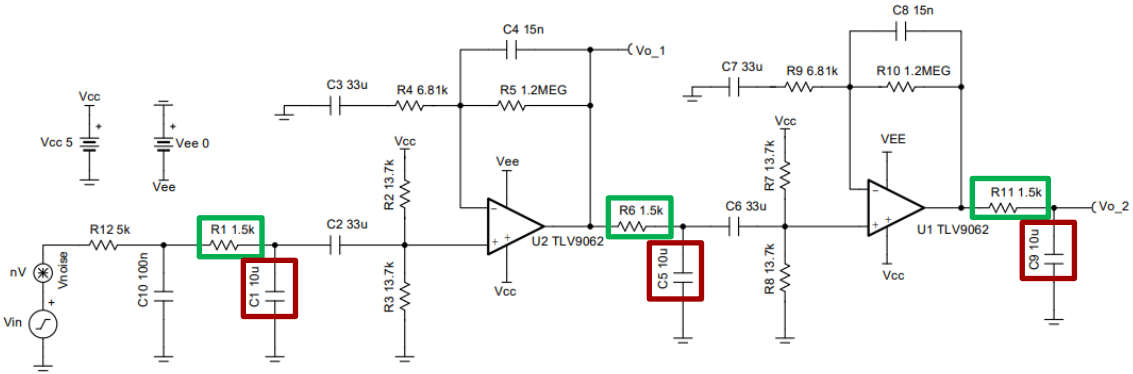

$$C1 = C5 = C9 = 10\mu F$$

$$R1 = R6 = R11 = \frac{1}{2 \times \pi \times f_L \times C1}$$

$$R1 = R6 = R11 = \frac{1}{2 \times \pi \times 0.7Hz \times 10\mu F} = 1.592k\Omega \approx 1.5k\Omega$$

Design Steps

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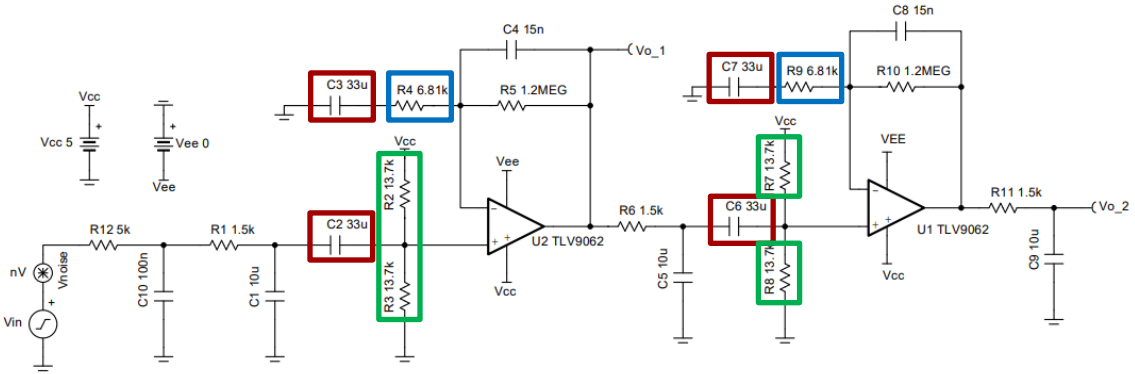
90 dB	f_L	f_H	V_{cc}	V_{ee}
	0.7 Hz	10 Hz	5V	0V



$$C2 = C3 = C6 = C7 = 33\mu F$$

$$R4 = R9 = \frac{1}{2 \times \pi \times f_H \times C2}$$

$$R4 = R9 = \frac{1}{2 \times \pi \times 10Hz \times 33\mu F} = 6.89\ k\Omega \approx 6.81\ k\Omega$$

$$R2 = R3 = R7 = R8 = 2 \times R4 = 13.62\ k\Omega \approx 13.7\ k\Omega$$

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Design Steps

AC Gain	Filter Cutoff Frequency		Supply	
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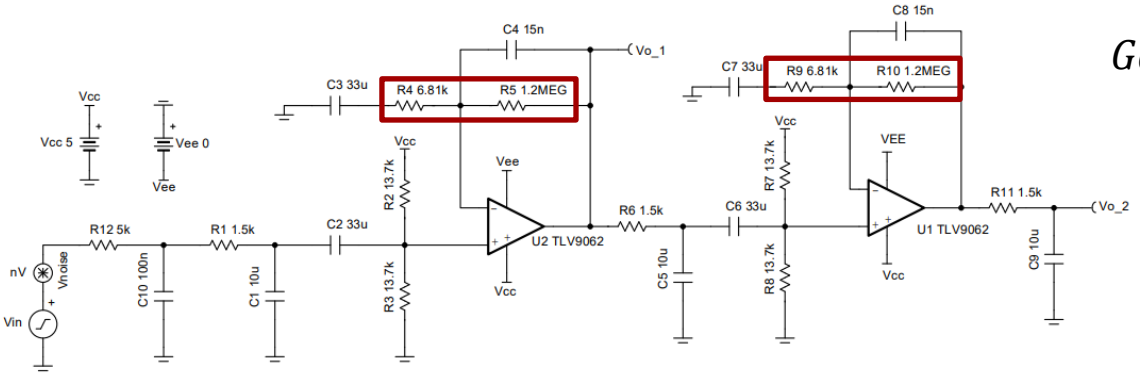

$$Gain = \frac{AC\ Gain}{2} = \frac{90dB}{2} = 45dB$$

$$Gain = 1 + \frac{R5}{R4}$$

$$R5 = (Gain - 1) \times R4$$

$$R5 = (177.828V/V - 1) \times 6.81k\Omega = 1.2M\Omega$$

Design Steps

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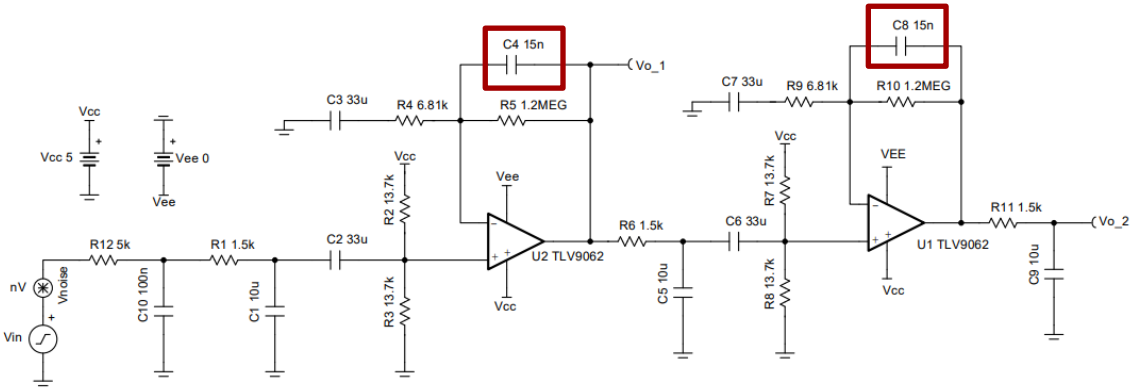

$$C4 = C8 = \frac{1}{2 \times \pi \times f_H \times R5}$$

$$C4 = C8 = \frac{1}{2 \times \pi \times 10Hz \times 1.2M\Omega} = 13.263nF \approx 15nF$$

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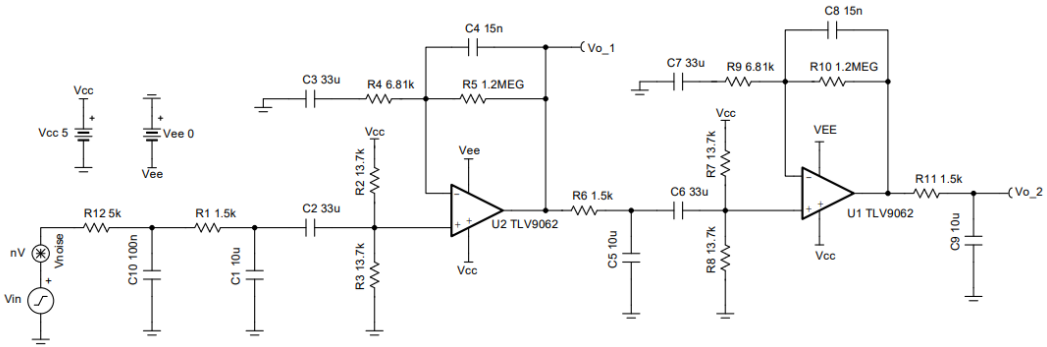
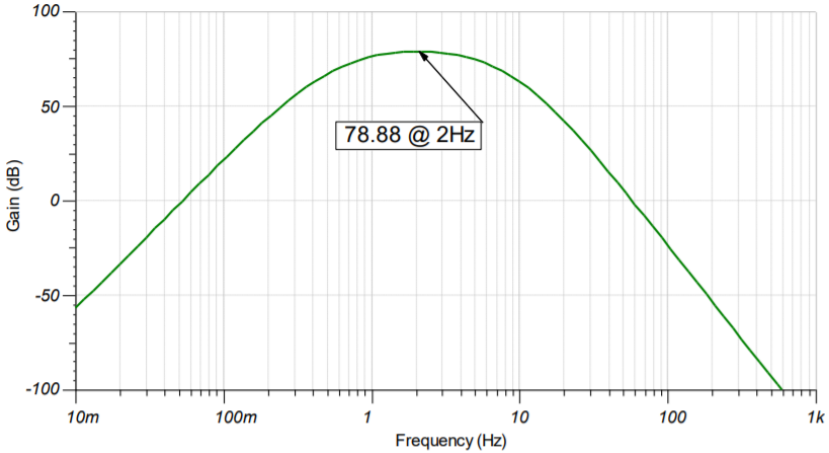
AC Results

AC Gain	Filter Cutoff Frequency		Supply	
90 dB	f_L	f_H	V_{cc}	V_{ee}
	0.7 Hz	10 Hz	5V	0V





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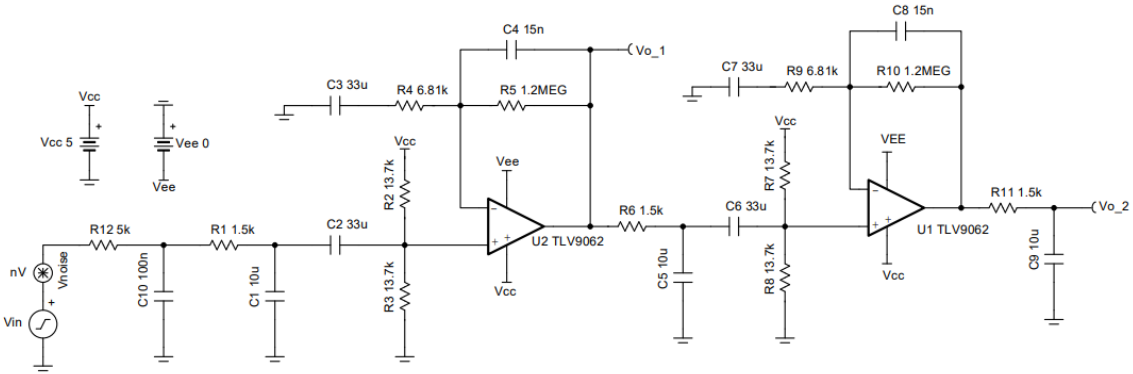
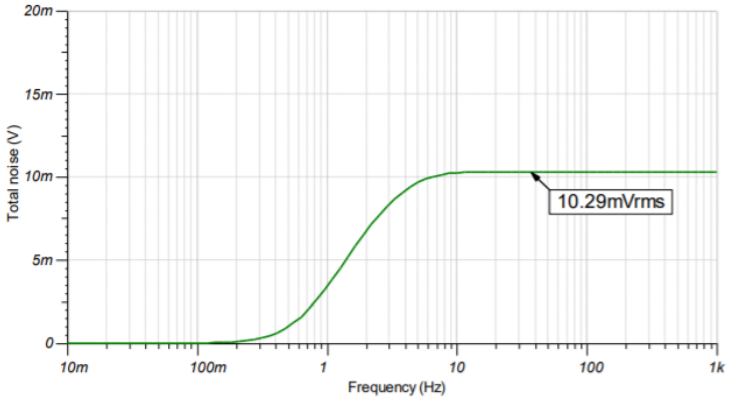
Noise Results

AC Gain	Filter Cutoff Frequency		Supply	
90 dB	f_L	f_H	V_{cc}	V_{ee}
	0.7 Hz	10 Hz	5V	0V





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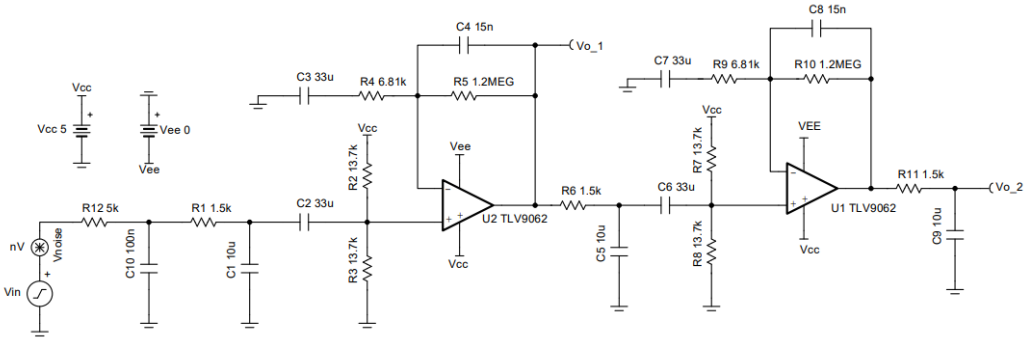
Design Notes

AC Gain	Filter Cutoff Frequency		Supply	
90 dB	f_L	f_H	V_{cc}	V_{ee}
	0.7 Hz	10 Hz	5V	0V



Design Notes:

1. For low-noise, long-range PIR sensor conditioner circuits be sure to use two or more amplifier stages to allow for sufficient loop gain.
2. Additional low-pass and high-pass filters can be added to further reduce noise.
3. RC filters on the output of the amplifiers are required to reduce the contribution of the intrinsic noise of the amplifier.

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
www.TI.com/analogrefguide
PDF, iTunes app and hardcopy available
PCB, analog, mixed signal design formulae
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TI Precision Labs
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Schematic entry and post-processor for waveform math

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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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