ULTIMATE ELECTRONICS: PRACTICAL CIRCUIT DESIGN AND ANALYSIS

7.EX

Chapter 7 Example Circuits

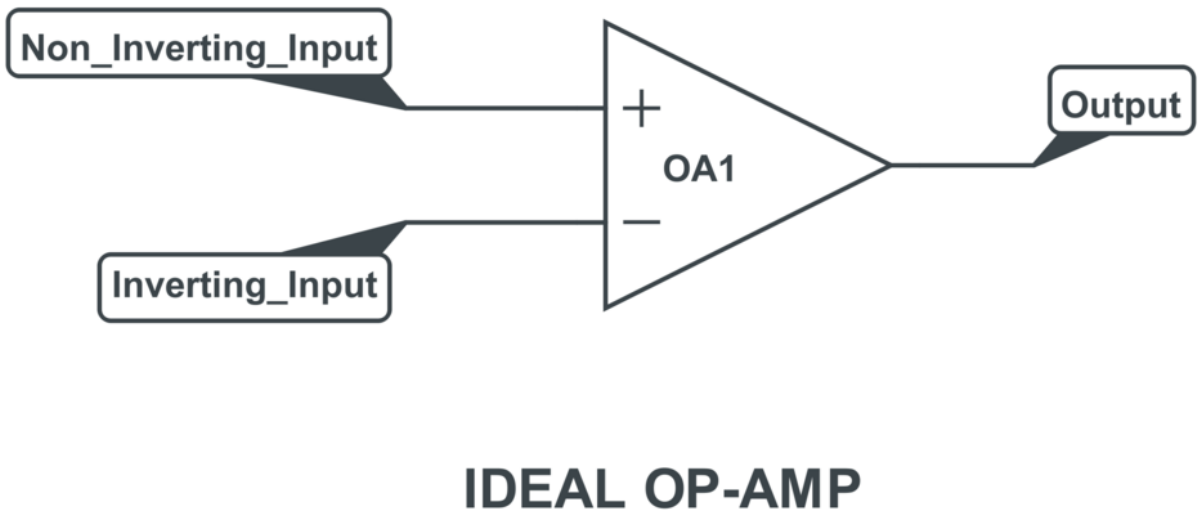
63 example circuits and simulations from Chapter 7: Op-Amps.

This page collects interactive circuits and simulations from Chapter 7 of Ultimate Electronics Book: Op-Amps.

Exercise Click any circuit to open in a new tab. Most include simulations.

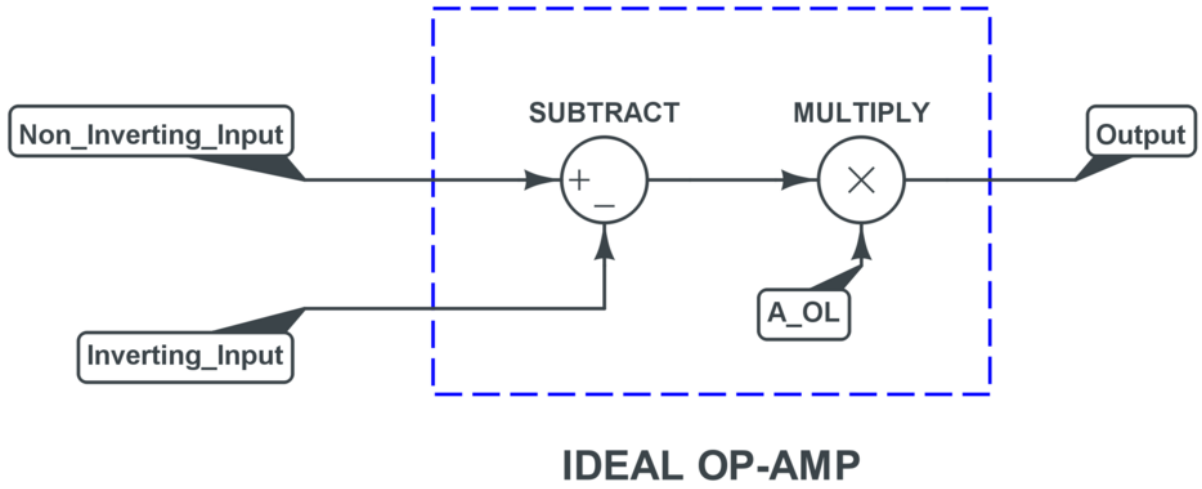
From Chapter 7.1 The Ideal Op-Amp (Operational Amplifier):

The ideal op-amp model is a key building block of designing analog filters, amplifiers, oscillators, sources, and more.



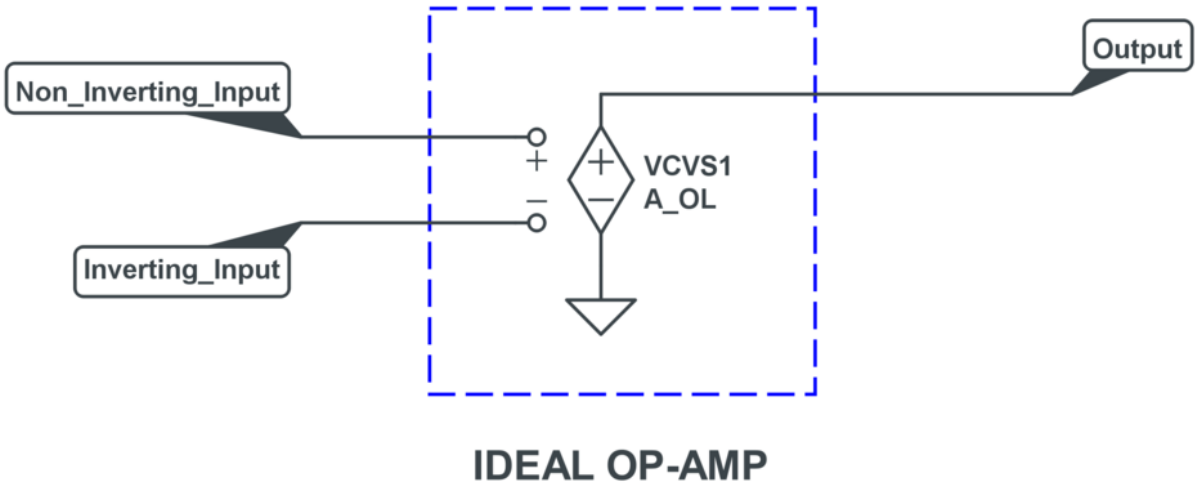
Ideal Op-Amp Symbol
circuitlab.com/c42kpkxv8a43k

Edit - Simulate



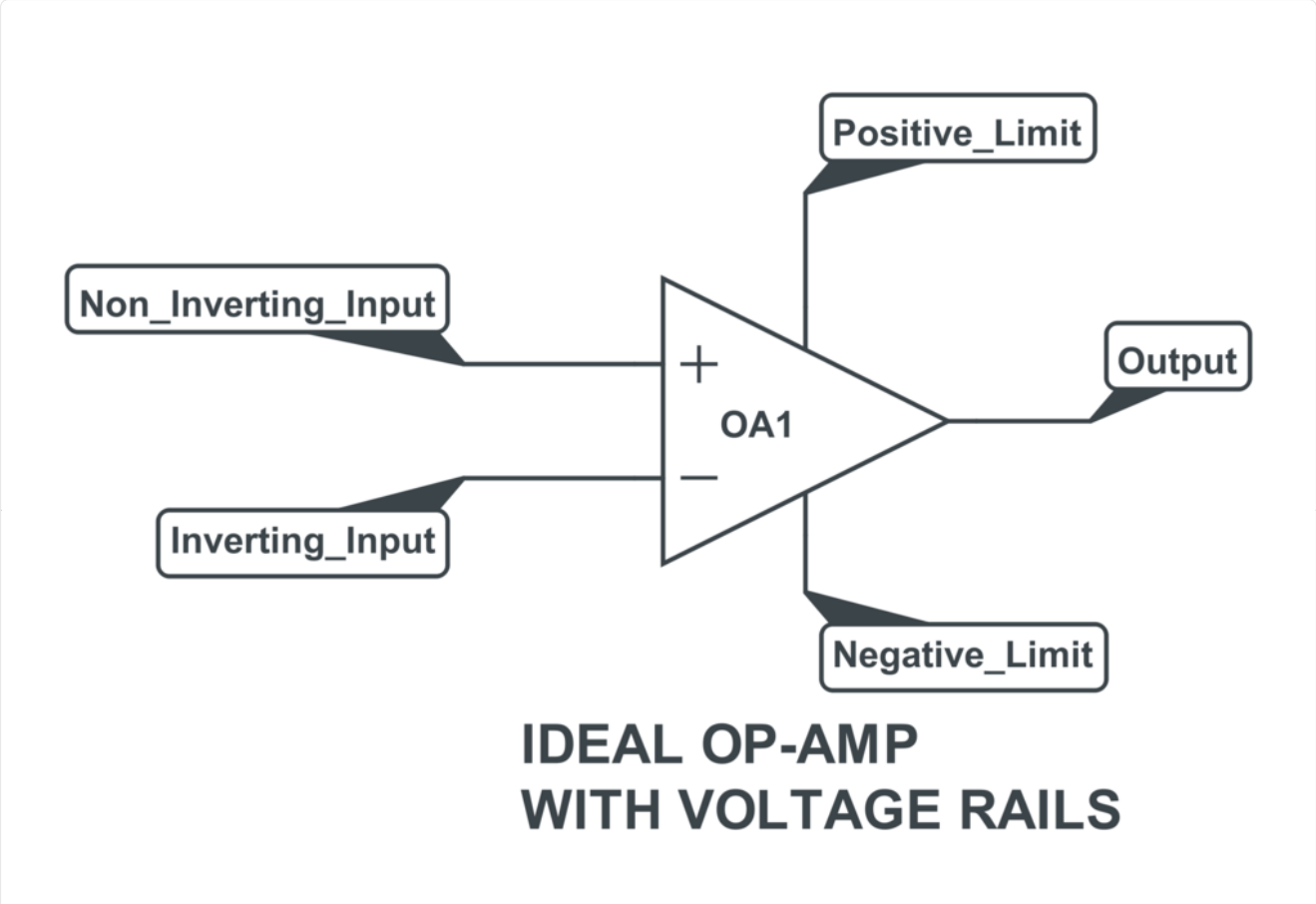
Ideal Op-Amp Subtraction and Multiplication
circuitlab.com/cv47d3w6nc9cs

Edit - Simulate



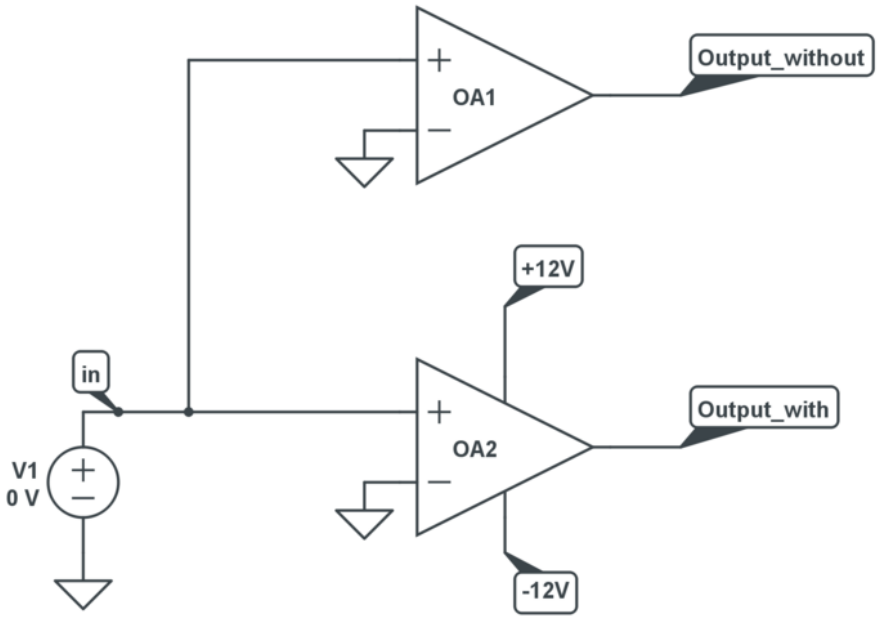
Ideal Op-Amp as VCVS
circuitlab.com/cs79ppnt7dr8f

Edit - Simulate



Ideal Op-Amp with Voltage Rails Symbol
circuitlab.com/c3nhuzcp8d3zc

Edit - Simulate



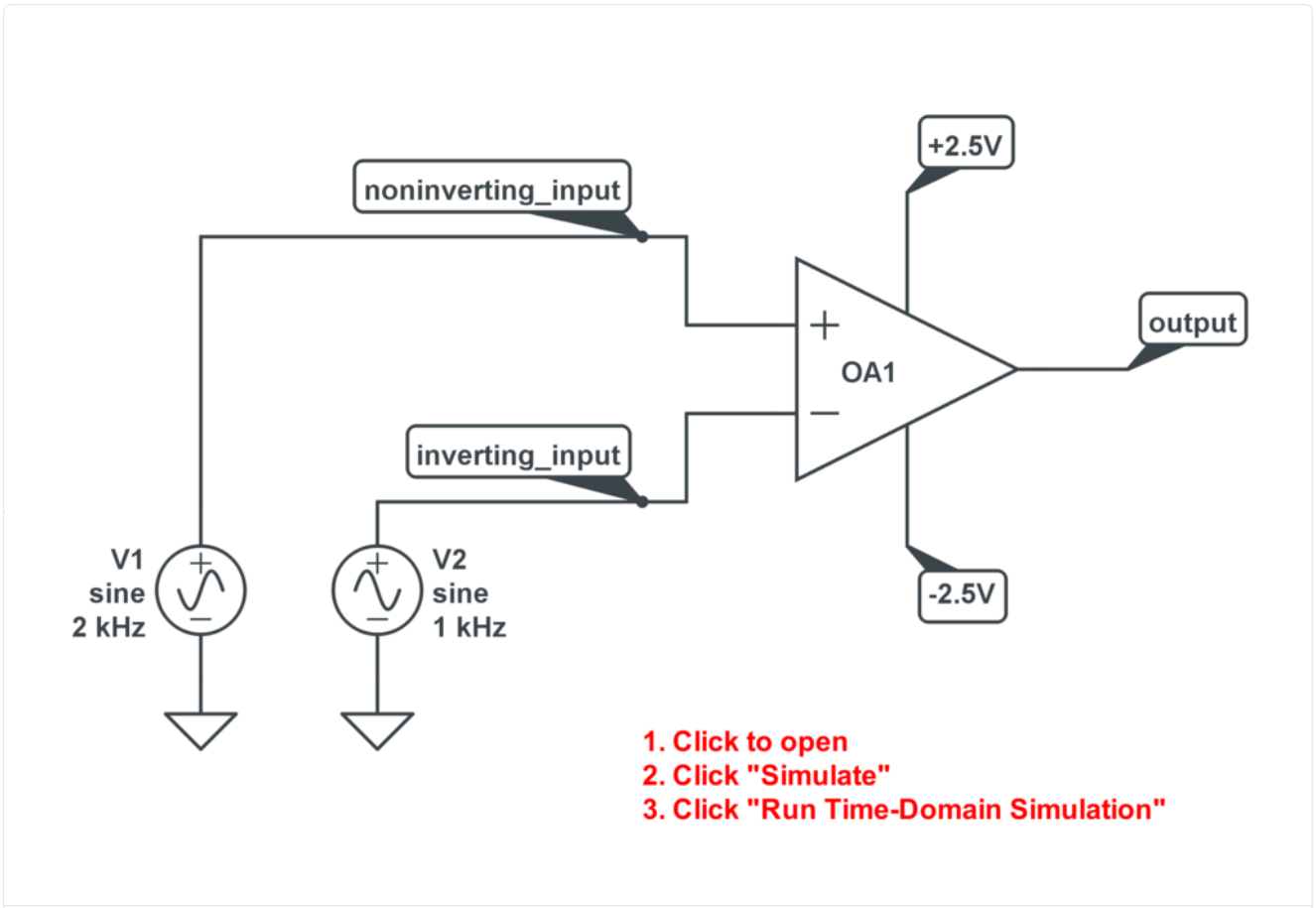
IDEAL OP-AMP
WITH & WITHOUT
VOLTAGE RAILS

1. Click to open
2. Click "Simulate"
3. Click "Run DC Sweep"

Run "DC Sweep" simulation
to see how adding supply rail limits change
the shape of the output curve.

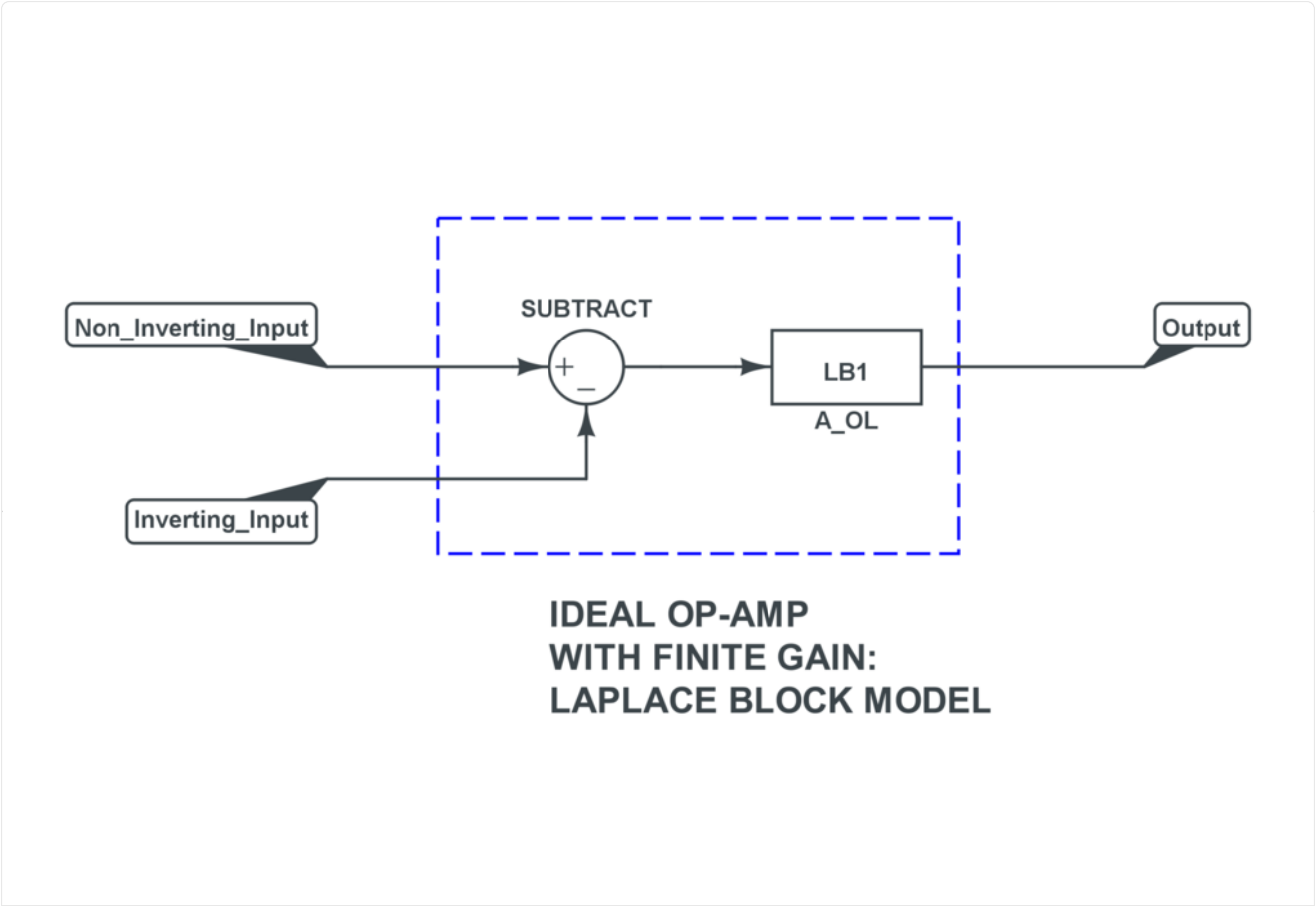
Op-Amp With and Without Voltage Rails DC Sweep Comparison
circuitlab.com/cy6wk2cksasa6

Edit - Simulate



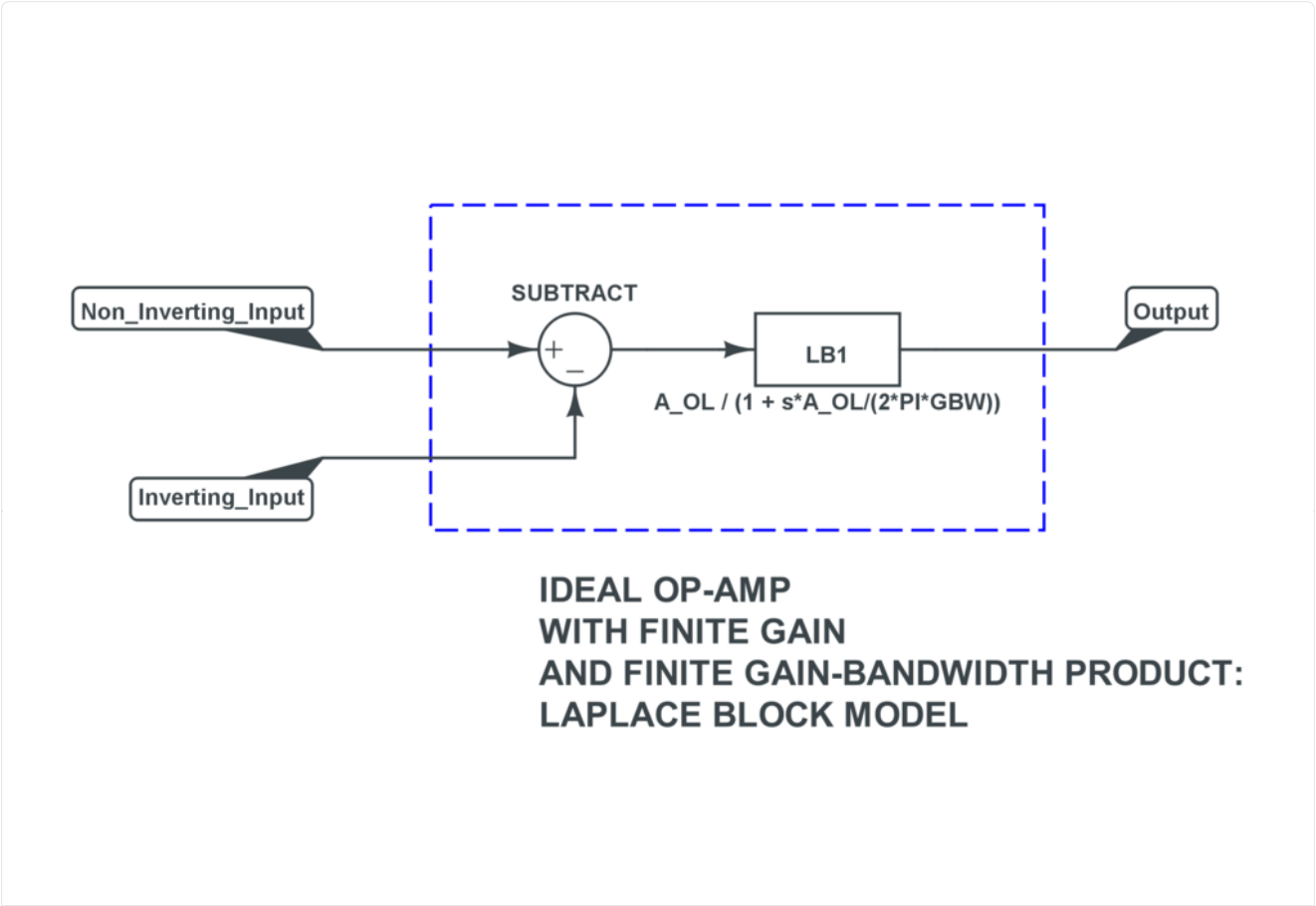
Op-Amp with Voltage Rails as Analog Comparator
circuitlab.com/c39z7cwks2hrz

Edit - Simulate



Ideal Op-Amp with Finite Gain: Laplace Block Model
circuitlab.com/ctq3jgk8rqewh

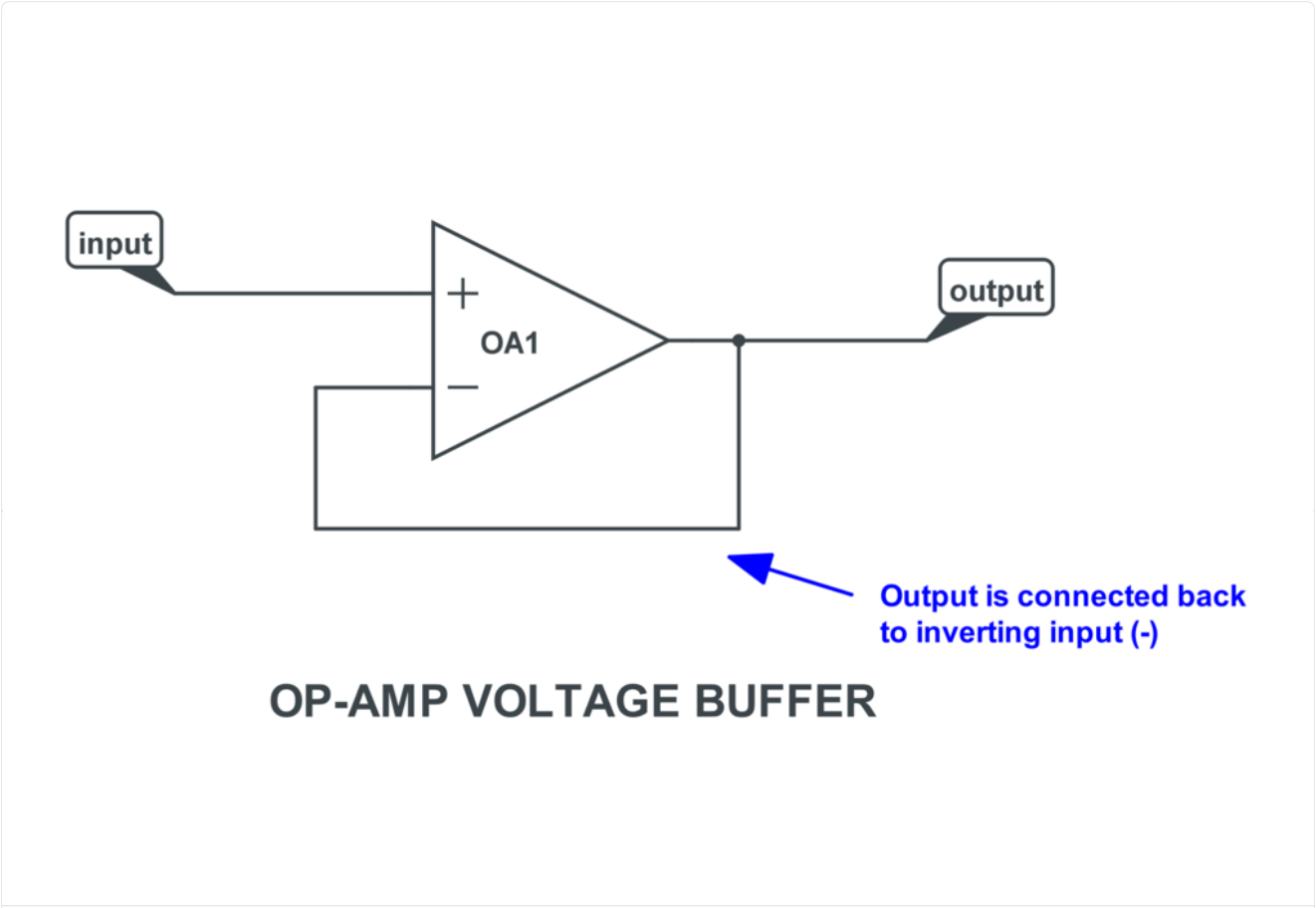
Edit - Simulate



Ideal Op-Amp with Finite Gain and Gain-Bandwidth Product: Laplace Block Model
circuitlab.com/can8pyj7dxf2b Edit - Simulate

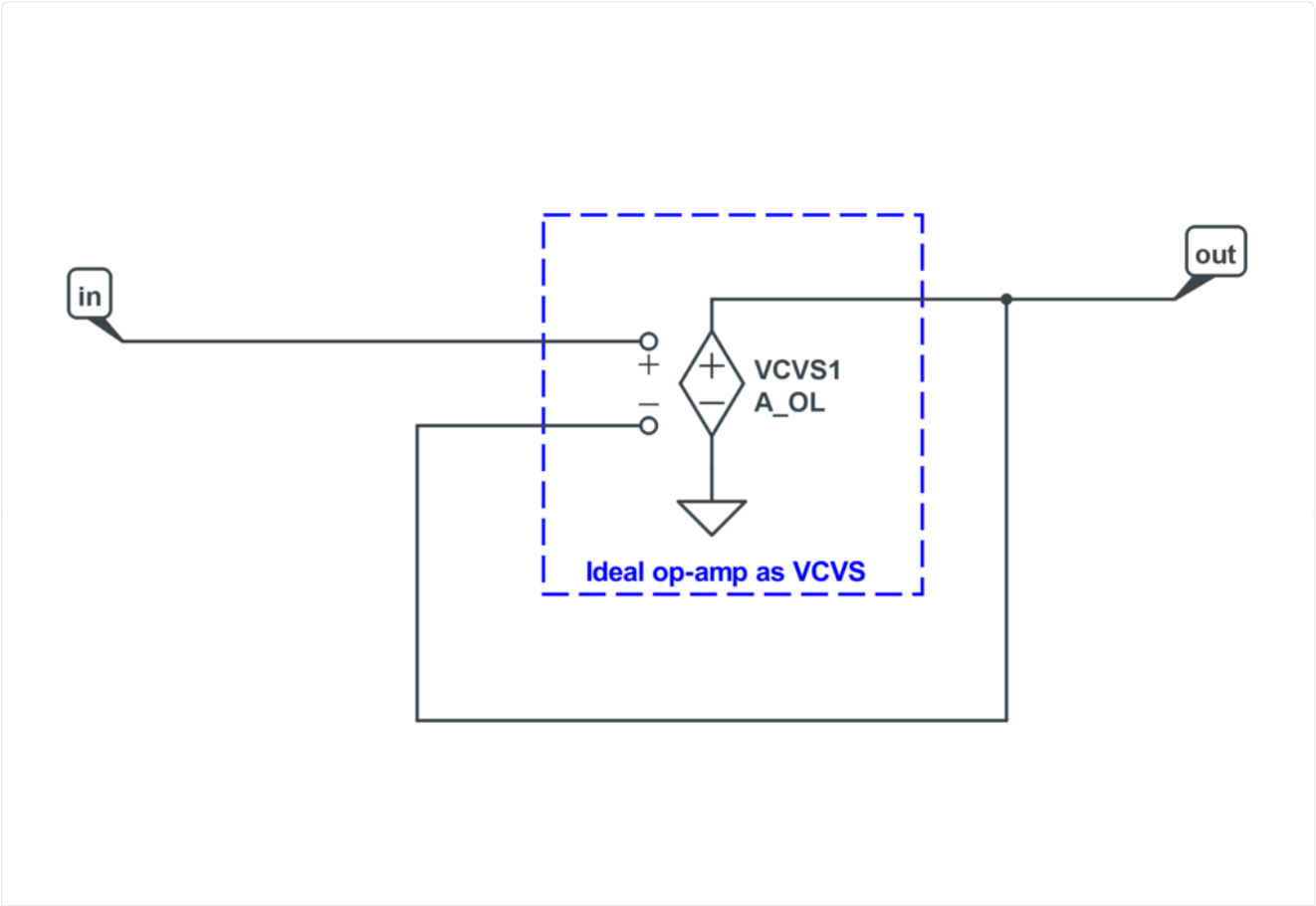
From Chapter 7.2 Op-Amp Voltage Buffer:

An op-amp voltage buffer mirrors a voltage from a high-impedance input to a low-impedance output.



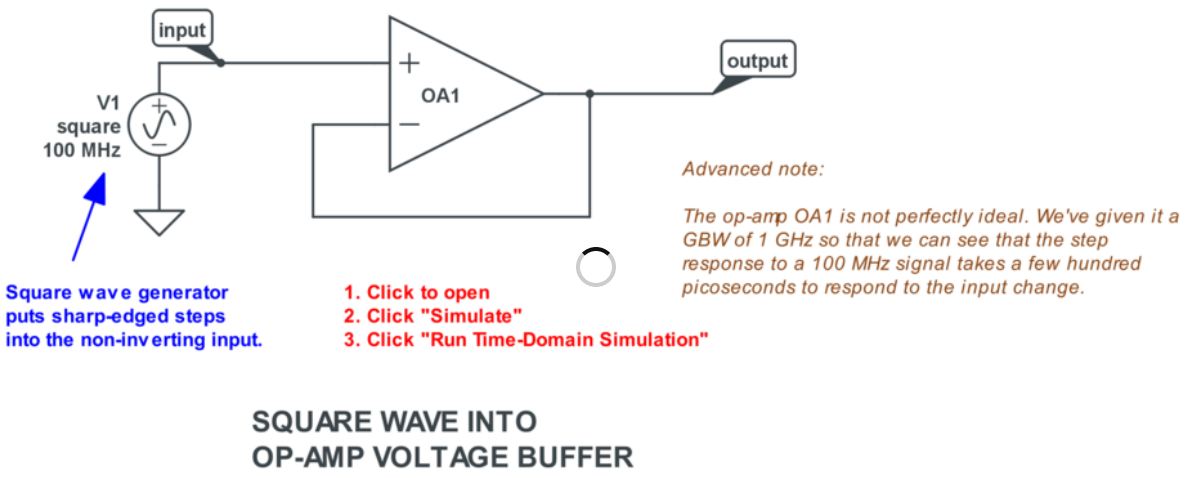
Op-Amp Voltage Buffer
circuitlab.com/c2gpmect8rv5e

Edit - Simulate



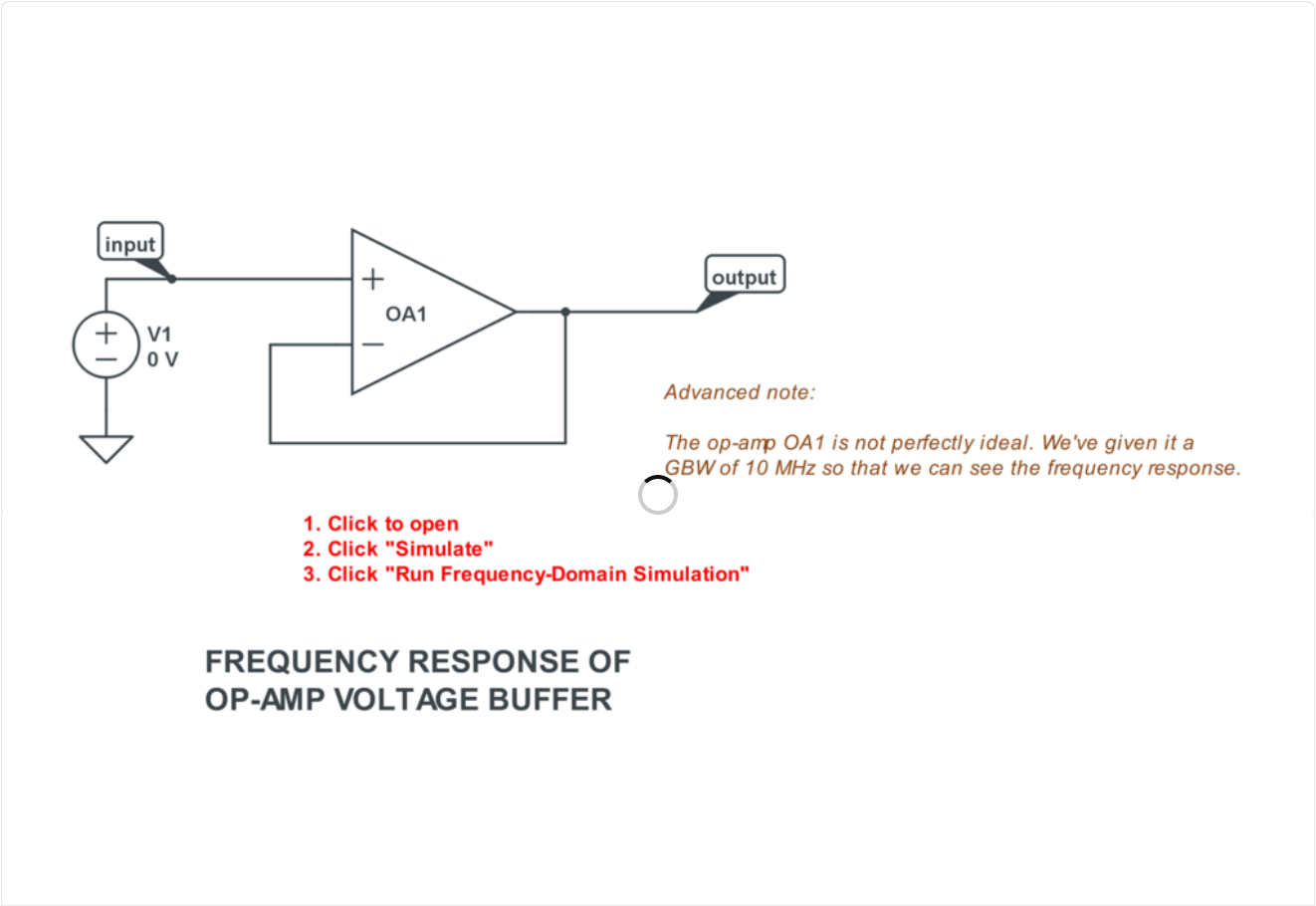
Op-Amp Voltage Buffer VCVS Model
circuitlab.com/czx96bfb4mmfn

Edit - Simulate



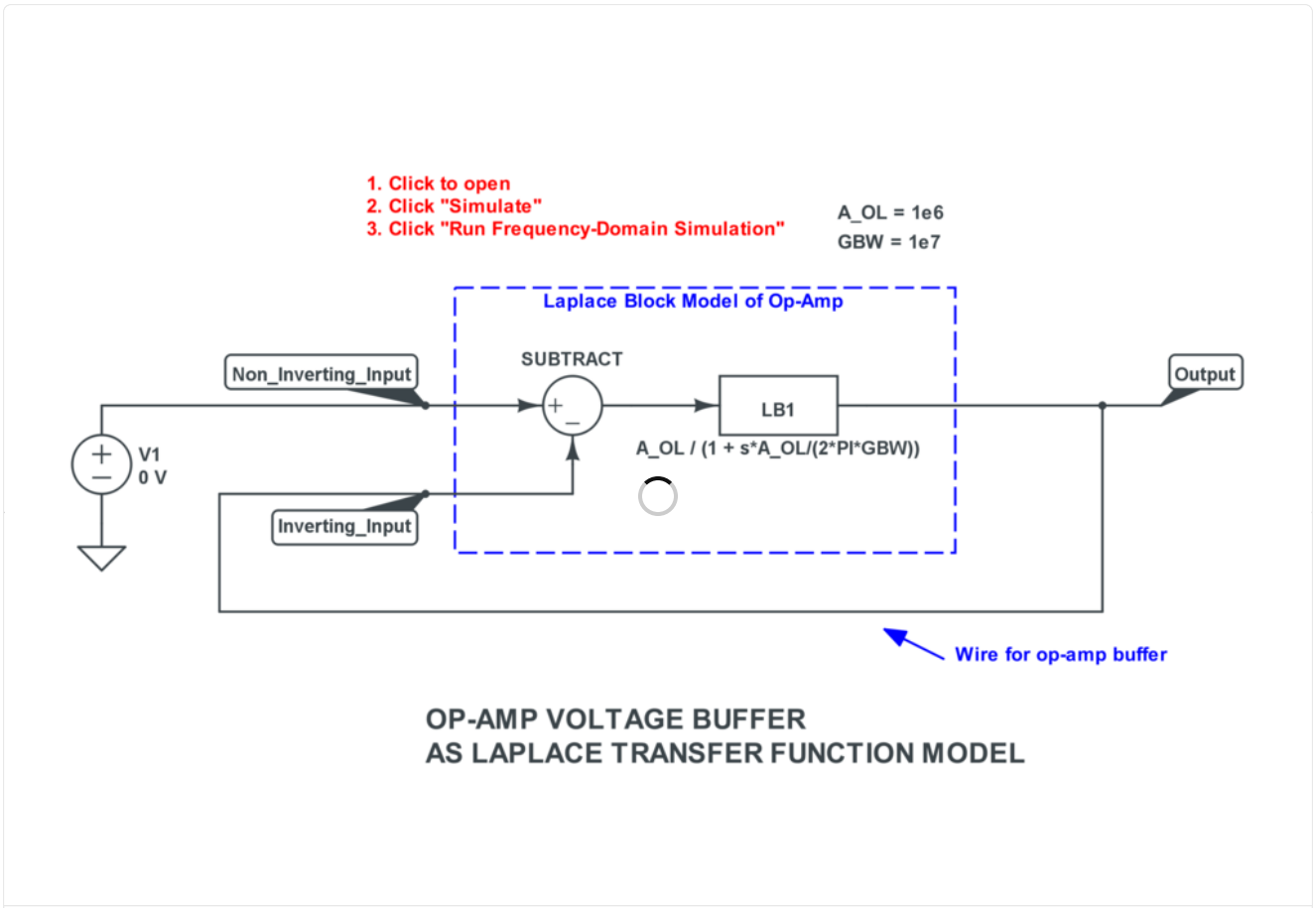
Square Wave into Op-Amp Voltage Buffer
circuitlab.com/cv9xf6jpa325g

Edit - Simulate



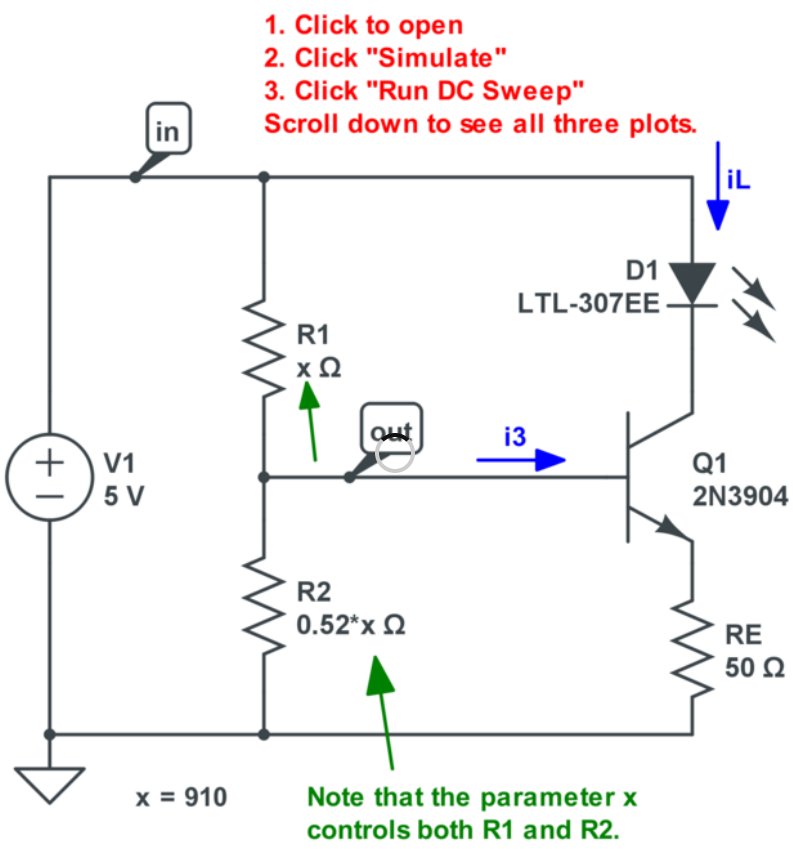
Frequency Response of Op-Amp Voltage Buffer
circuitlab.com/ct47w8u2tanx5

Edit - Simulate



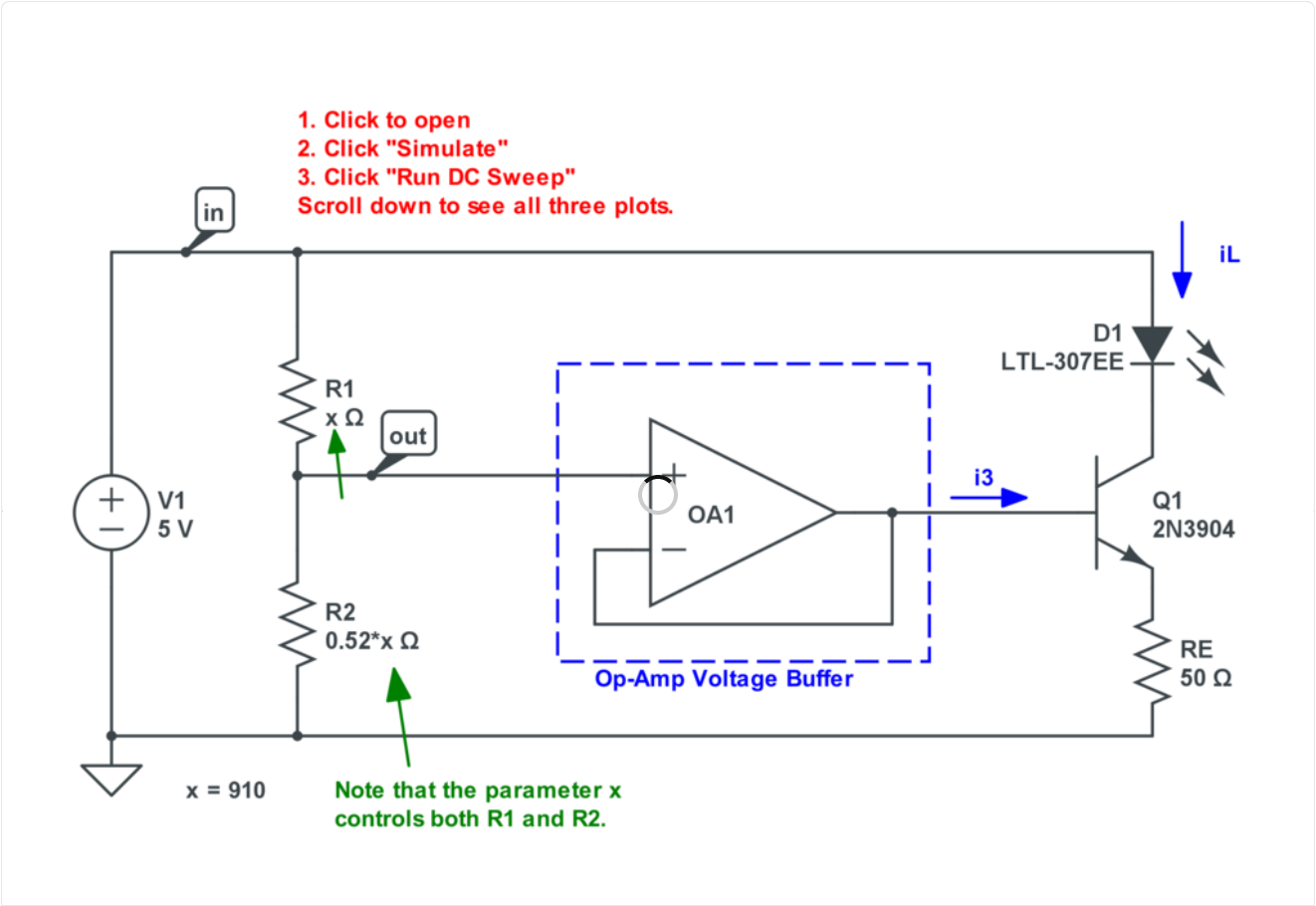
Op-Amp Voltage Buffer as Laplace Transfer Function
circuitlab.com/c3j294fm9929n

Edit - Simulate



LED Current Control with Voltage Divider and BJT, Resistance Parameter
circuitlab.com/cz56bu5r8j8b9

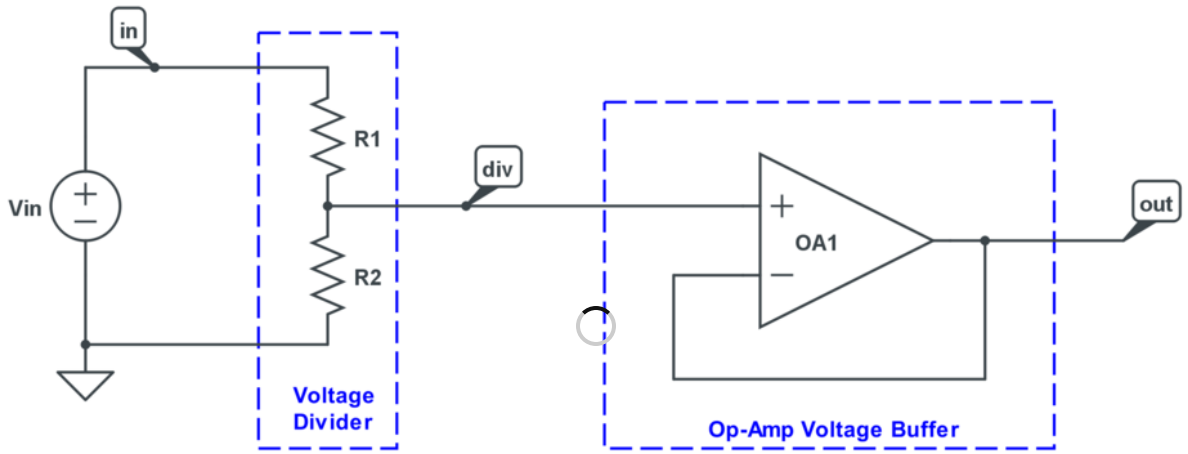
Edit - Simulate



LED Current Control with Op-Amp Buffered Voltage Divider and BJT
circuitlab.com/c27285snky768 Edit - Simulate

From Chapter 7.3 Op-Amp Voltage Reference:

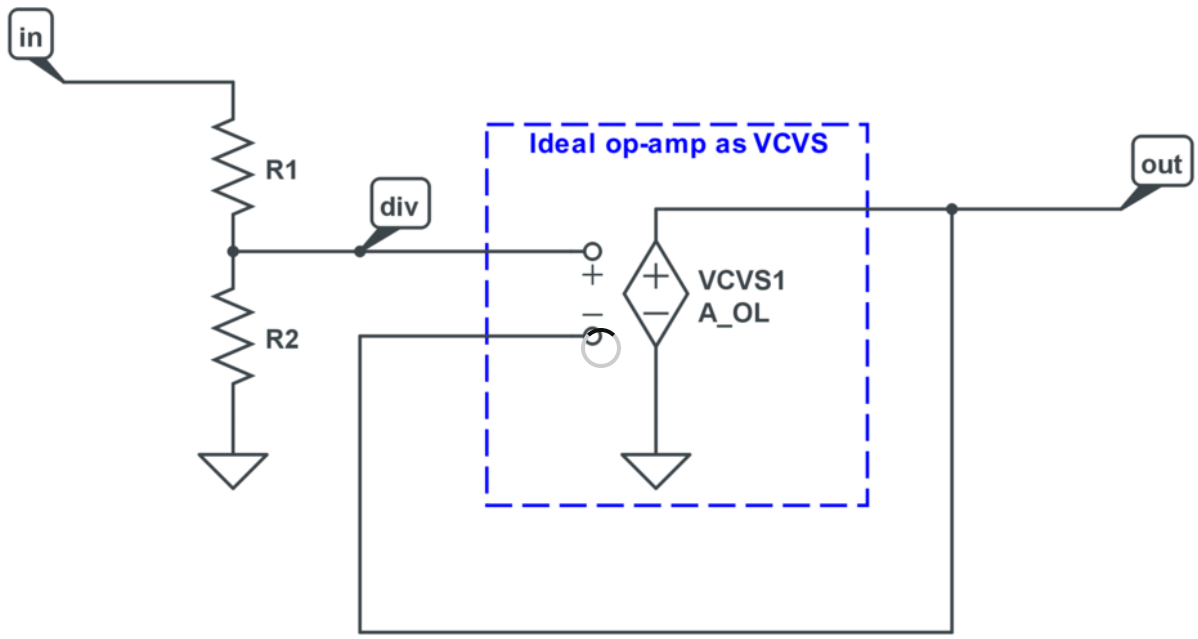
A voltage divider (or other reference element) plus an op-amp can create a fixed or adjustable voltage reference.



OP-AMP VOLTAGE REFERENCE

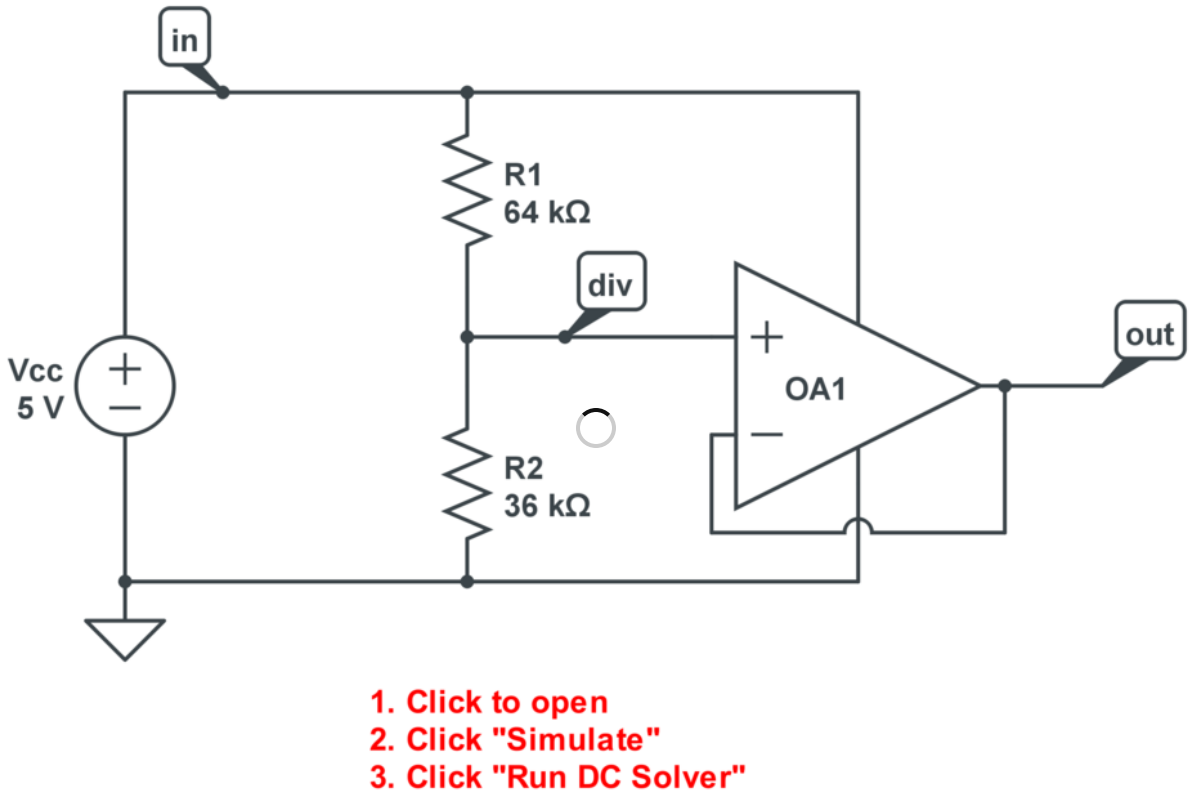
Op-Amp Voltage Reference
circuitlab.com/ctb9tj6thtyu4

Edit - Simulate



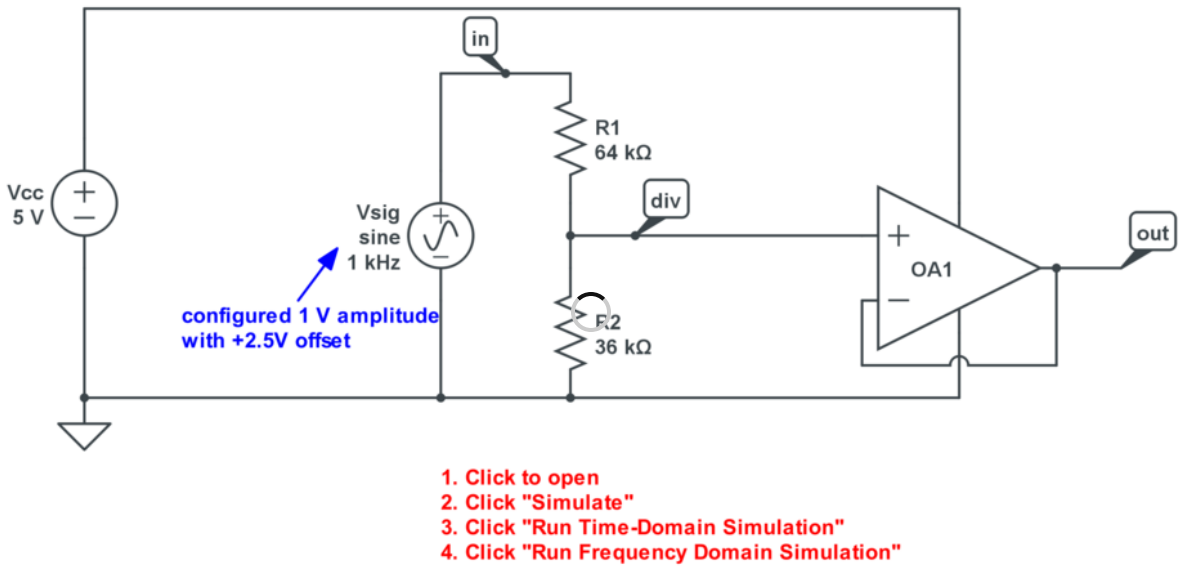
Op-Amp Voltage Reference VCVS Model
circuitlab.com/c72rfqvfybptg

Edit - Simulate



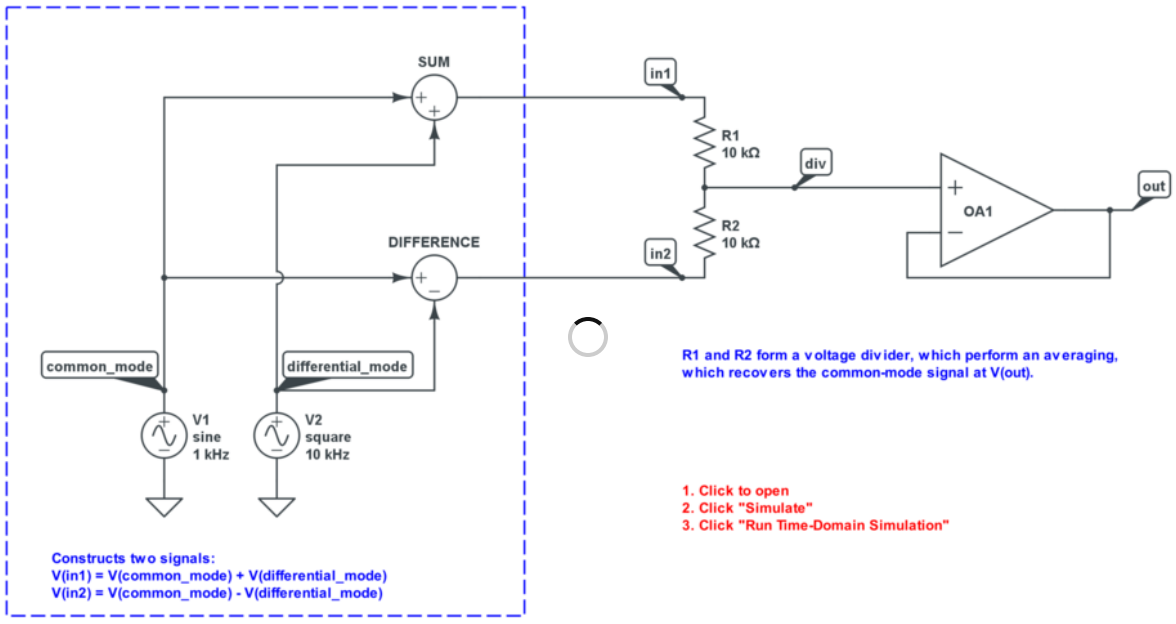
Op-Amp Voltage Reference: 5V to 1.8V DC Example
circuitlab.com/c9z4mk57ap4c9

Edit - Simulate



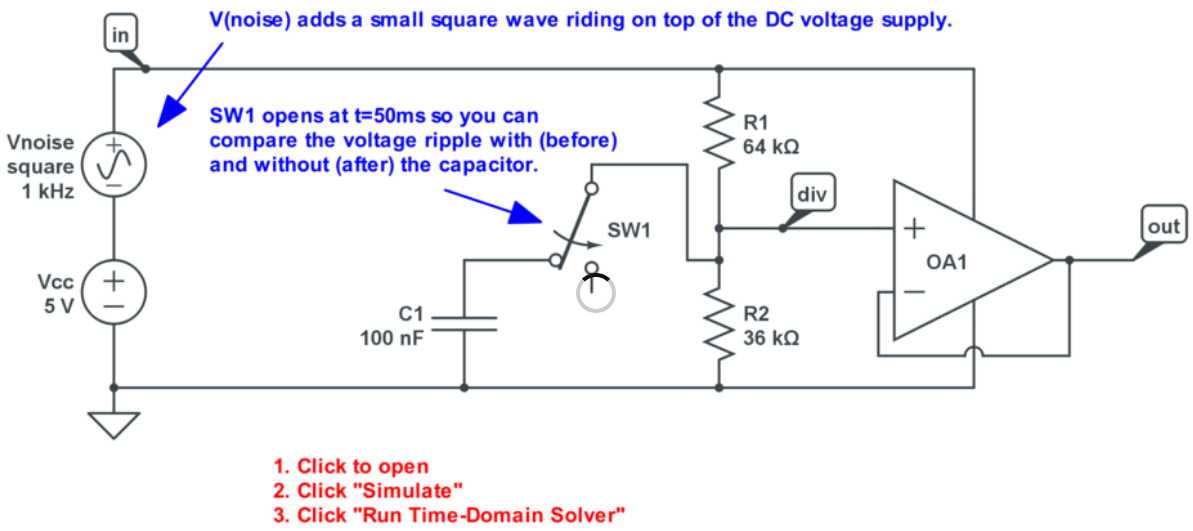
Op-Amp Voltage Reference: Signal Reducer Example
circuitlab.com/cvyj75jz57twc

Edit - Simulate



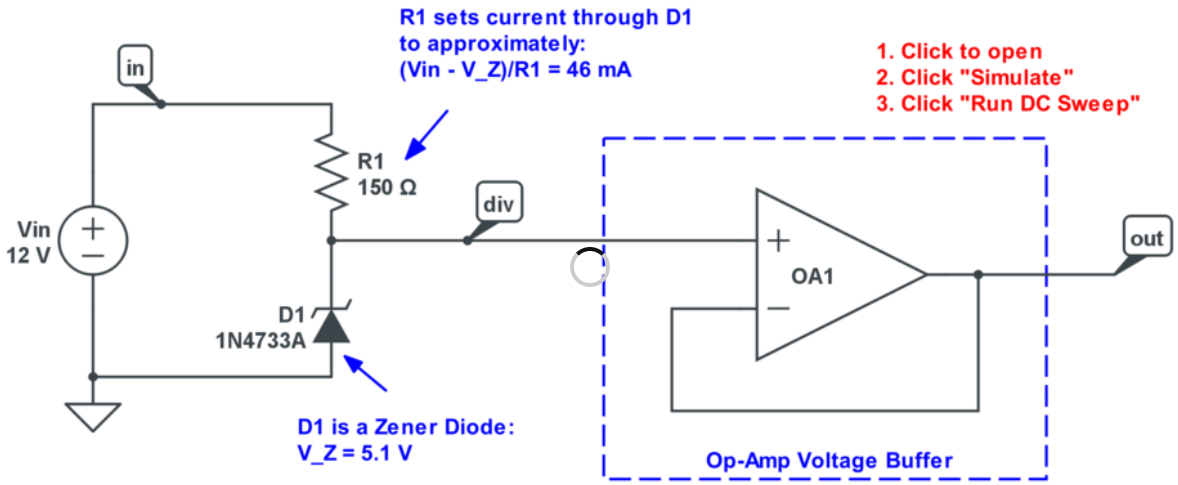
Op-Amp Voltage Averager: Common-Mode Signal Recovery
circuitlab.com/crtg6qf32qc9z

Edit - Simulate



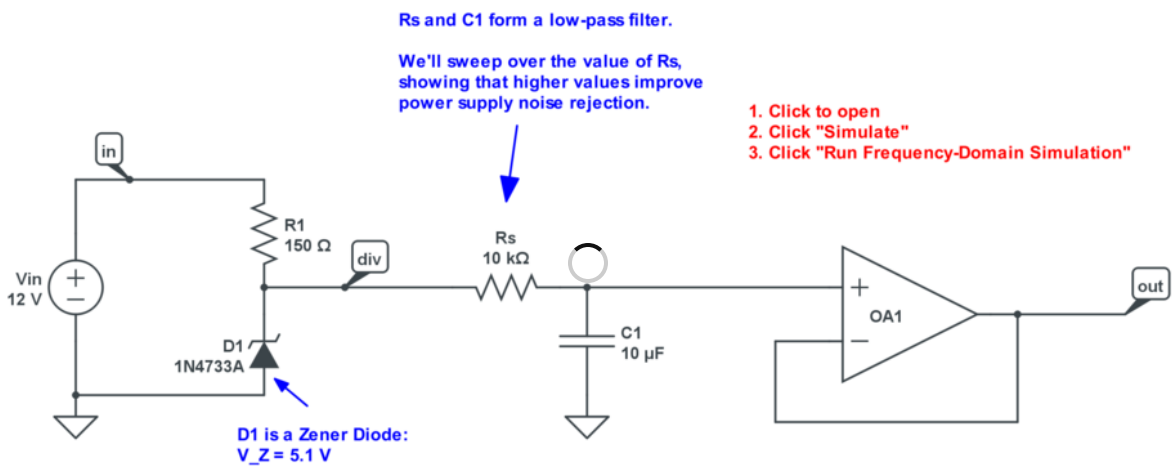
Capacitor Smoothes Op-Amp Voltage Reference
circuitlab.com/cjxd89bna2624

Edit - Simulate



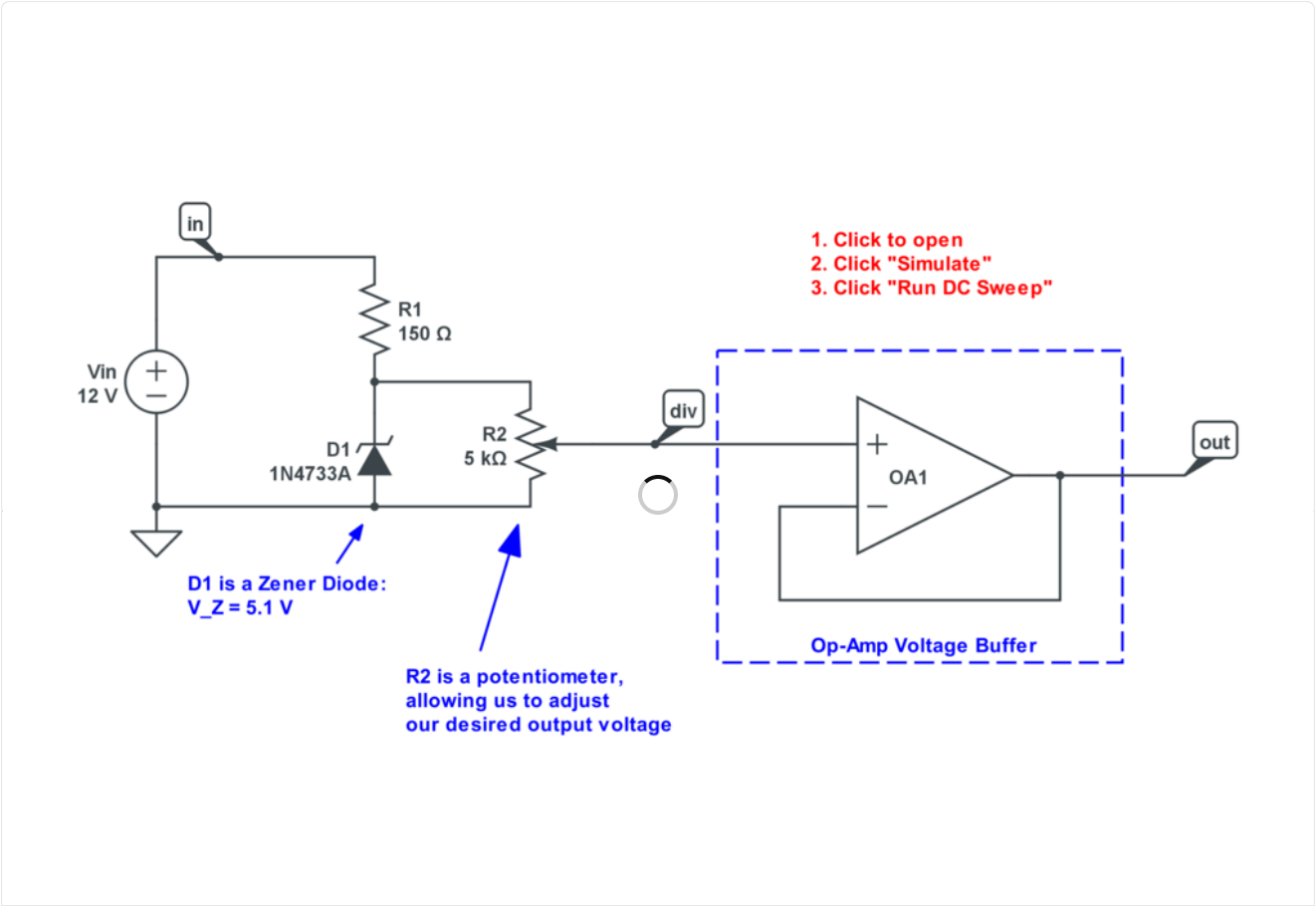
Zener Diode Op-Amp Voltage Reference
circuitlab.com/cn8t7824cbz47

Edit - Simulate



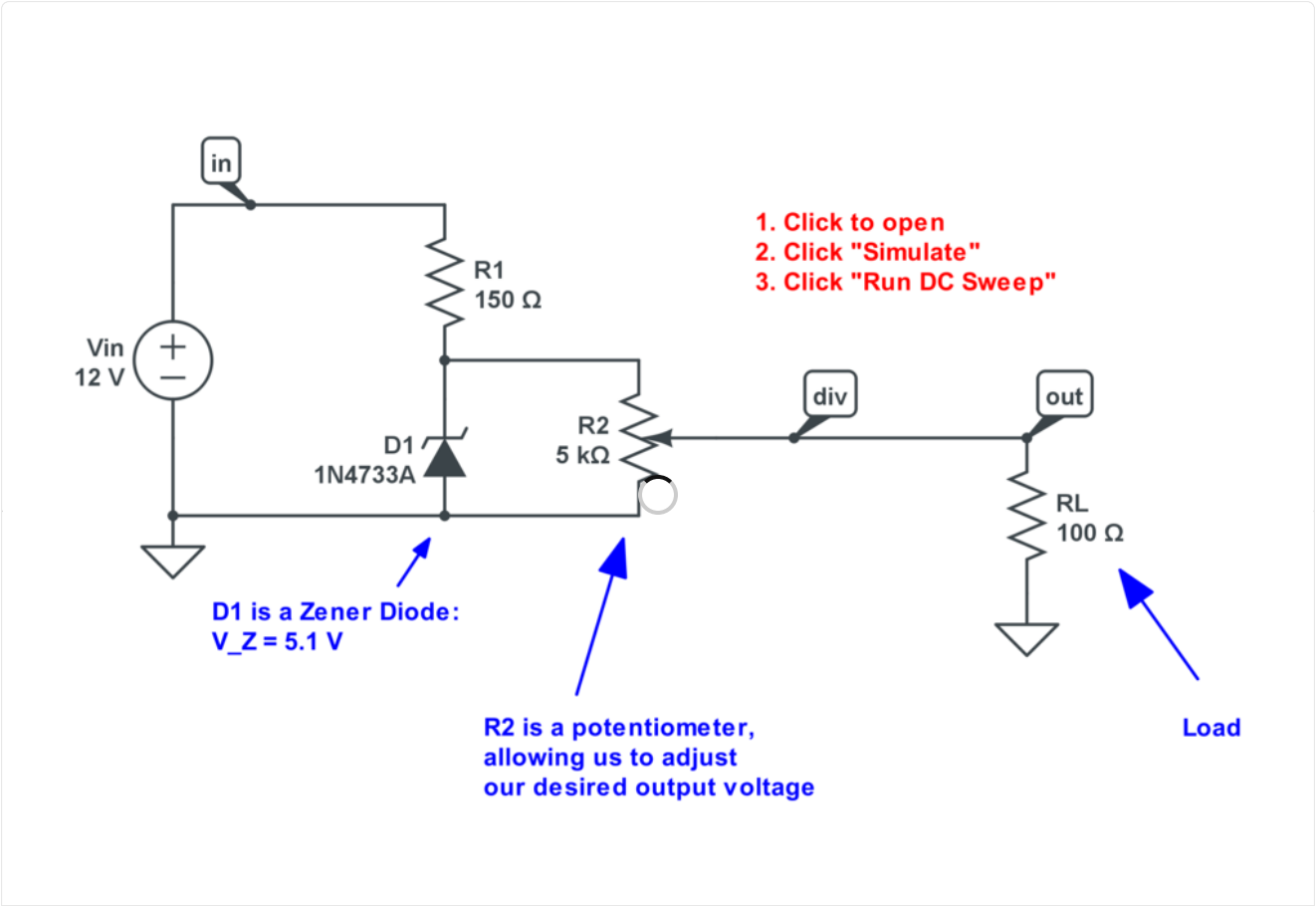
Zener Diode Op-Amp Voltage Reference with Capacitor
circuitlab.com/cct3dw8uz2e66

Edit - Simulate



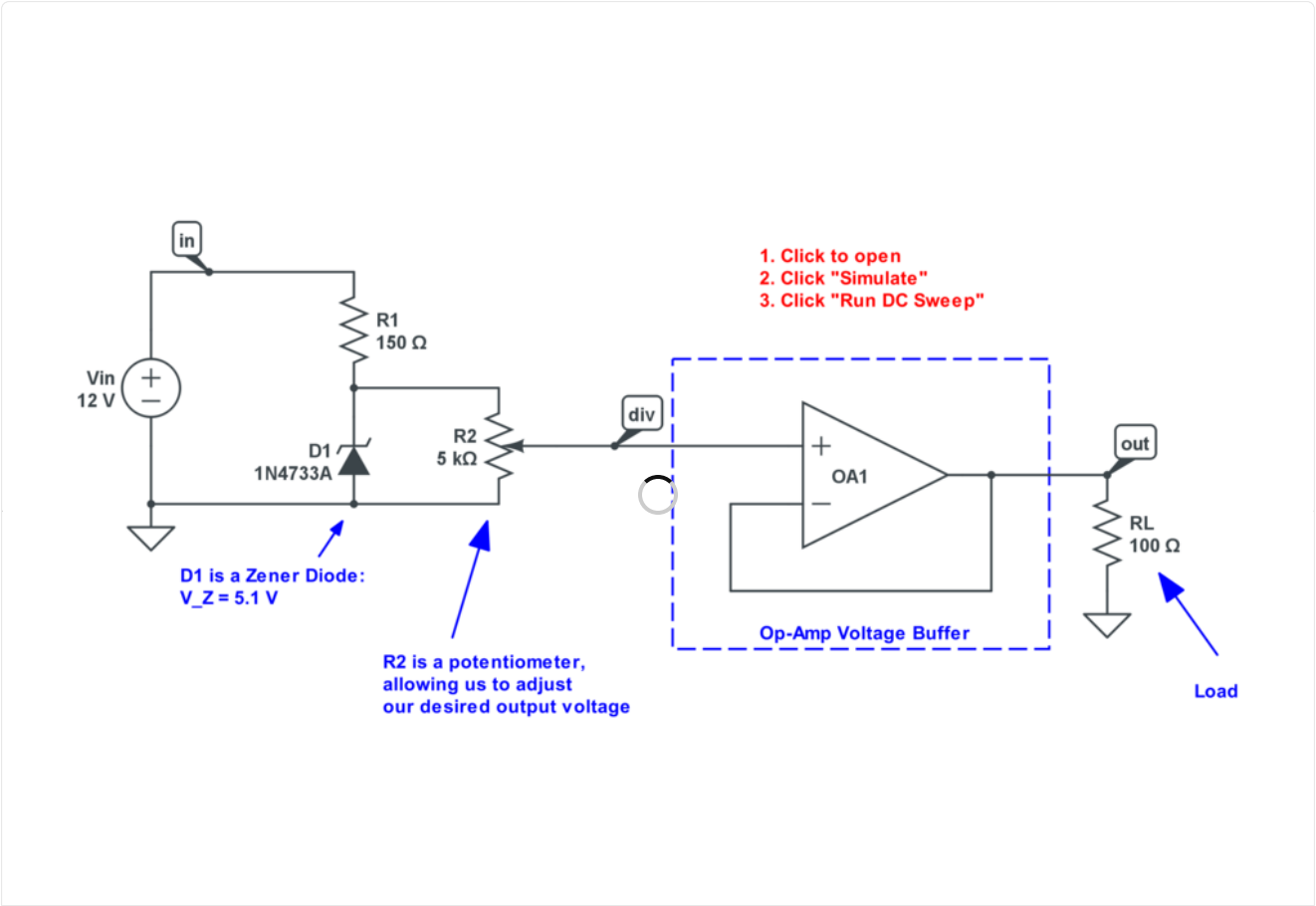
Zener Diode, Potentiometer, Op-Amp: Adjustable Voltage Reference
circuitlab.com/chvw343g59bd8

Edit - Simulate



Adjustable Zener-based Voltage Reference Under Load (Unbuffered)
circuitlab.com/c9p4uvmmg26xz

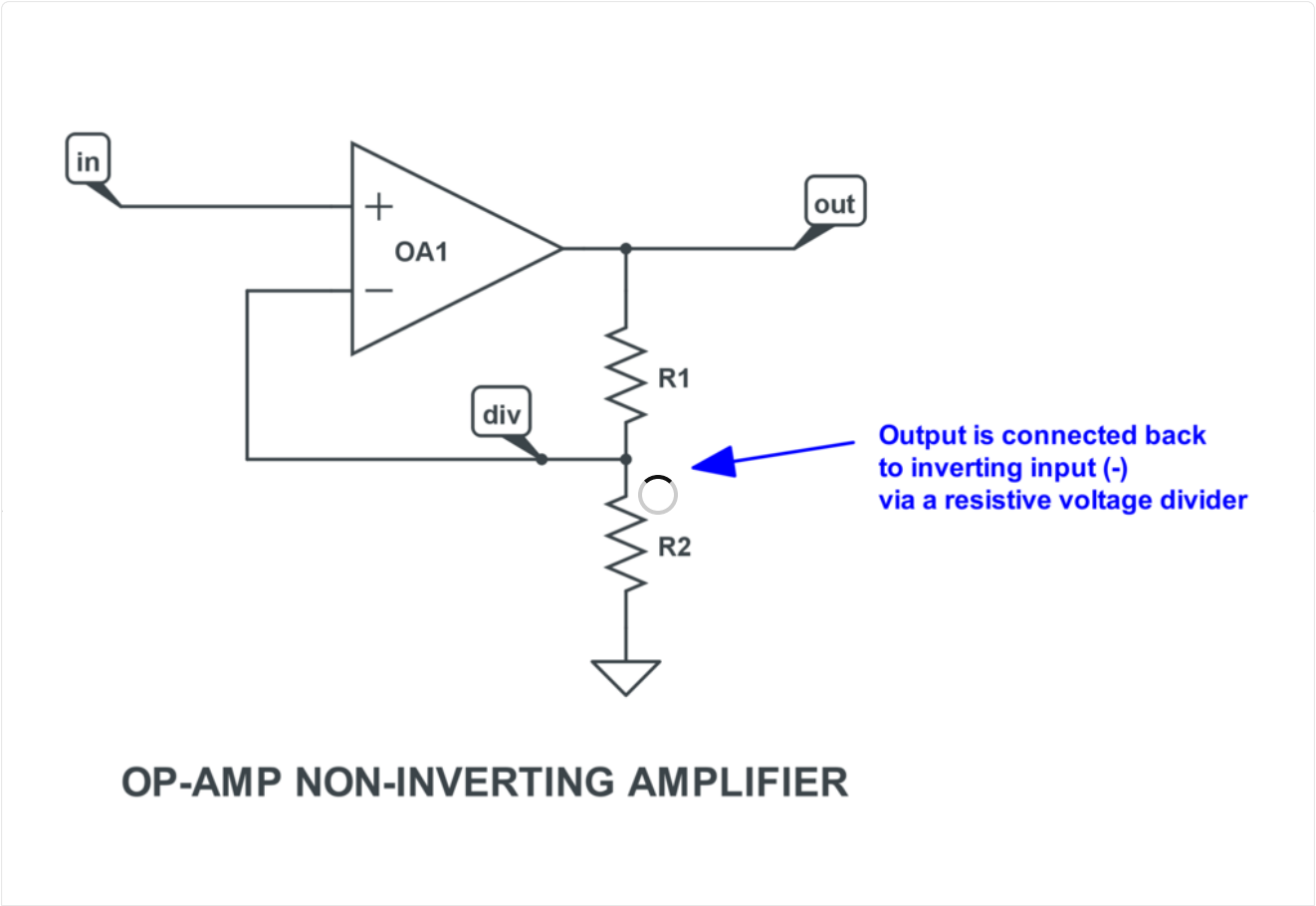
Edit - Simulate



Adjustable Zener-based Voltage Reference Under Load (With Op-Amp Buffer)
circuitlab.com/cxskwwjv9sza4 Edit - Simulate

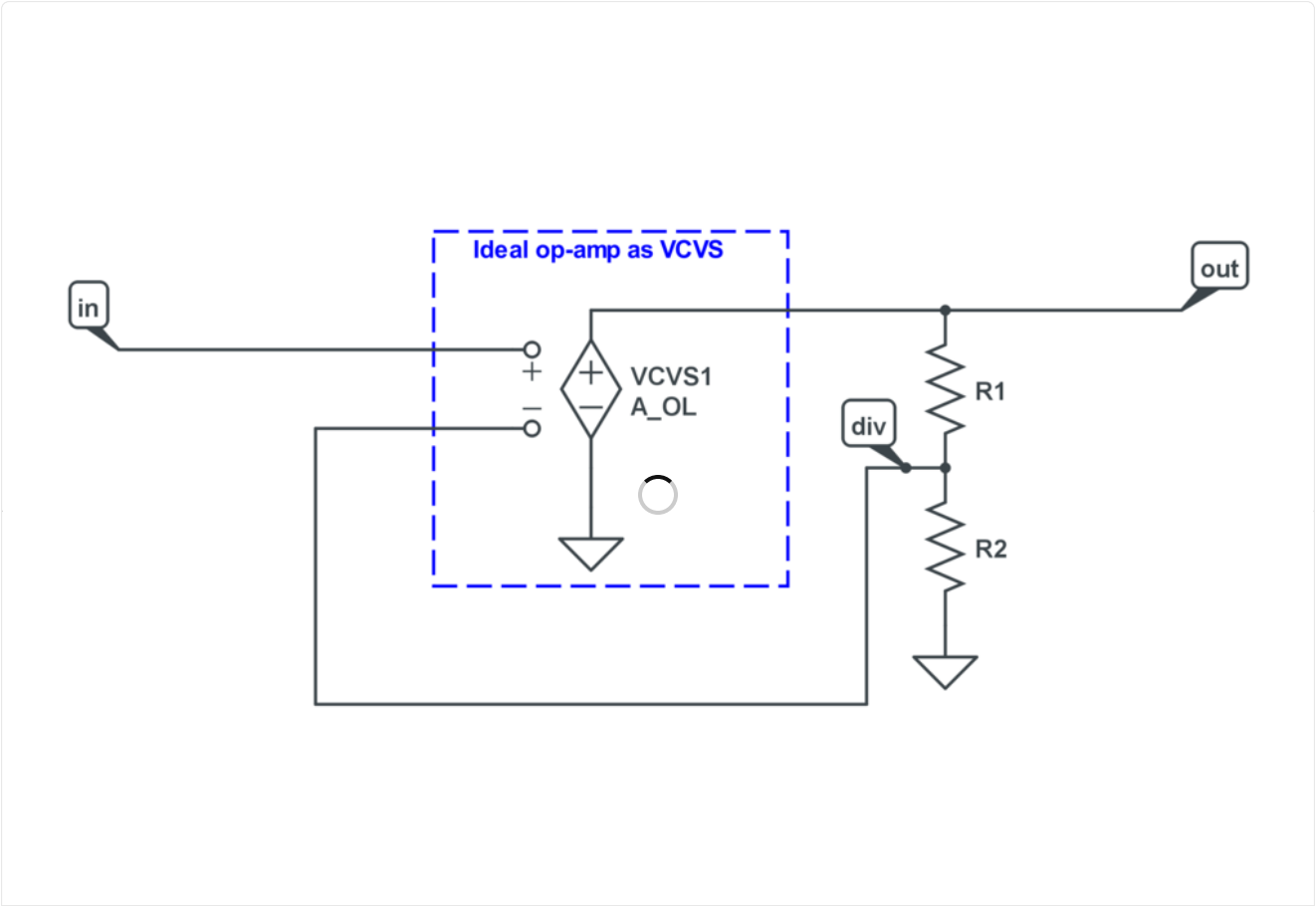
From Chapter 7.4 Op-Amp Non-Inverting Amplifier:

An op-amp circuit forming a voltage amplifier, using negative feedback to multiply an input signal by a positive gain set by two resistors.



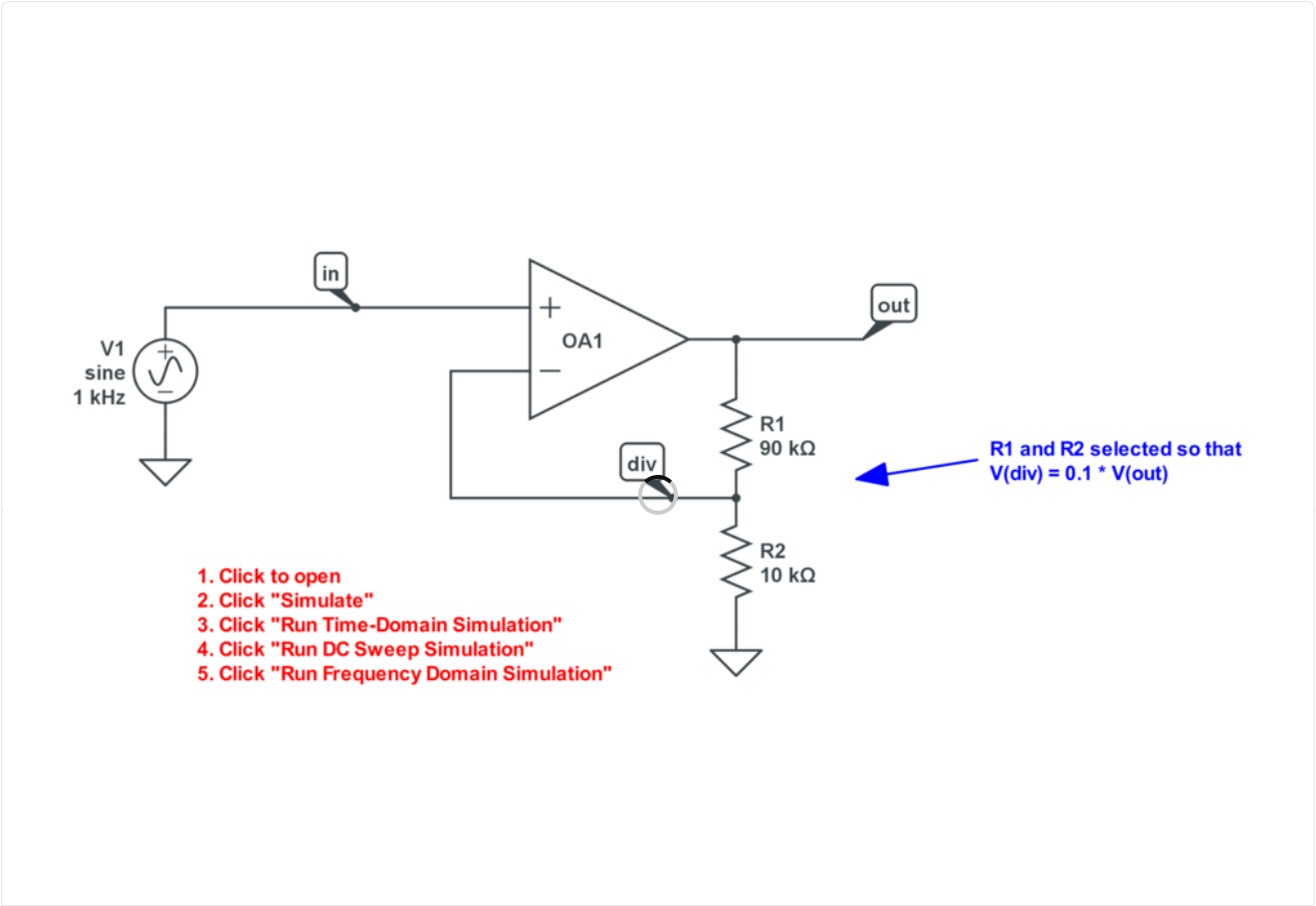
Op-Amp Non-Inverting Amplifier
circuitlab.com/c4wnat6ynz2ek

Edit - Simulate



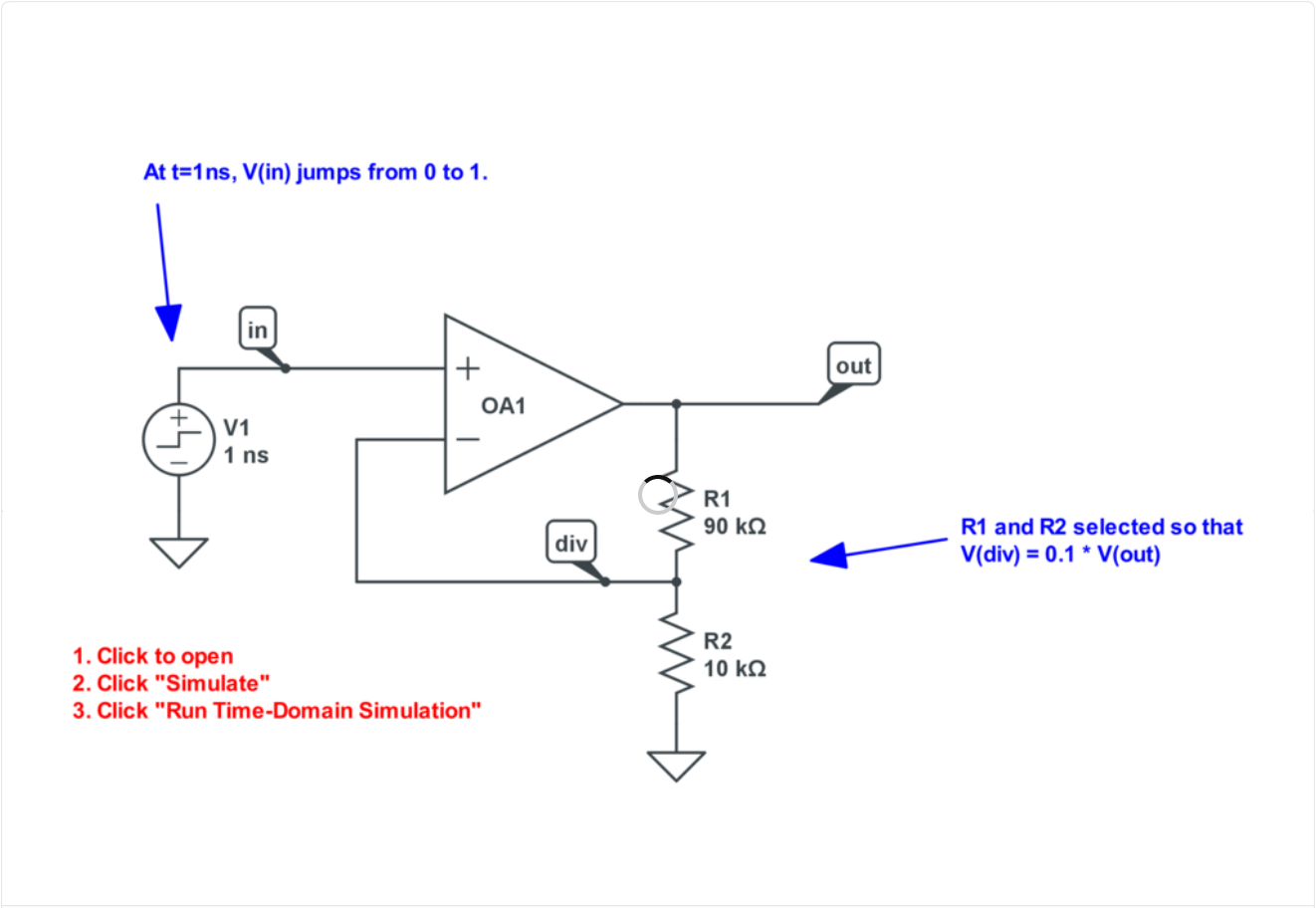
Op-Amp Non-Inverting Amplifier VCVS Model
circuitlab.com/cq3ssz7y3pkpj

Edit - Simulate



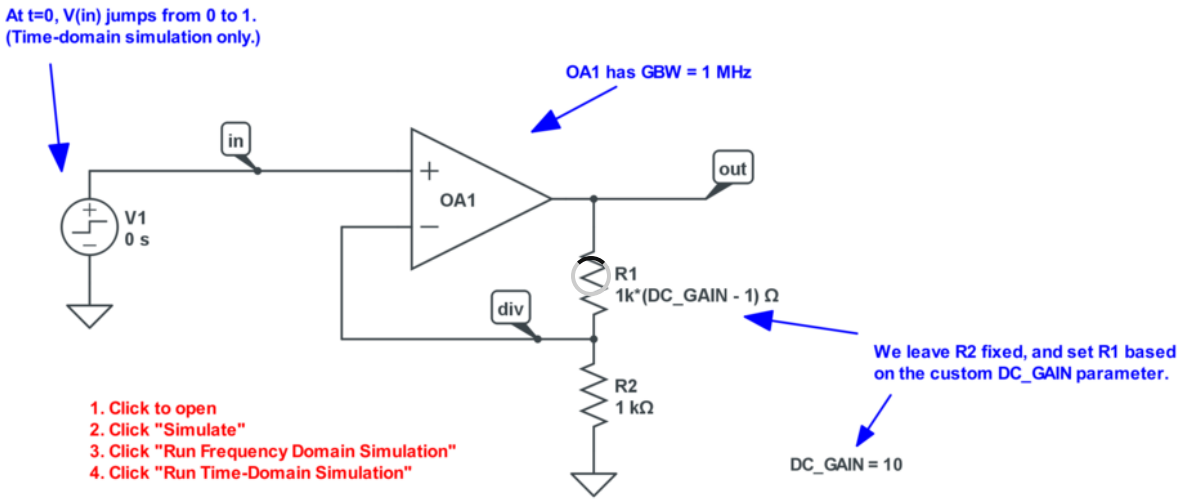
Op-Amp Non-Inverting Amplifier Gain of 10 Example
circuitlab.com/cnm6354nkc2jm

Edit - Simulate



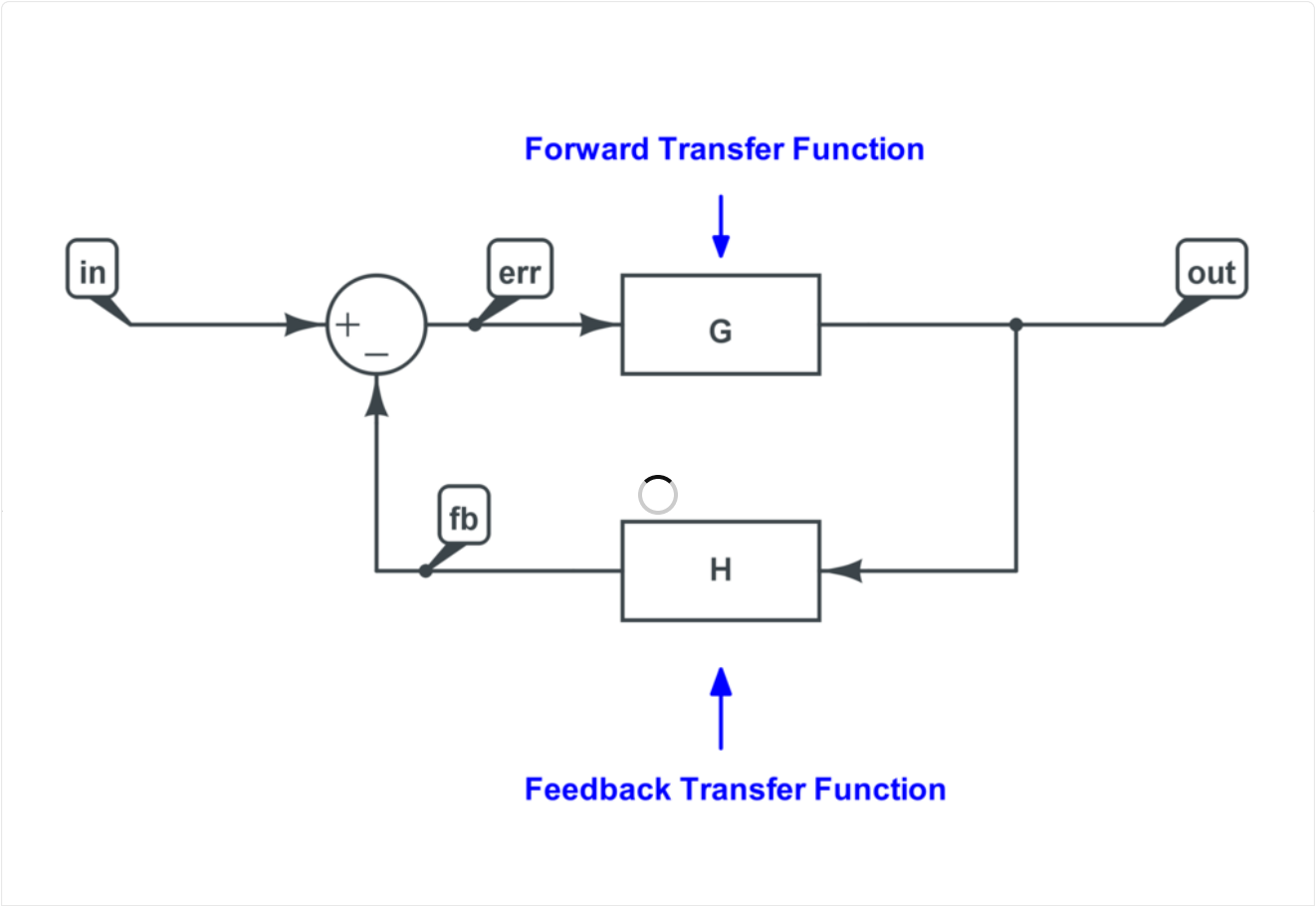
Op-Amp Non-Inverting Amplifier Gain of 10 Step Response
circuitlab.com/c9xykgb57wstt

Edit - Simulate



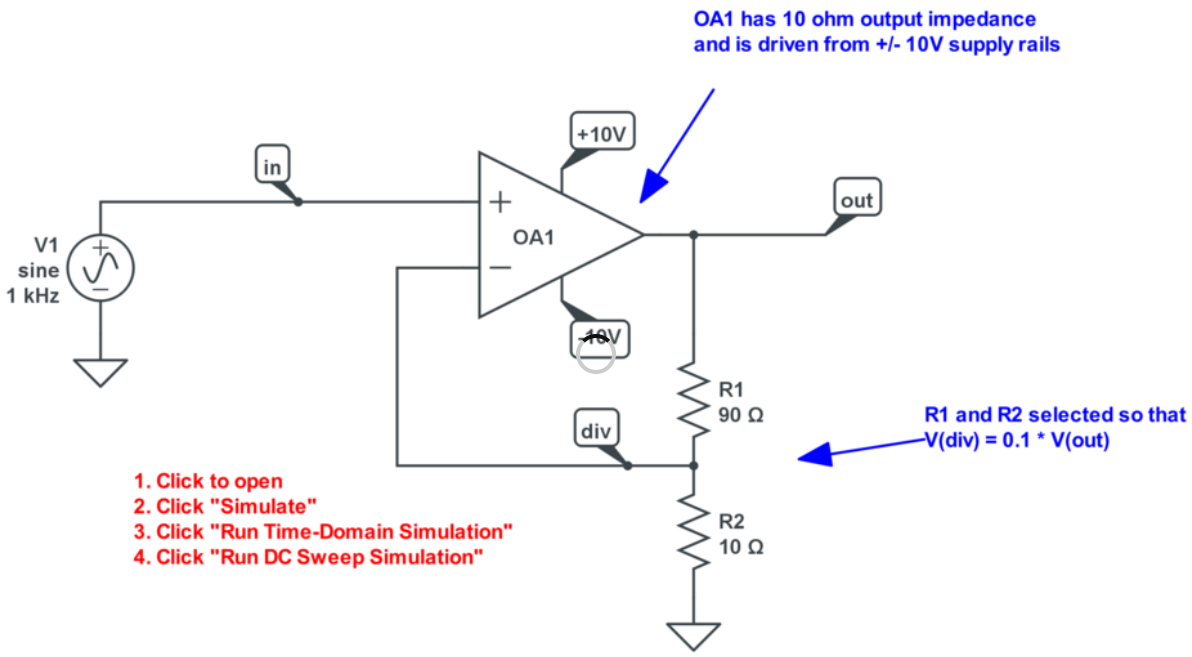
Op-Amp Non-Inverting Amplifier - Gain vs. Bandwidth Tradeoff
circuitlab.com/c2v2mwrd2t966

Edit - Simulate



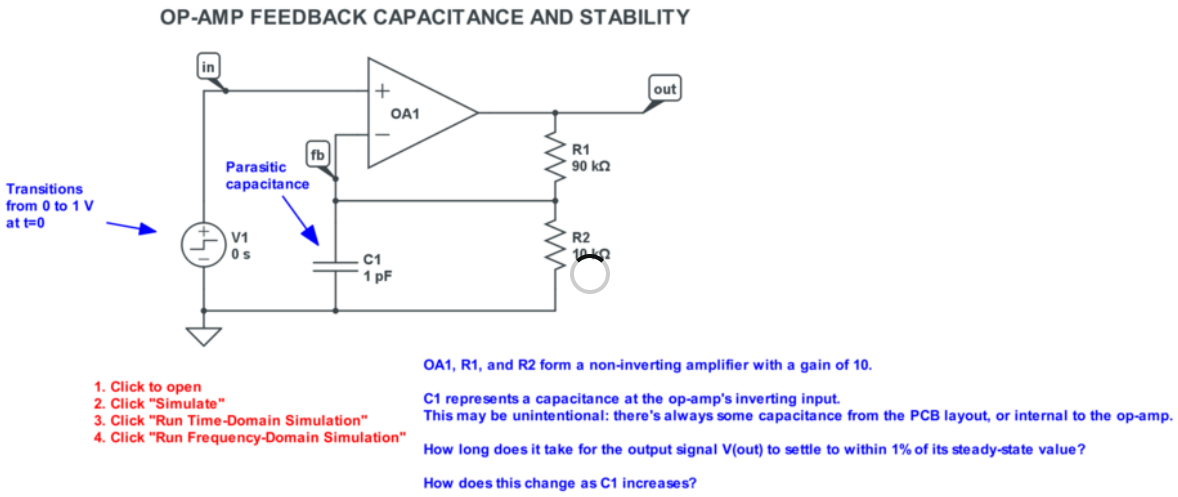
Closed-Loop Transfer Function Block Diagram
circuitlab.com/c42n7tesuxm2d

Edit - Simulate



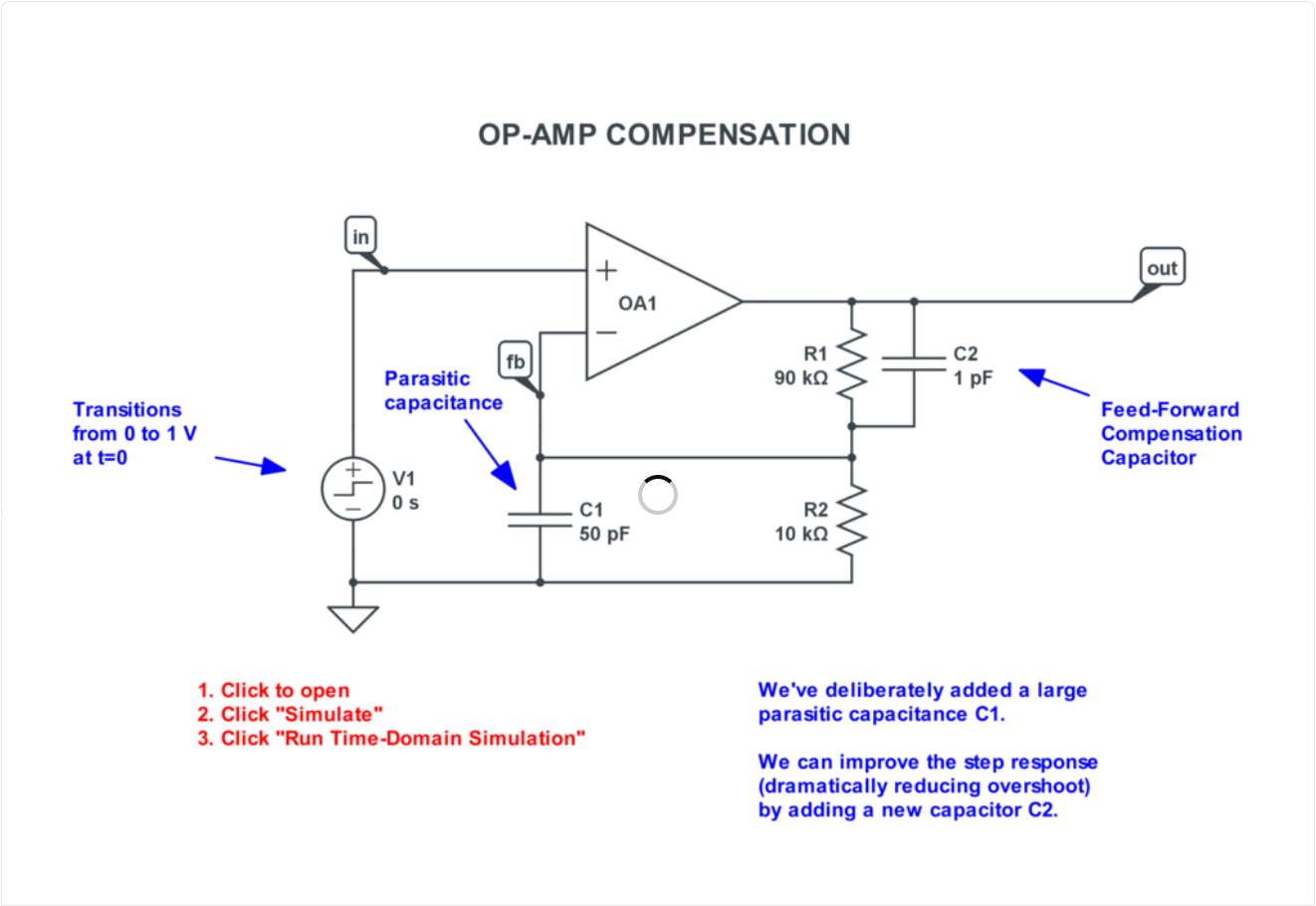
Op-Amp Non-Inverting Amplifier - Clipping due to Output Impedance
circuitlab.com/c2xqt2ju44bm7

Edit - Simulate



Op-Amp Non-Inverting Amplifier Feedback Parasitic Capacitiance Stability Issues
circuitlab.com/ctahy46huss23

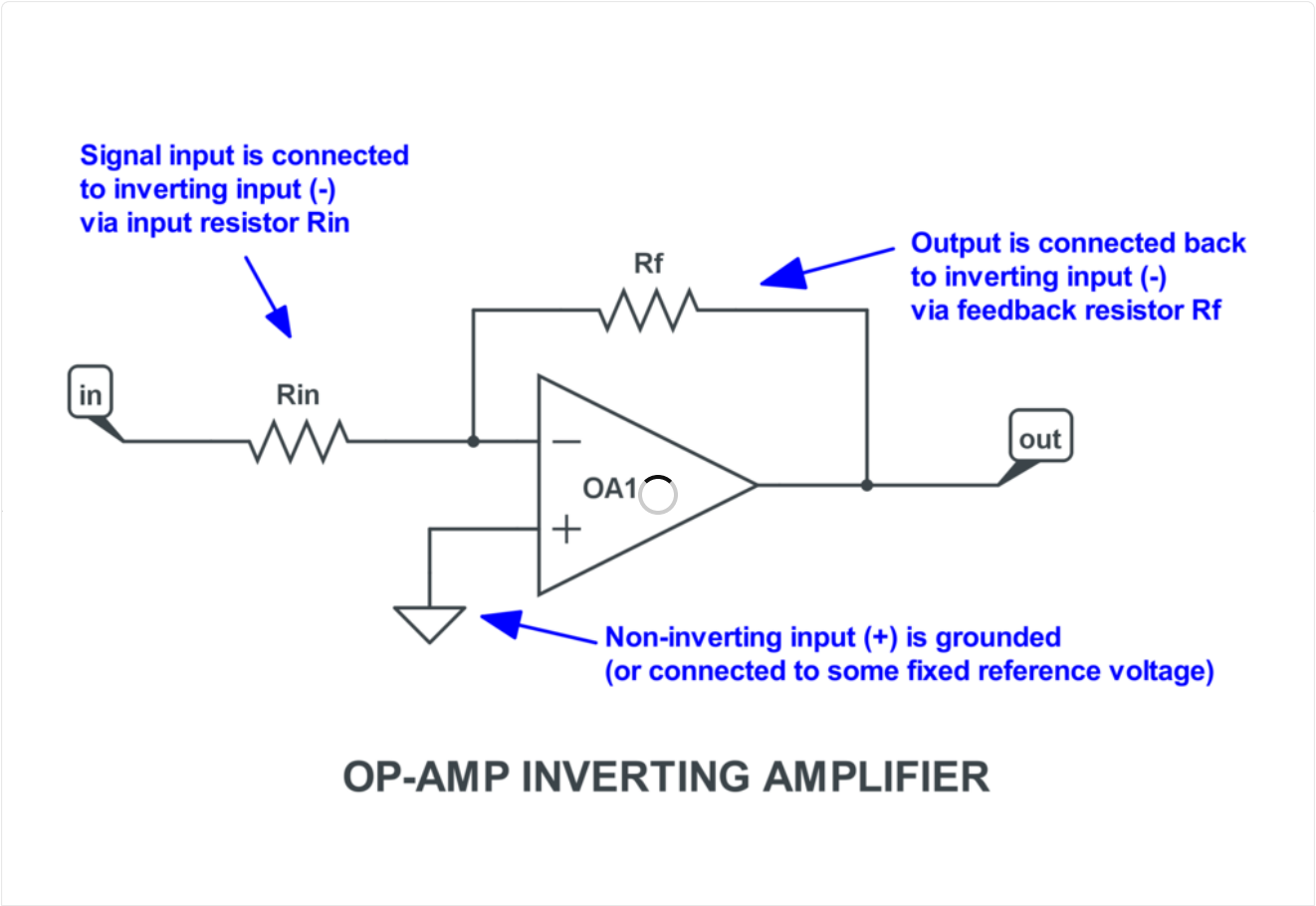
Edit - Simulate



Op-Amp Non-Inverting Amplifier - Feed-Forward Compensation Capacitor
circuitlab.com/c9wqubpx4g4g5 Edit - Simulate

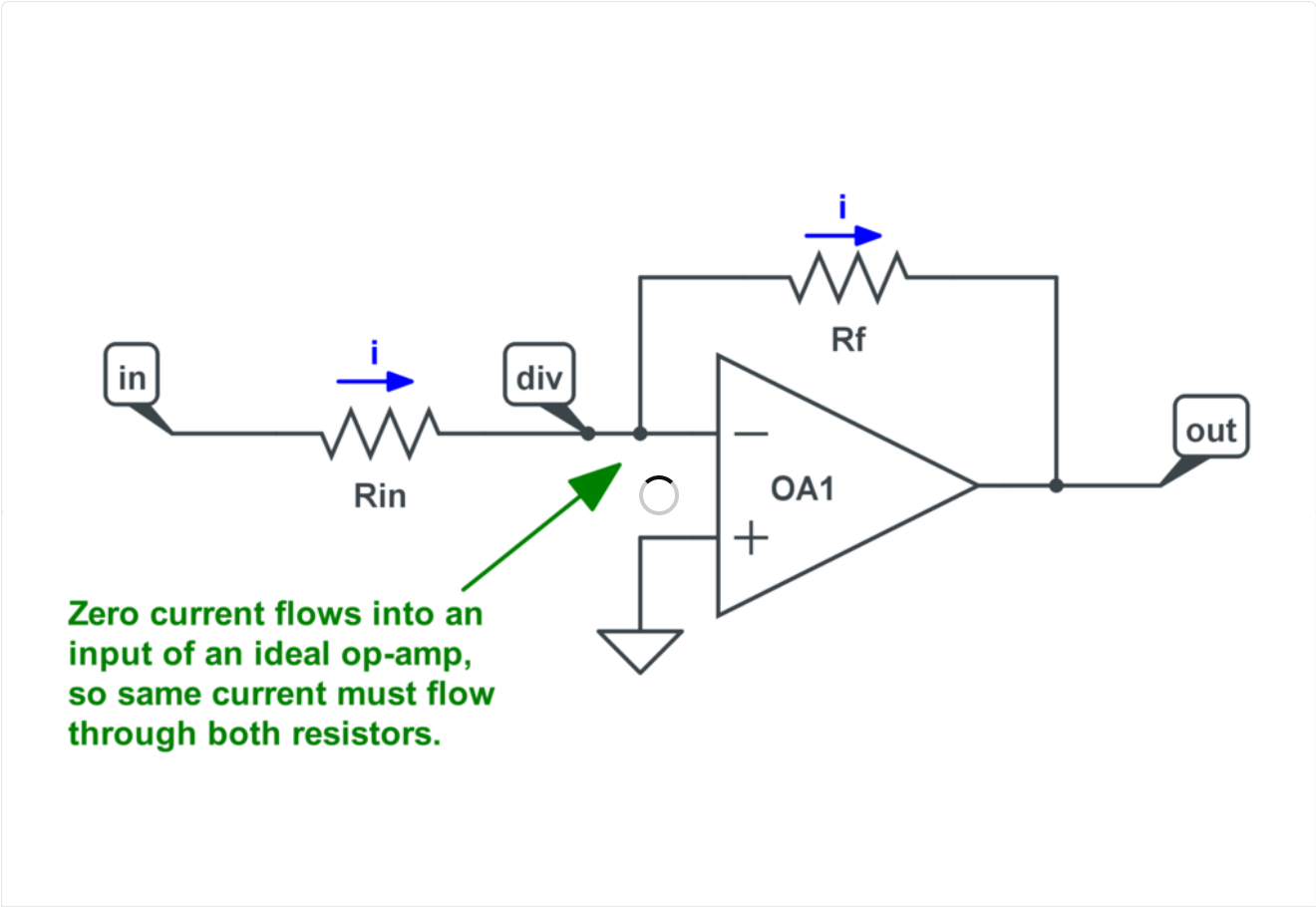
From Chapter 7.5 Op-Amp Inverting Amplifier:

An op-amp circuit forming a voltage amplifier with negative gain set by the ratio of two resistors.



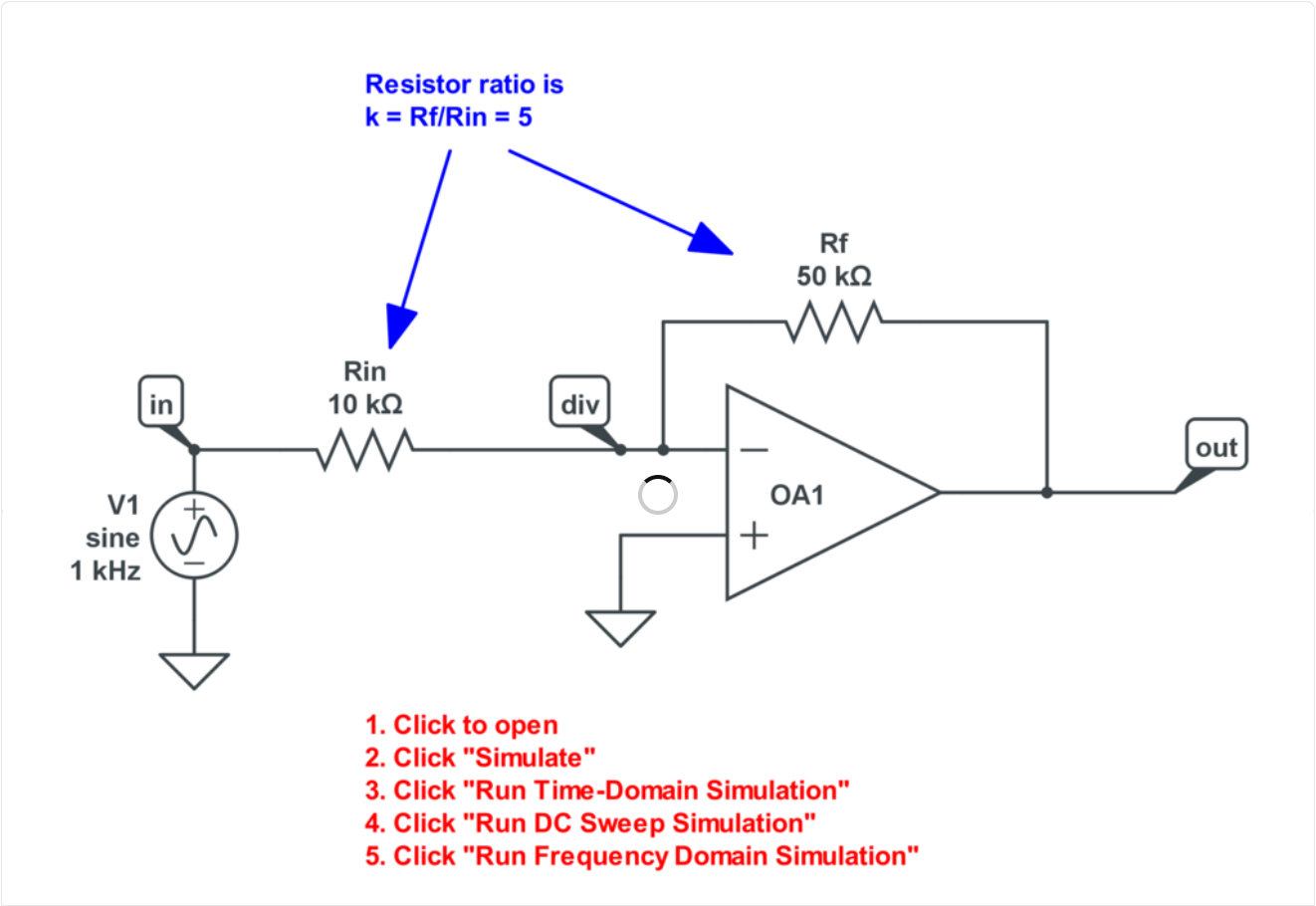
Op-Amp Inverting Amplifier
circuitlab.com/cbrb4w7egr83k

Edit - Simulate



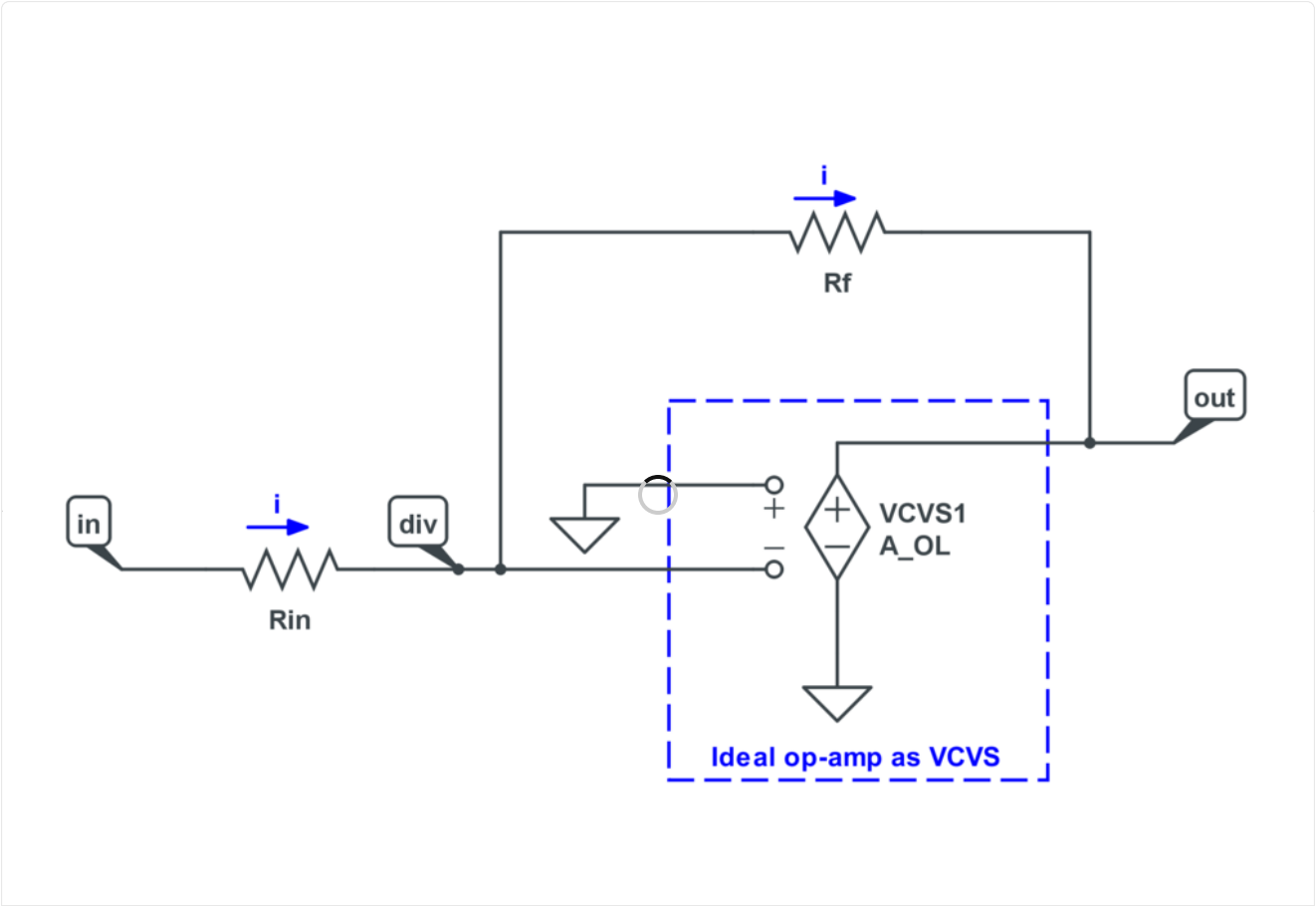
Op-Amp Inverting Amplifier - Labeled Inverting Input
circuitlab.com/c576qm3vwjhtp

Edit - Simulate



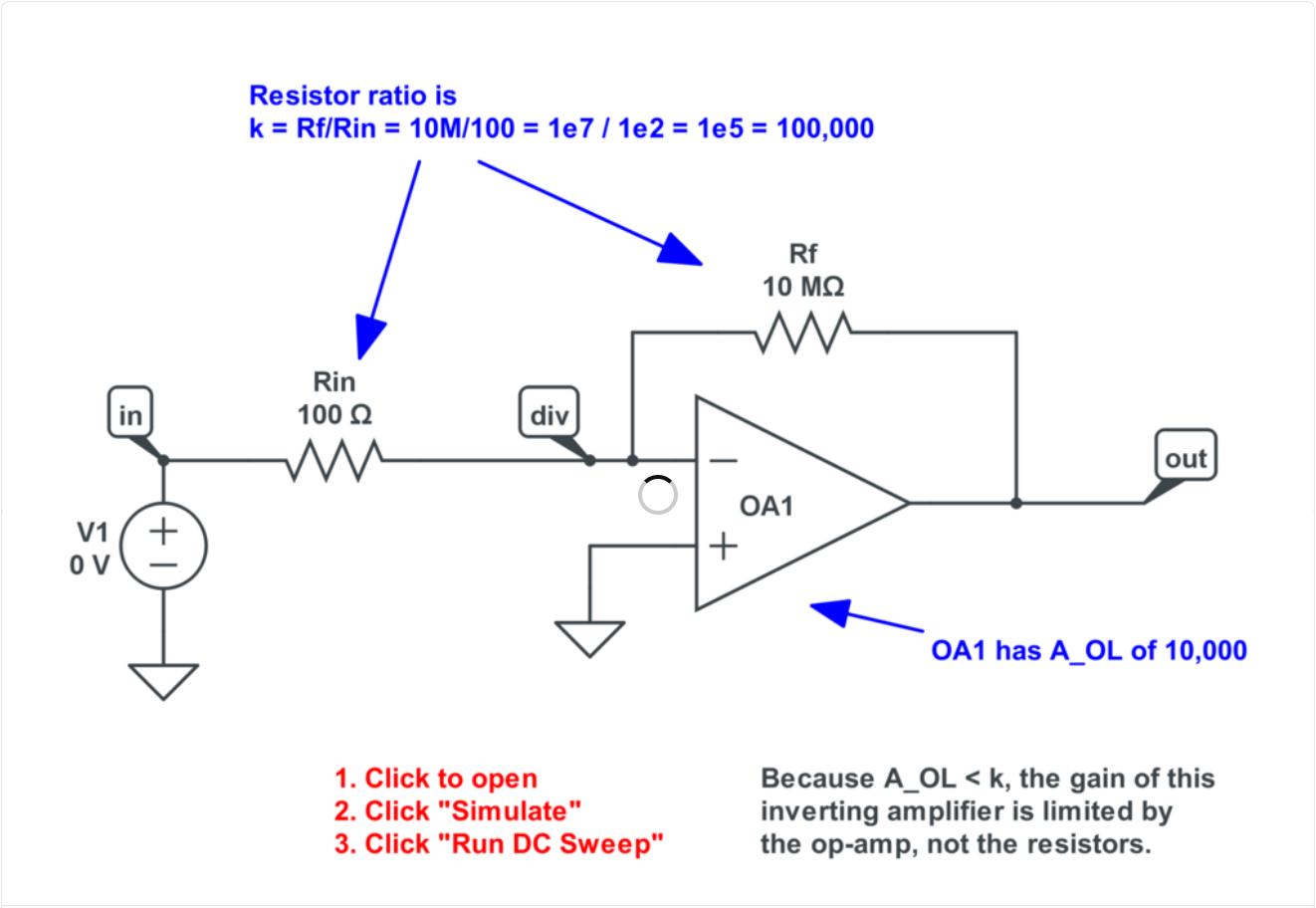
Op-amp Inverting Amplifier - Gain of -5 Example
circuitlab.com/c23xfs3587jd8

Edit - Simulate



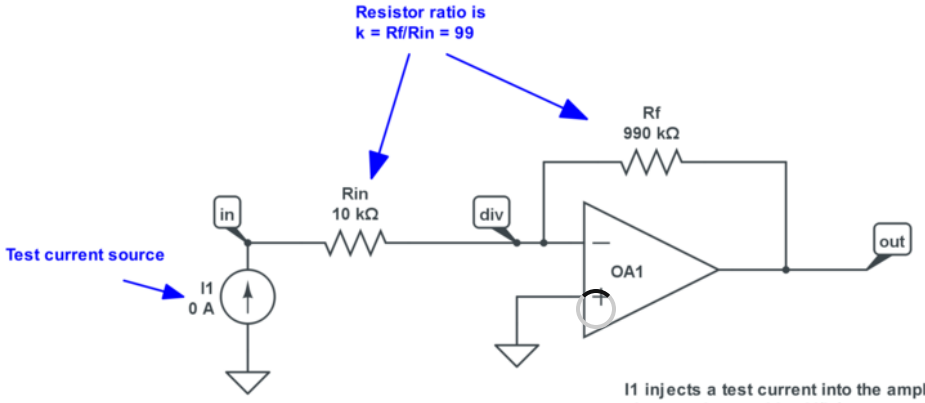
Op-Amp Inverting Amplifier VCVS Model
circuitlab.com/c5kgdge4xjgq7

Edit - Simulate



Op-Amp Inverting Amplifier - Limited by Open-Loop Gain
circuitlab.com/ctjm6t325a9he

Edit - Simulate



1. Click to open
2. Click "Simulate"
3. Click "Run Frequency Domain Simulation"

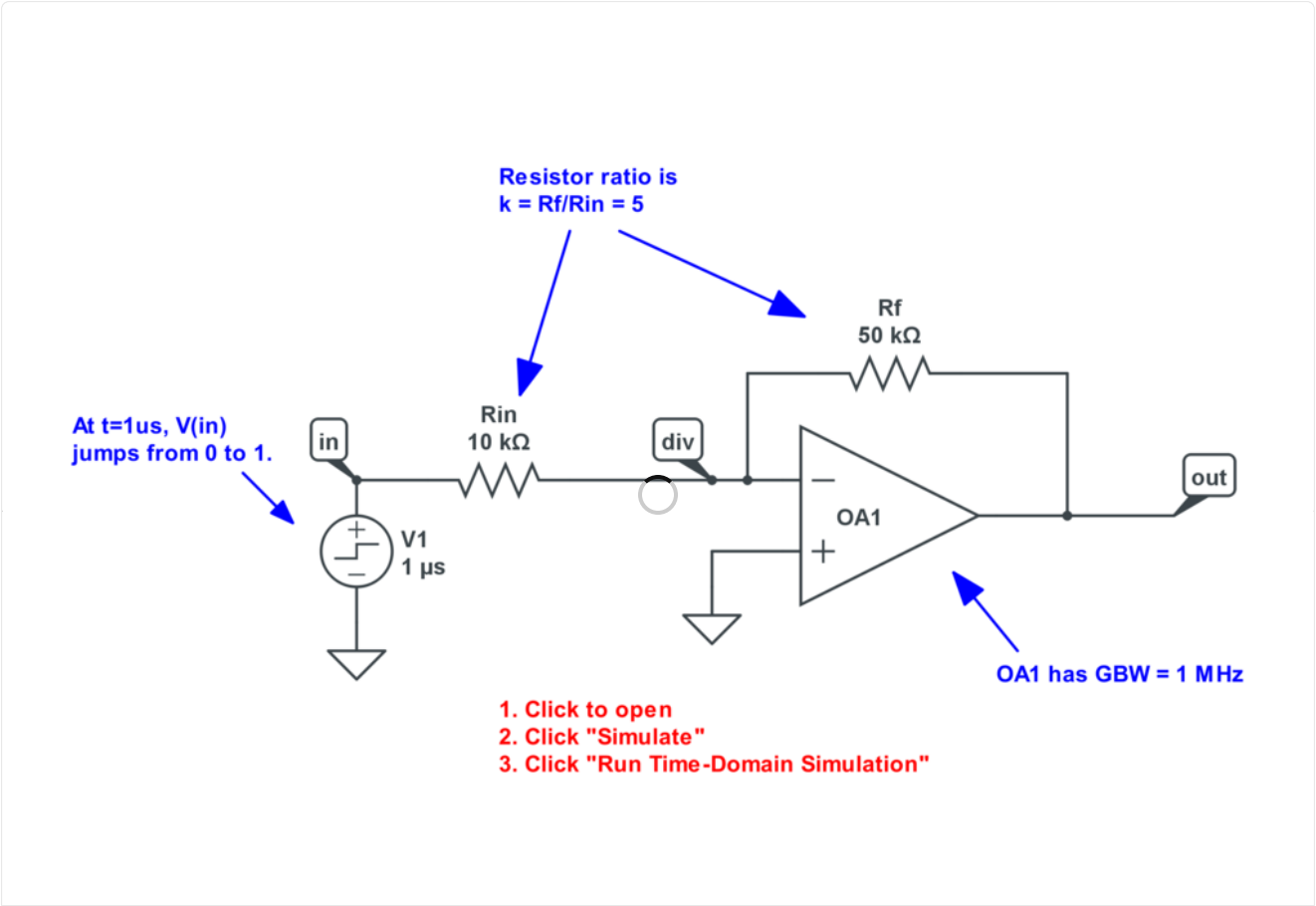
I1 injects a test current into the amplifier input, and we observe the resulting V(in) to measure the input impedance.

The first plot shows the input impedance of the amplifier in Ohms.

Notice that:
- At low frequencies, it's equal to 10k = Rin
- At high frequencies, it's equal to 1M = Rin+Rf
- The transition starts to happen at approximately 100 kHz = A_OL / k

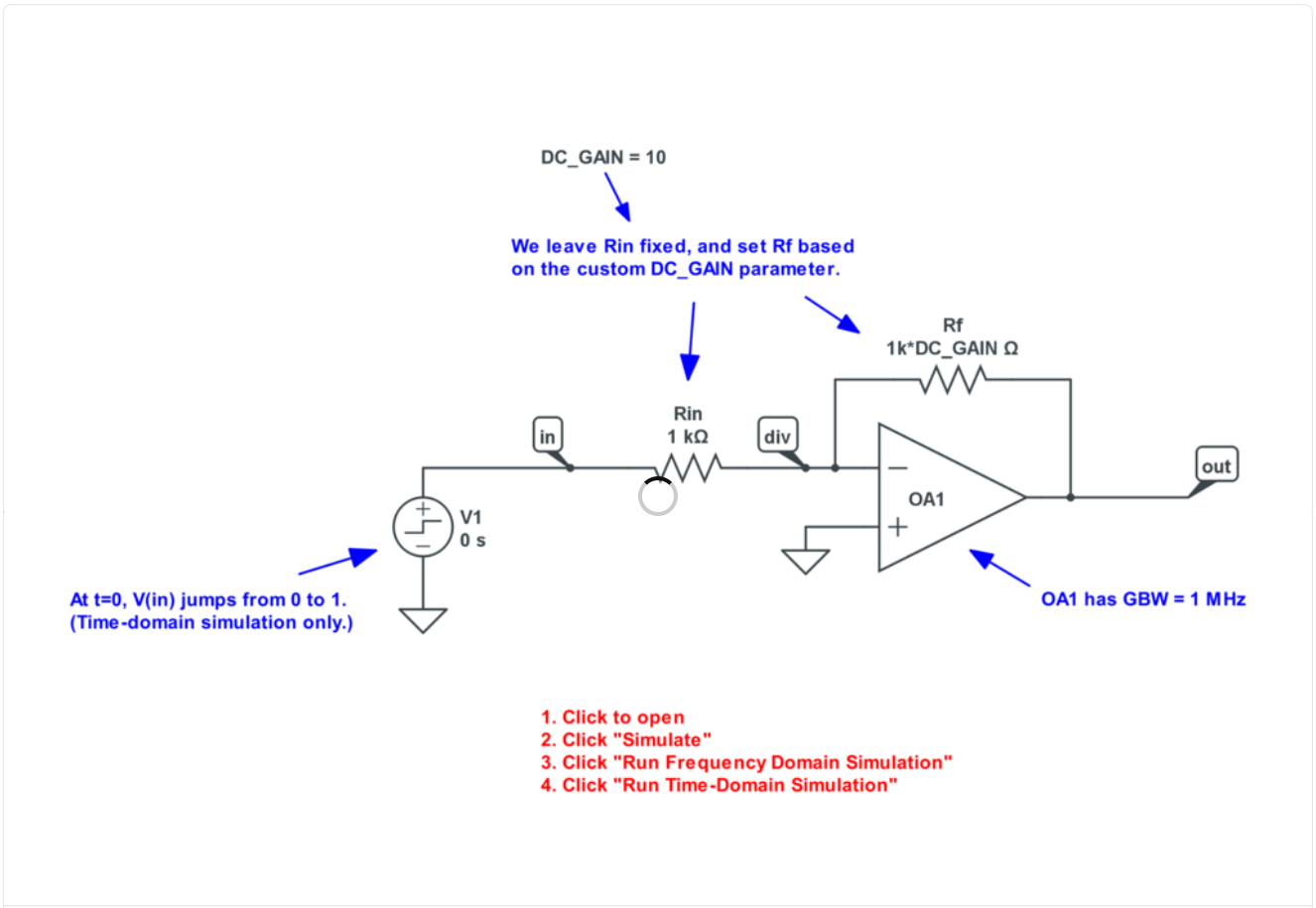
Op-Amp Inverting Amplifier - Input Impedance Simulation
circuitlab.com/c7gvkuez25b24

Edit - Simulate



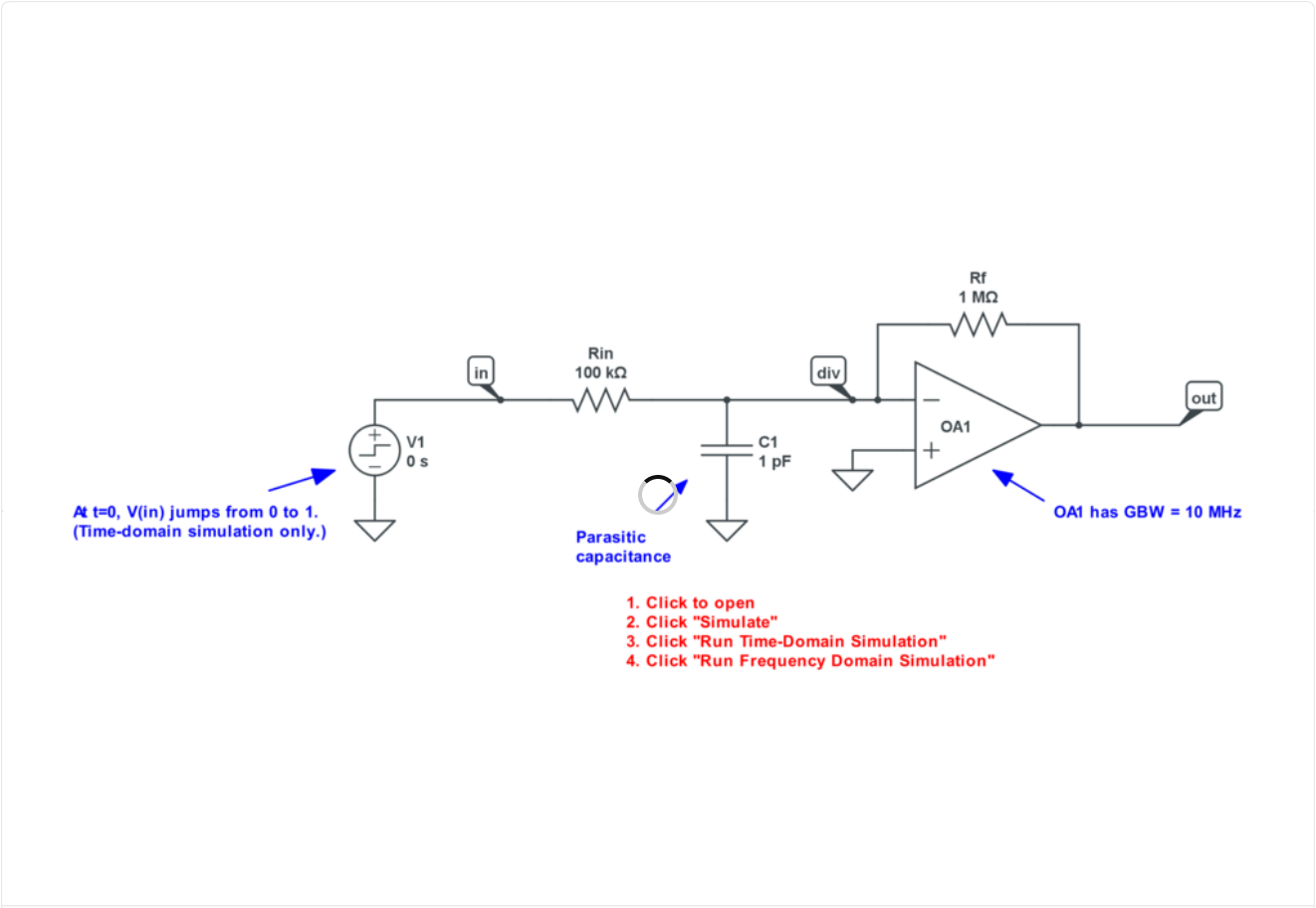
Op-Amp Inverting Amplifier - Step Response
circuitlab.com/c5493kmczatef

Edit - Simulate



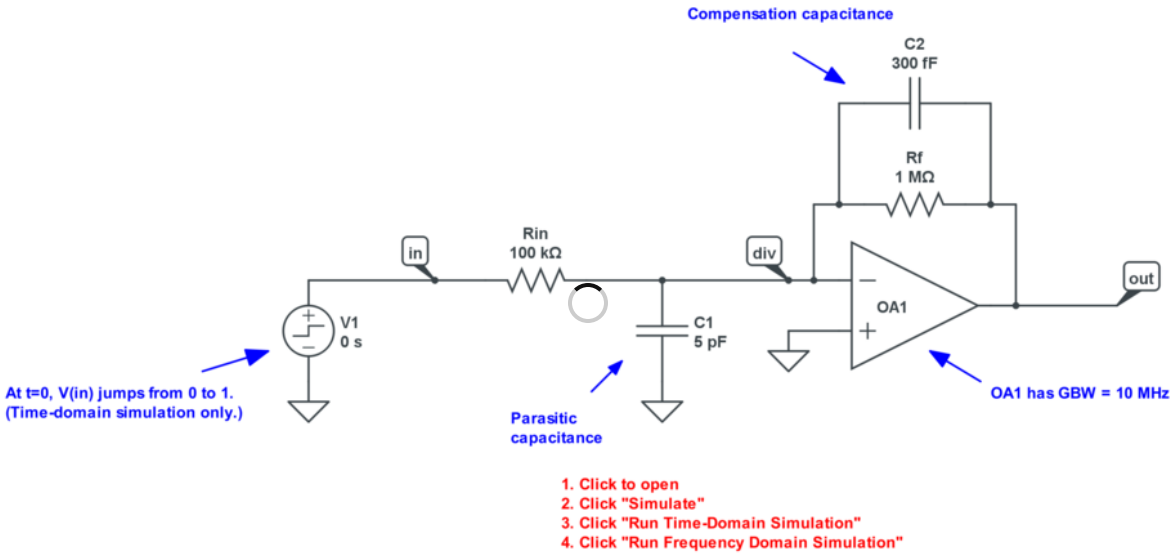
Op-Amp Inverting Amplifier - Gain vs. Bandwidth Tradeoff
circuitlab.com/cm5yf4gjyqf4t

Edit - Simulate



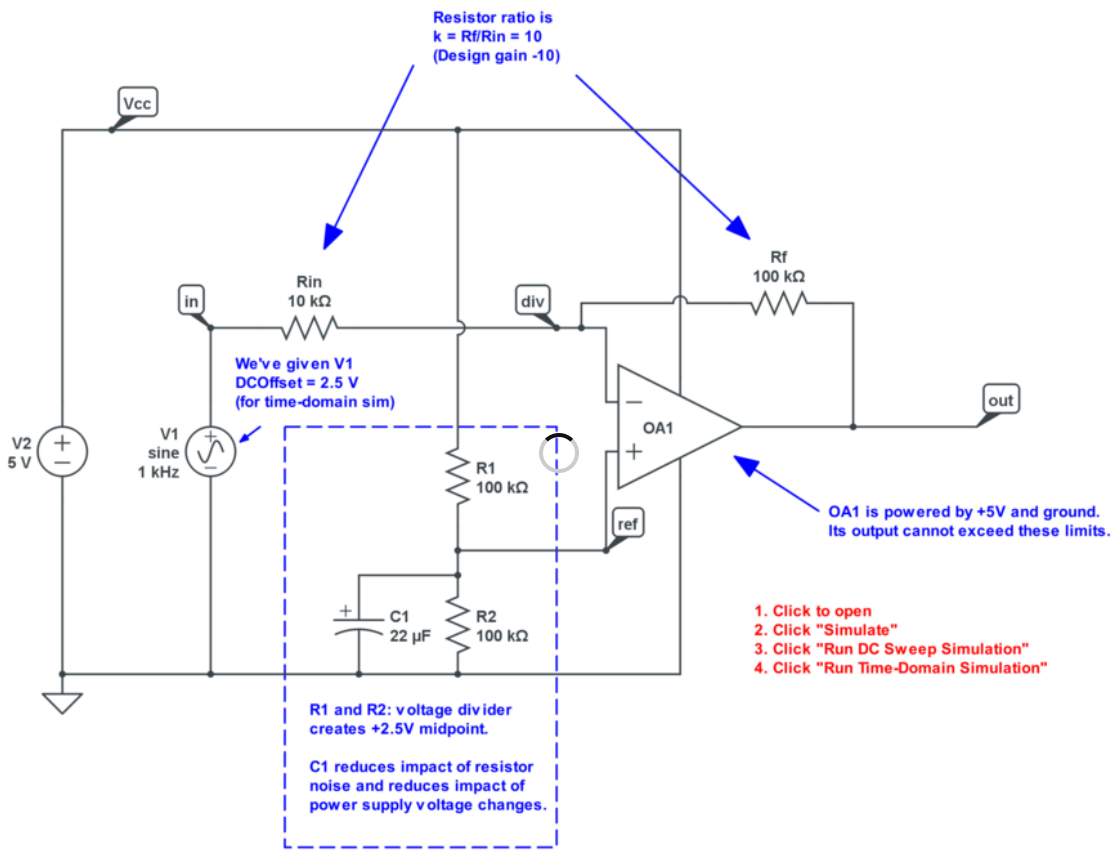
Op-Amp Inverting Amplifier - Instability due to Parasitic Capacitance
circuitlab.com/c8x5srsmhd6zg

Edit - Simulate



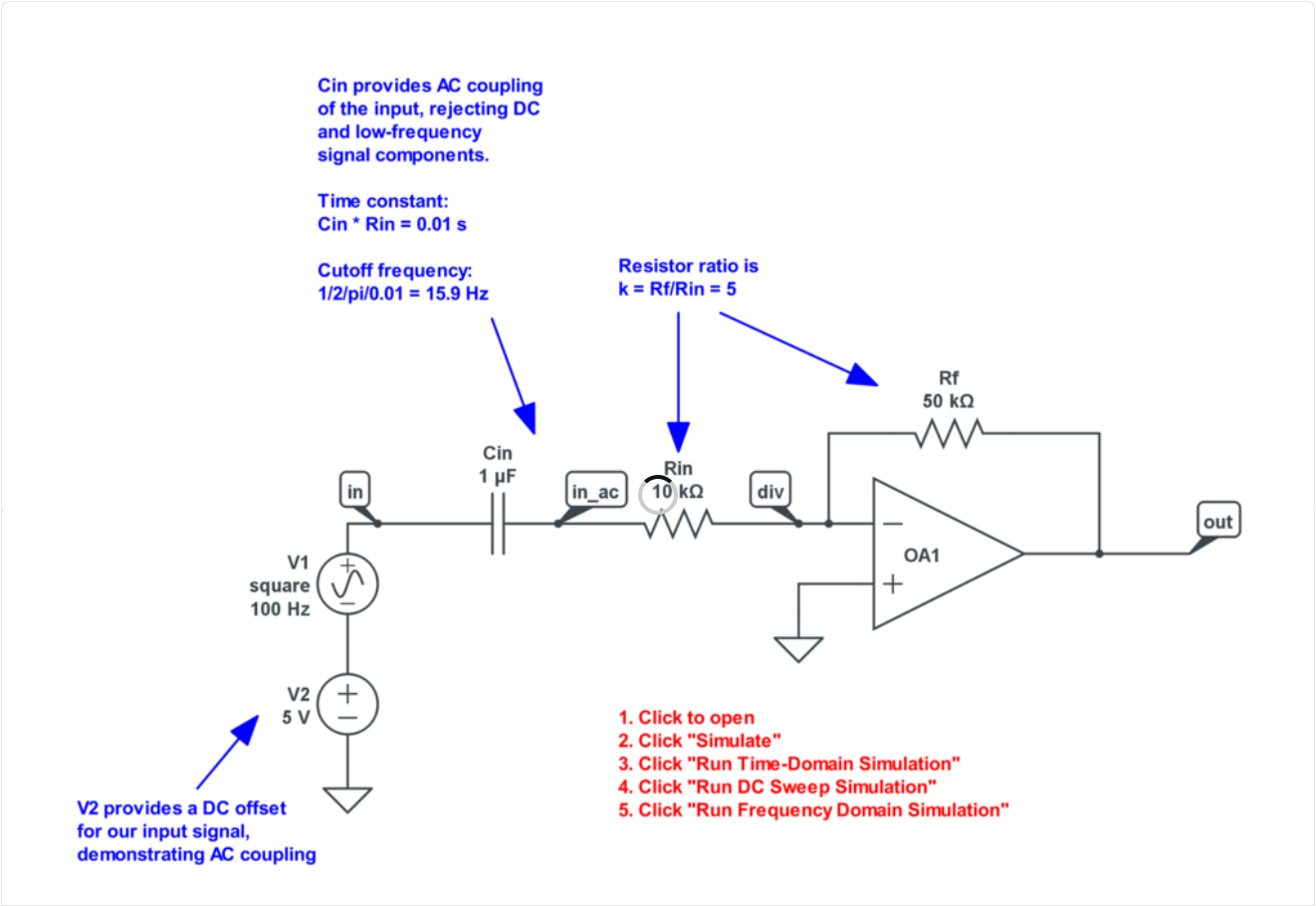
Op-Amp Inverting Amplifier - Compensation Capacitor
circuitlab.com/cdr6eey9rx4hn

Edit - Simulate



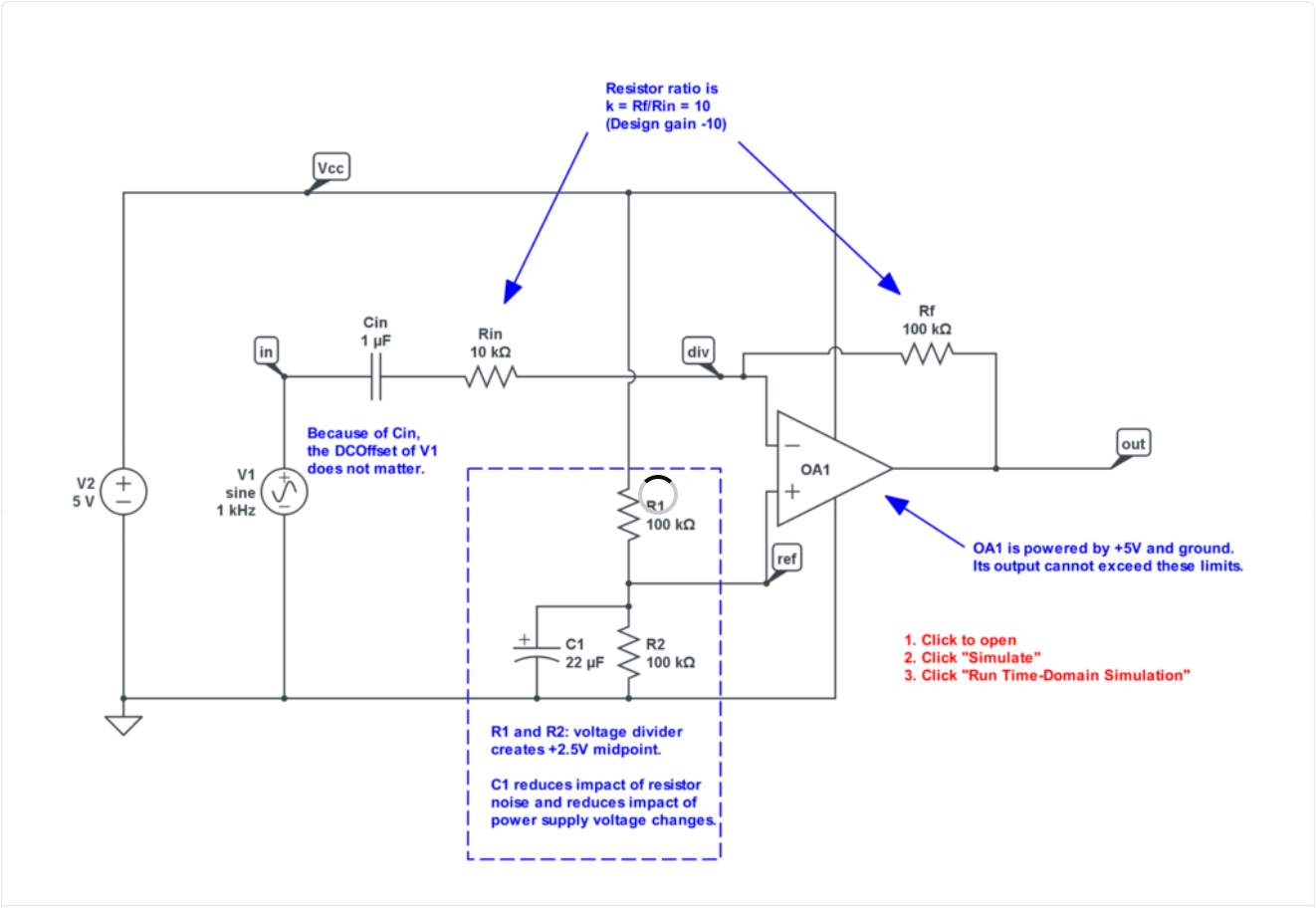
Op-Amp Inverting Amplifier - Single-Supply
circuitlab.com/c65s8x3e2je9e

Edit - Simulate



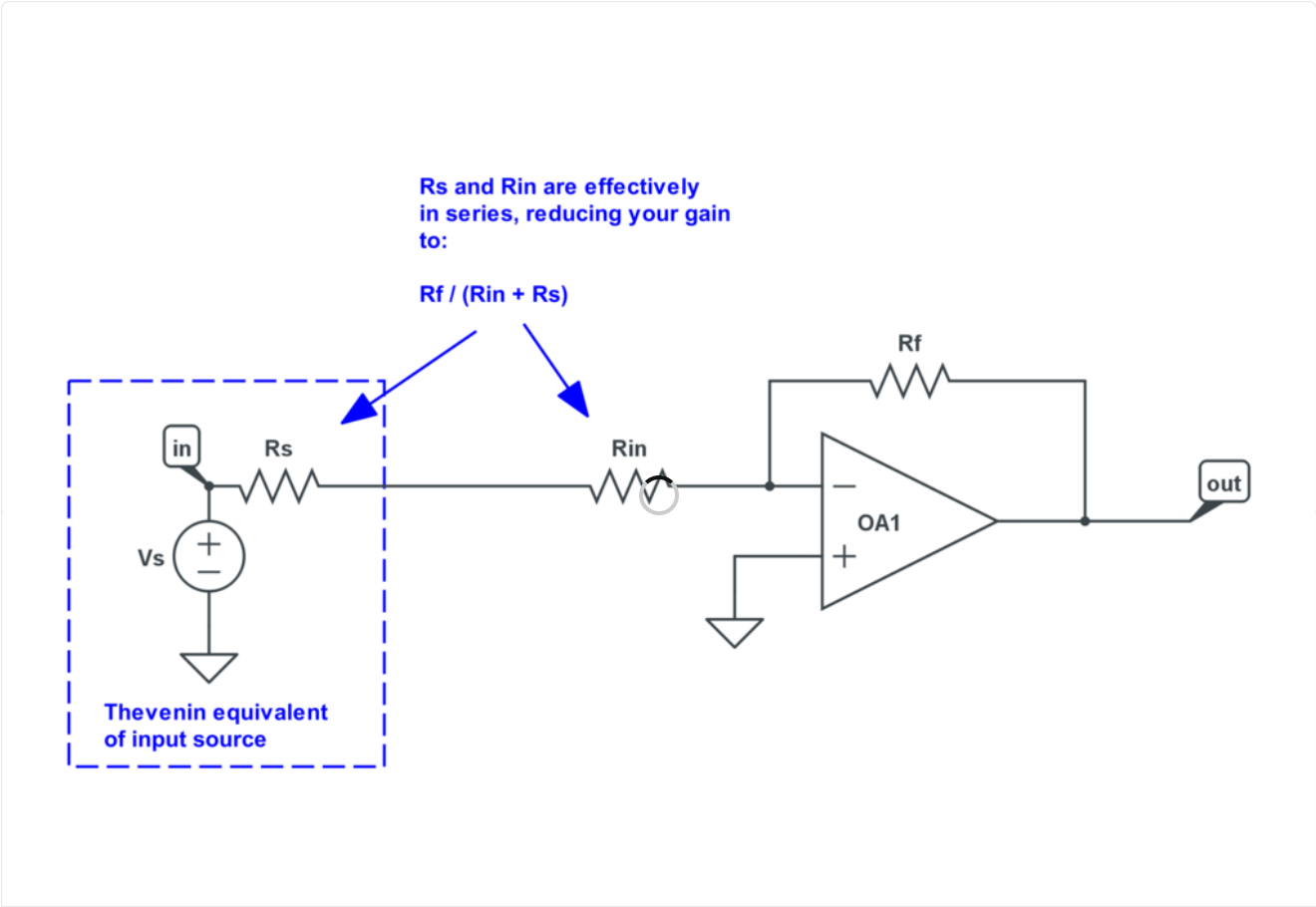
Op-Amp Inverting Amplifier - AC Coupling
circuitlab.com/cf6ypt432etz2

Edit - Simulate



Op-Amp Inverting Amplifier - Single-Supply, AC Coupled
circuitlab.com/cws5ghw72yj3d

Edit - Simulate

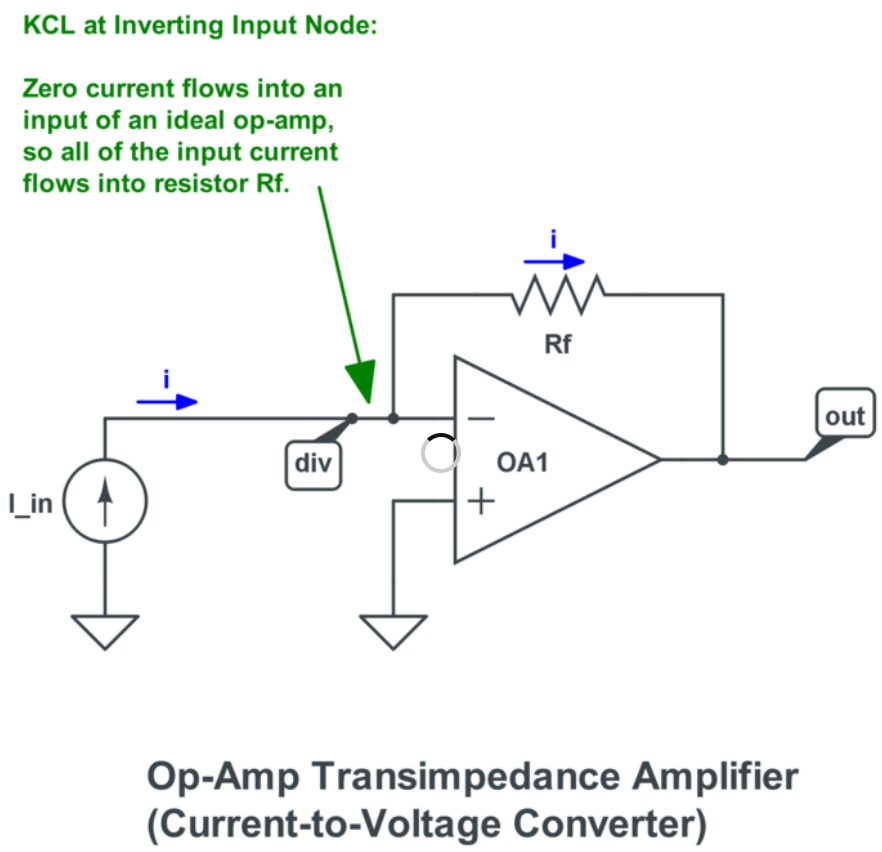


Op-Amp Inverting Amplifier with Thevenin Equivalent Source Input
circuitlab.com/c5q537vb823cn

Edit - Simulate

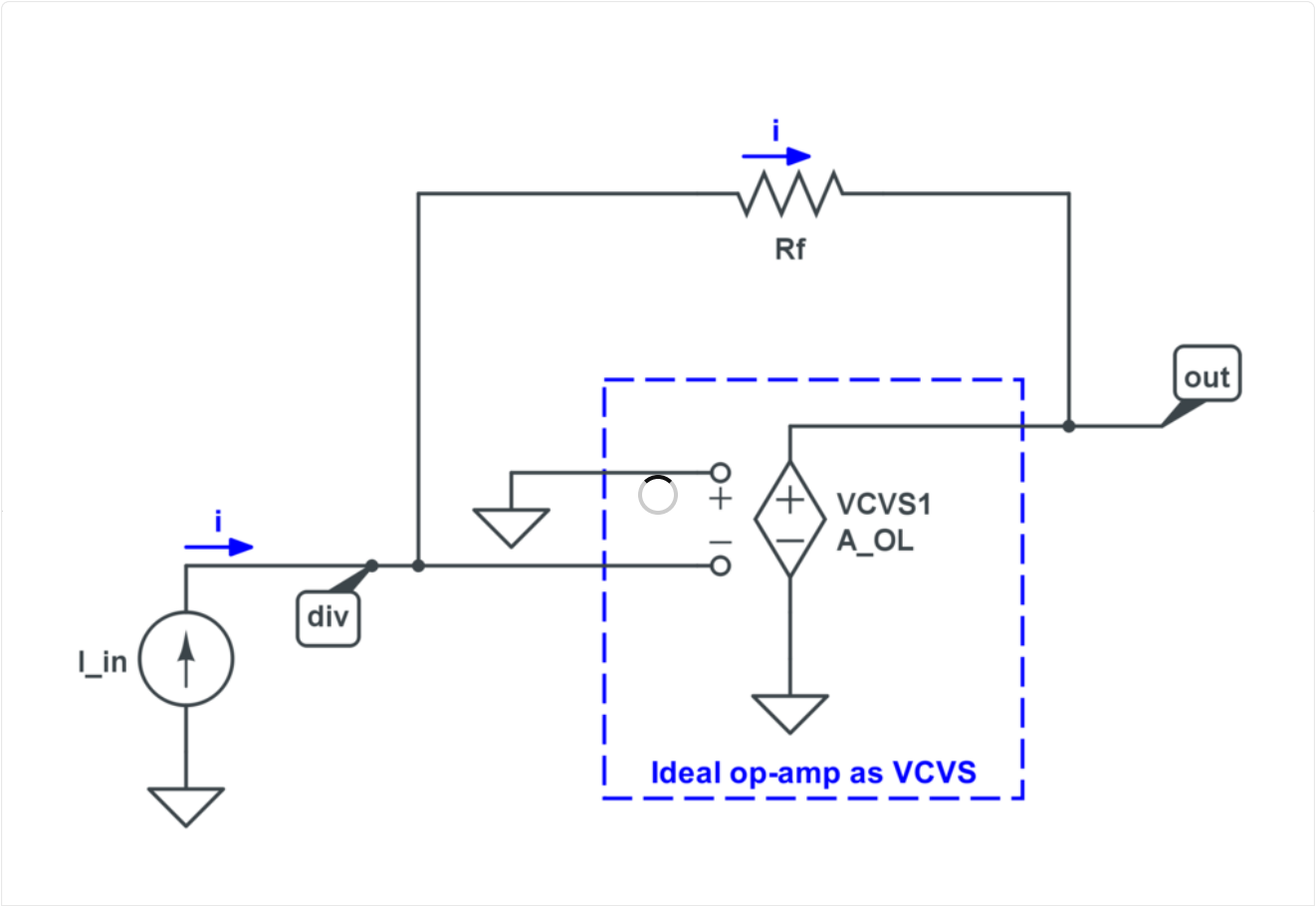
From Chapter 7.6 Op-Amp Transimpedance Amplifier:

A transimpedance amplifier (TIA) converts a current to a voltage and is often used with current-based sensors like photodiodes. It's also a common building block that helps explain the performance and stability limits of many other op-amp circuits.



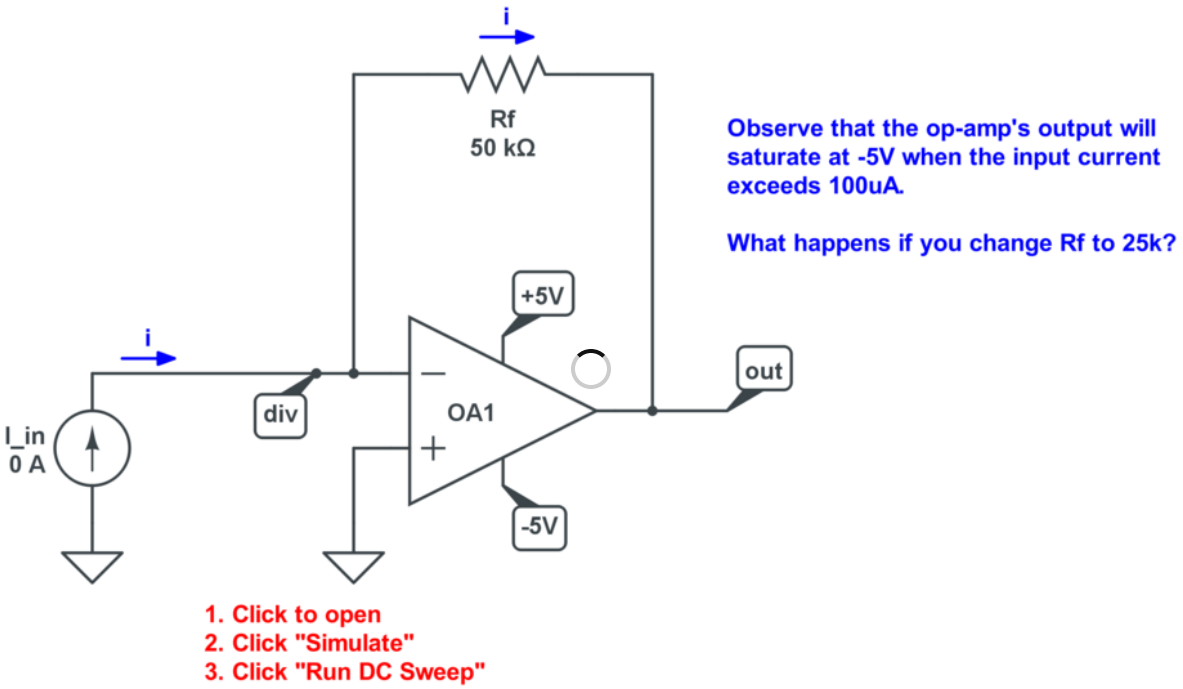
Op-Amp Transimpedance Amplifier - Labeled
circuitlab.com/c9c575e8ks4rq

Edit - Simulate



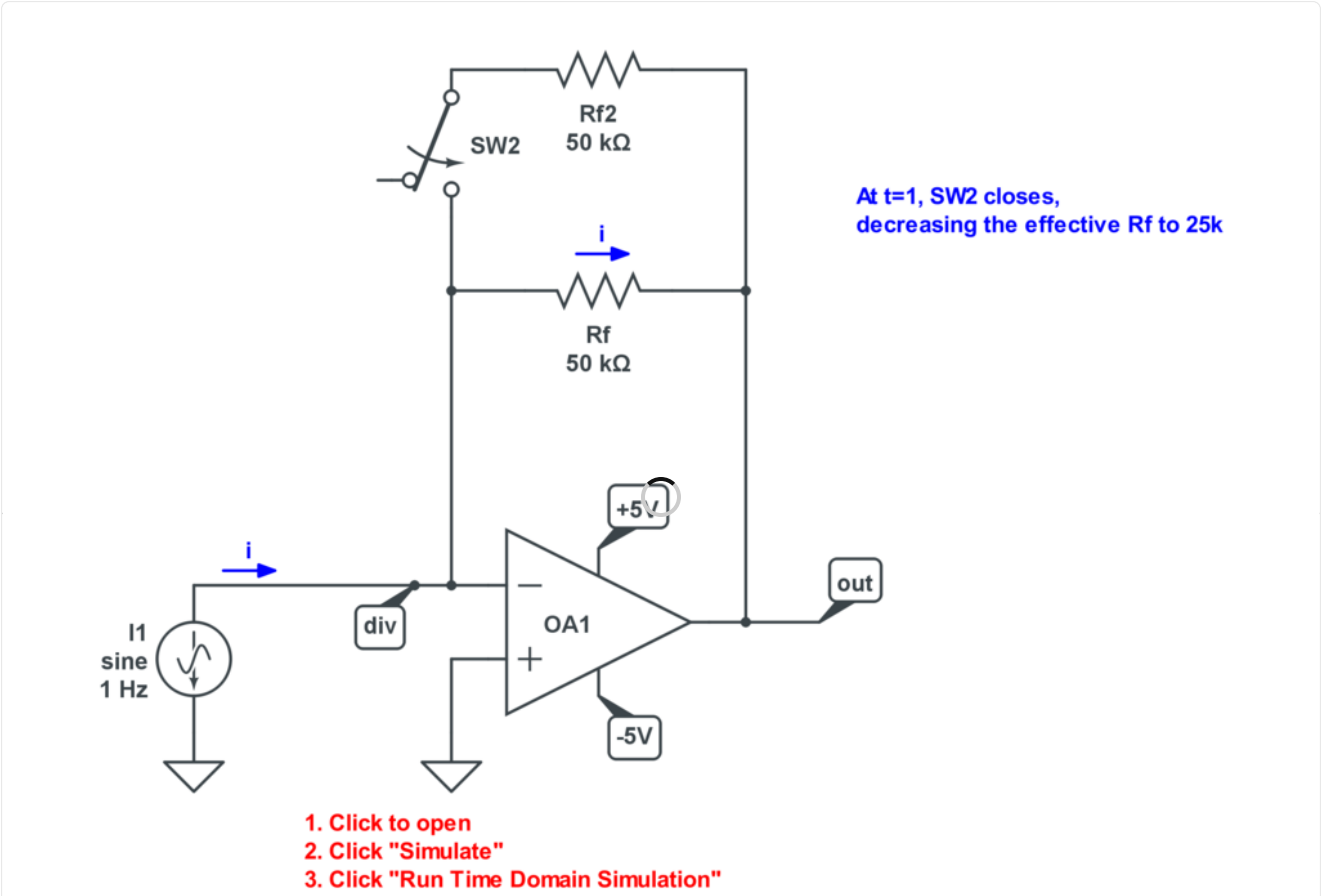
Op-Amp Transimpedance Amplifier VCVS Model
circuitlab.com/cd5qtq6tcn2va

Edit - Simulate



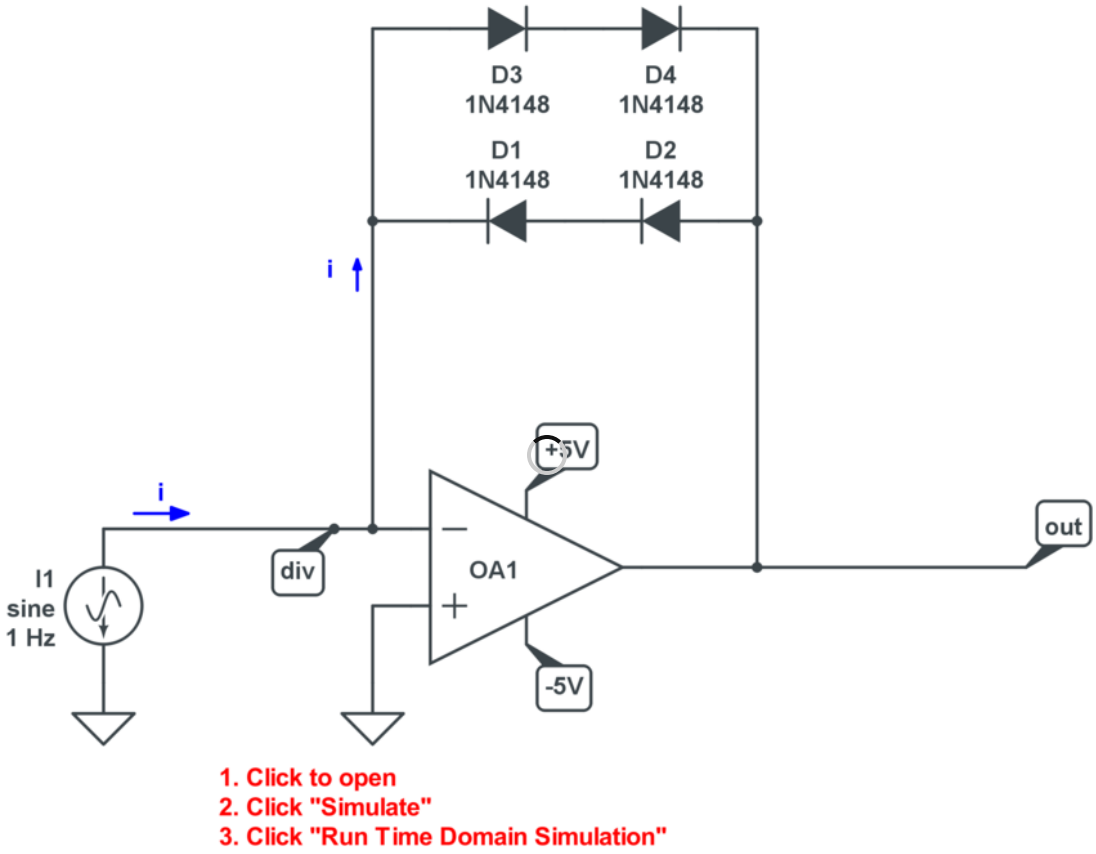
Op-Amp Transimpedance Amplifier - 50k Resistance DC Sweep Simulation
circuitlab.com/cy56xh92e2v57

Edit - Simulate



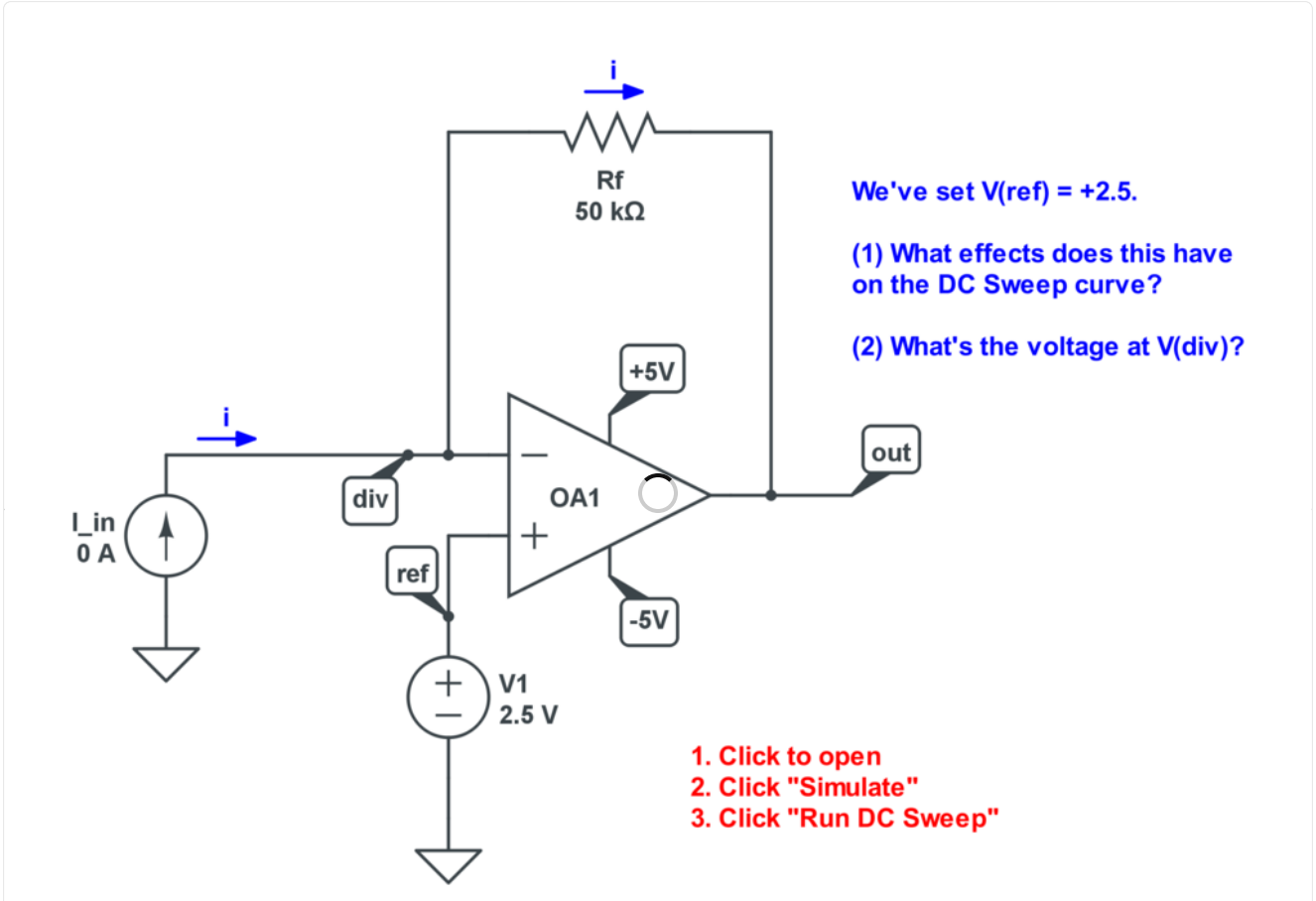
Op-Amp Transimpedance Amplifier - Switched Resistance Simulation
circuitlab.com/c733z7nm5fbby

Edit - Simulate



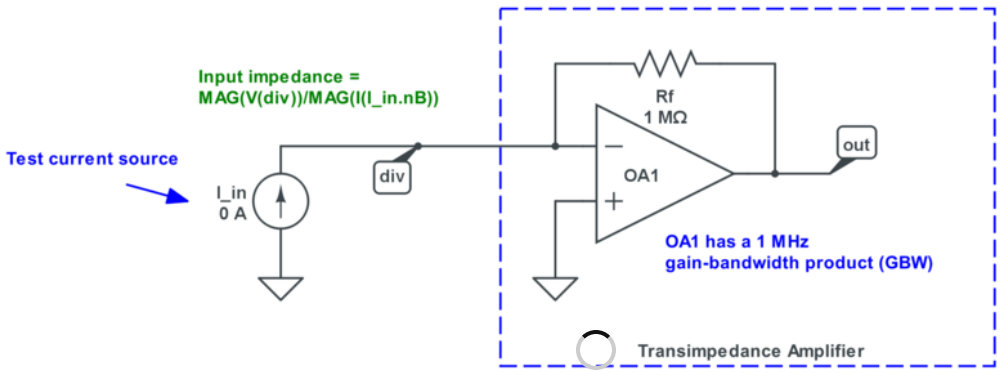
Op-Amp Transimpedance Amplifier - Logarithmic Response
circuitlab.com/c6gpwqp963hr7

Edit - Simulate



Op-Amp Transimpedance Amplifier - Moved Bias Point - DC Sweep Simulation
circuitlab.com/c823eq49s6h7k

Edit - Simulate



1. Click to open
2. Click "Simulate"
3. Click "Run Frequency Domain Simulation"

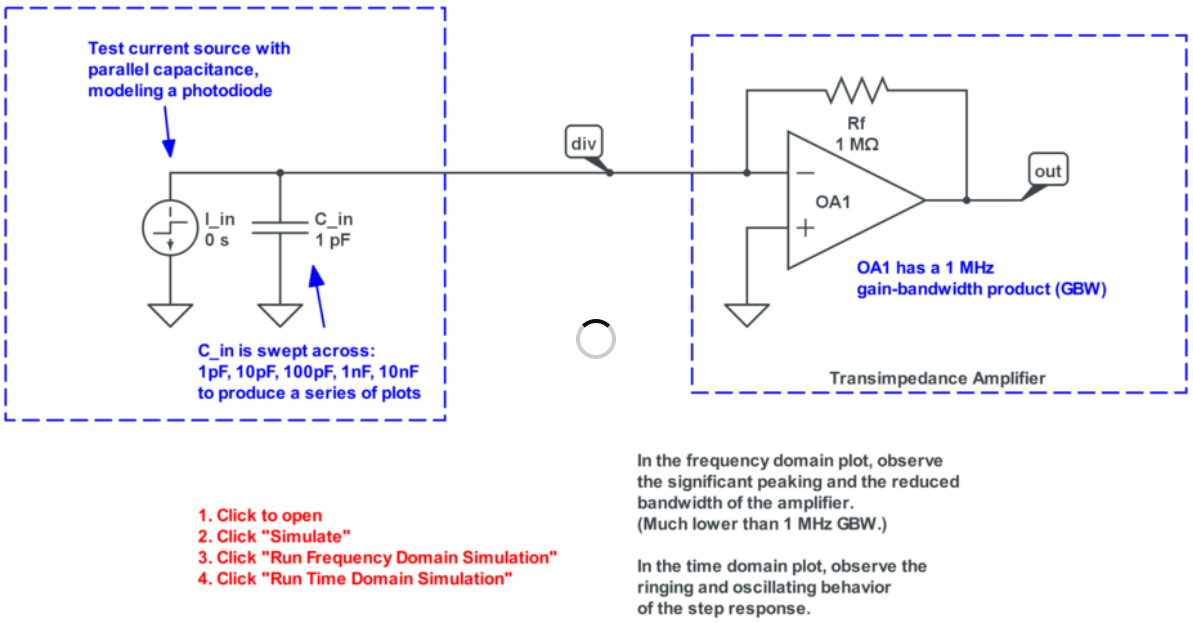
I1 injects a test current into the amplifier input, and we observe the resulting V(in) to measure the input impedance.

The first plot shows the input impedance of the amplifier in Ohms.

Notice that:
- At low frequencies, it's equal to approximately 0
- At high frequencies, it's equal to 1M = Rf
- The transition happens centered around 1 MHz = GBW

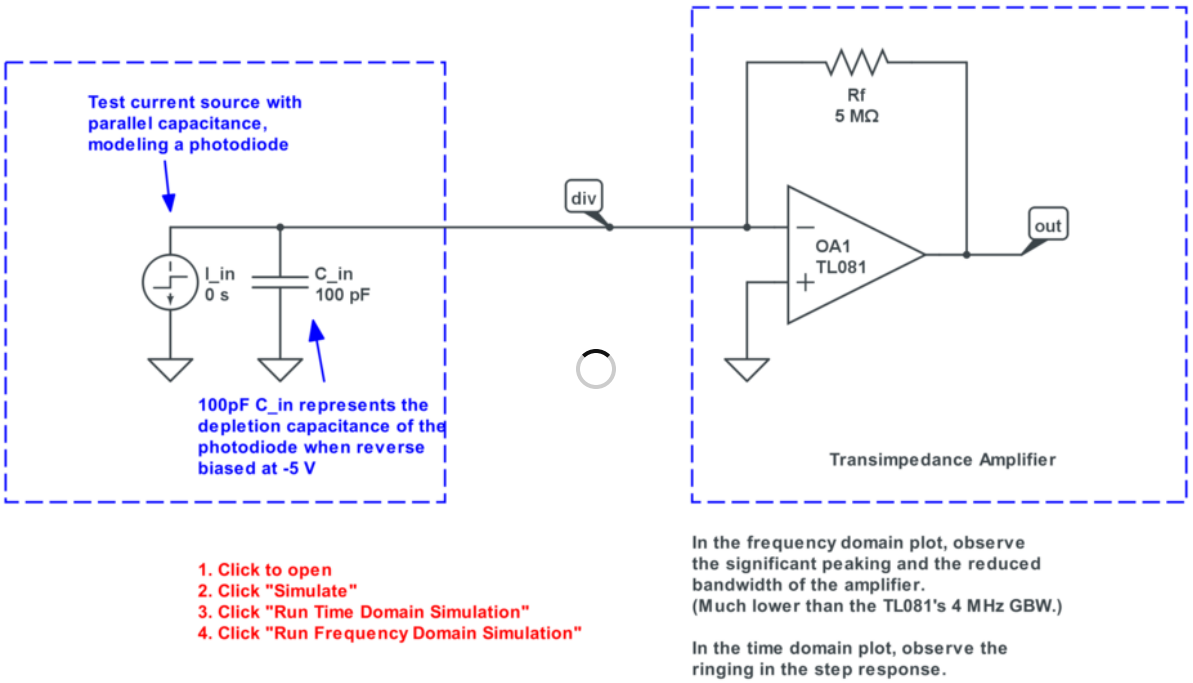
Op-Amp Transimpedance Amplifier - Input Impedance
circuitlab.com/ce6tag6r6t3jj

Edit - Simulate



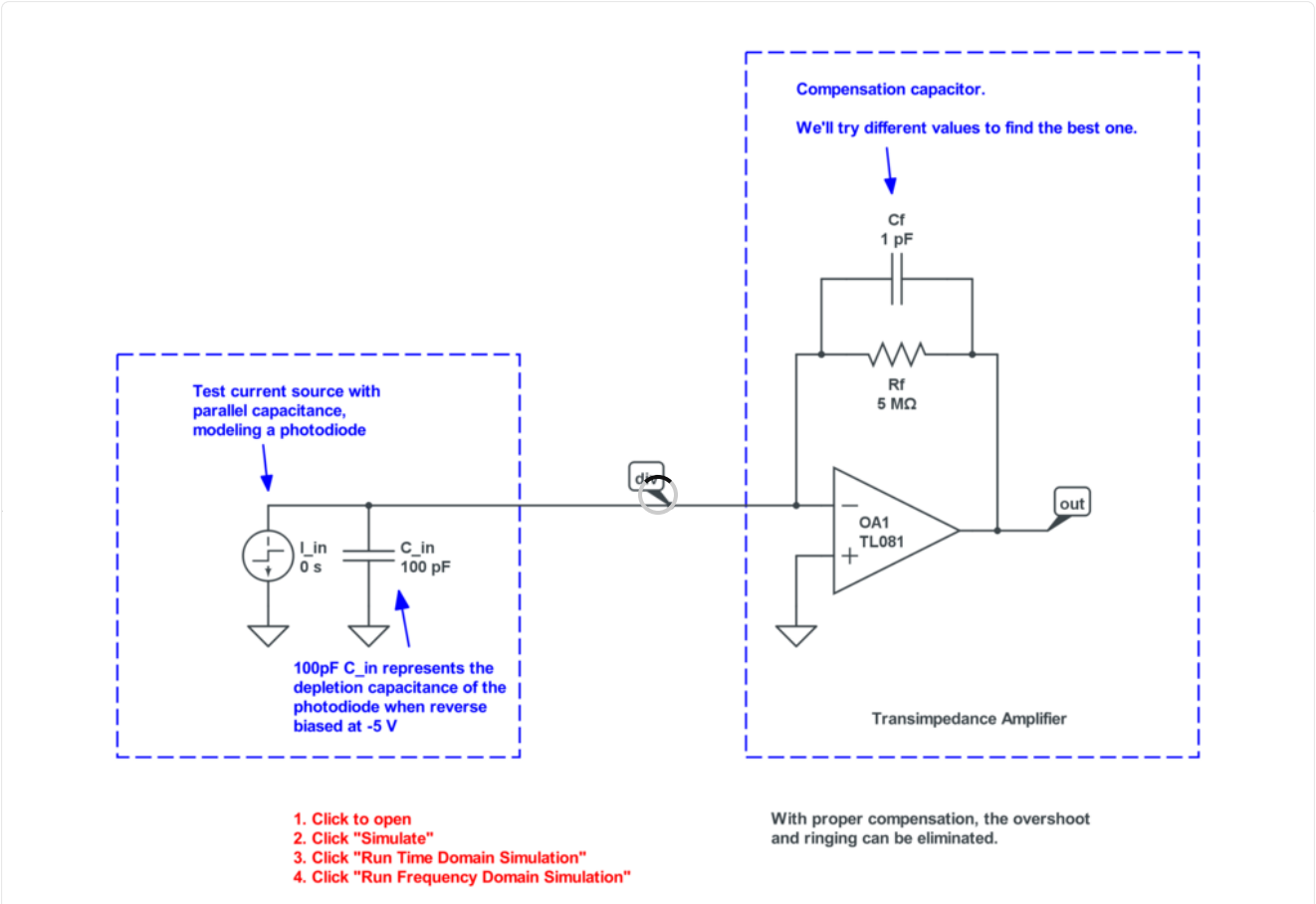
Op-Amp Transimpedance Amplifier - Frequency Response and Input Capacitance
circuitlab.com/cv5d652s6w55e

Edit - Simulate

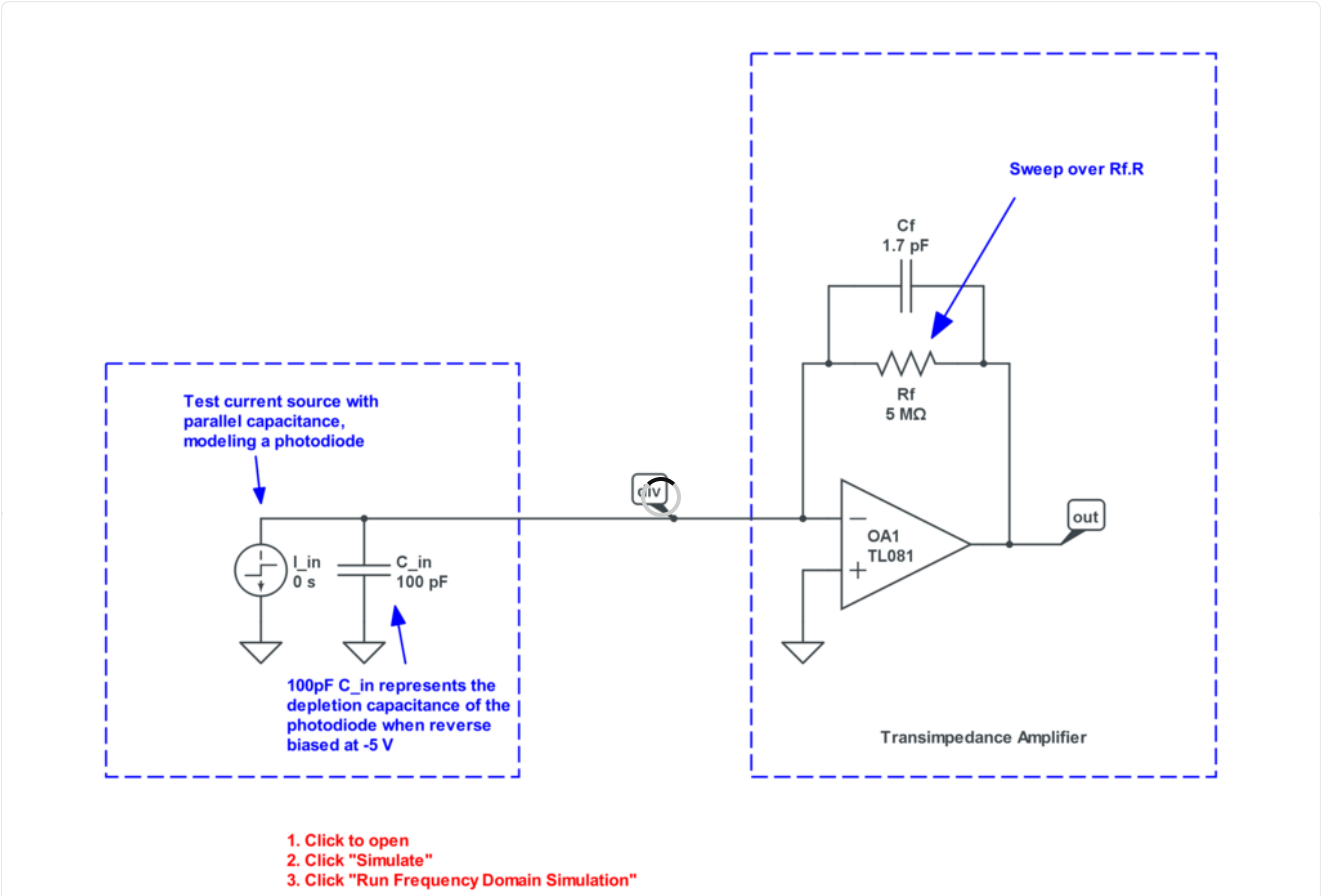


Op-Amp Transimpedance Amplifier - Photodiode Example - Uncompensated
circuitlab.com/cmy22d5hj37gq

Edit - Simulate

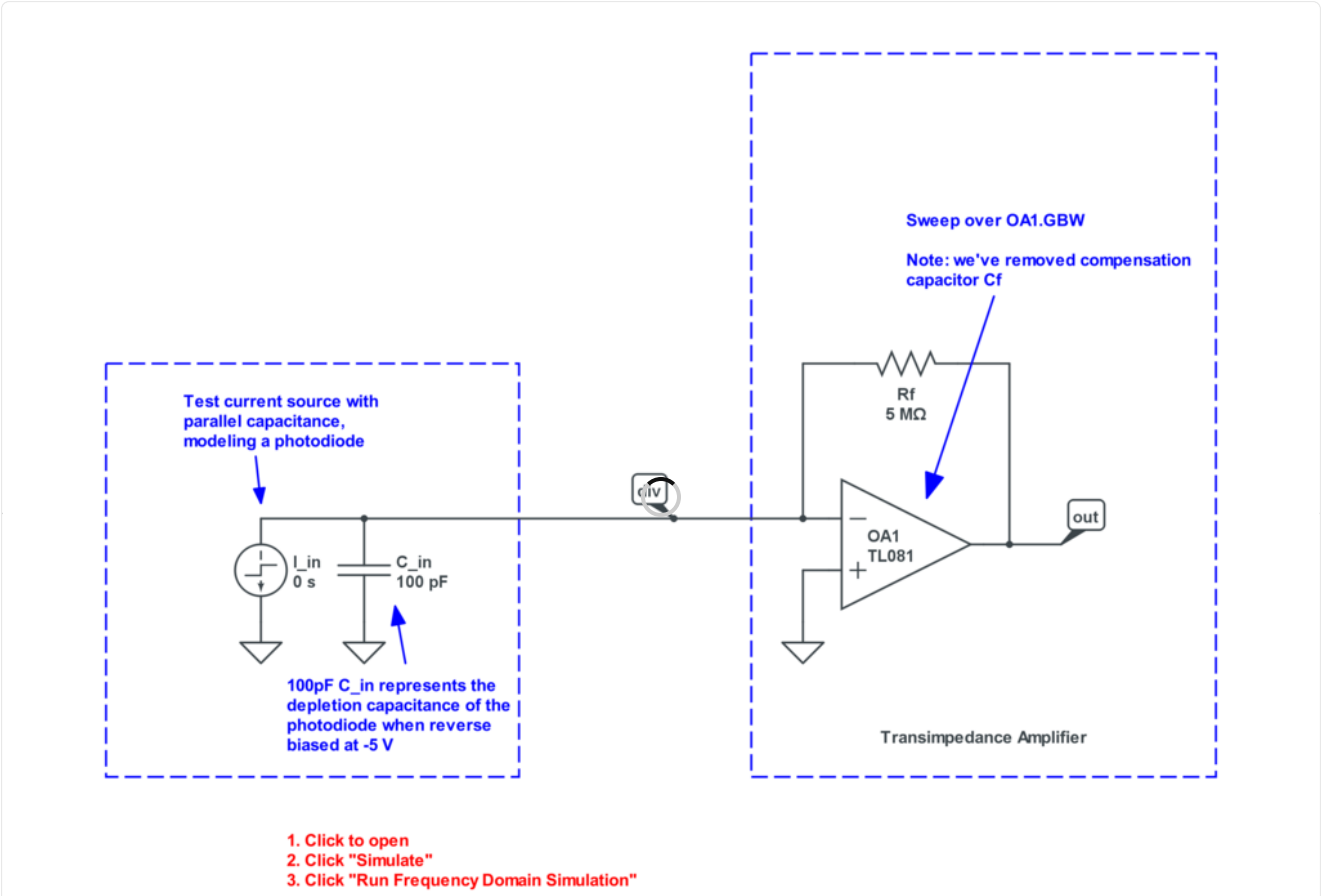


Op-Amp Transimpedance Amplifier - Photodiode Example - With Compensation Capa… Edit - Simulate
circuitlab.com/cd57wr47kn9tj



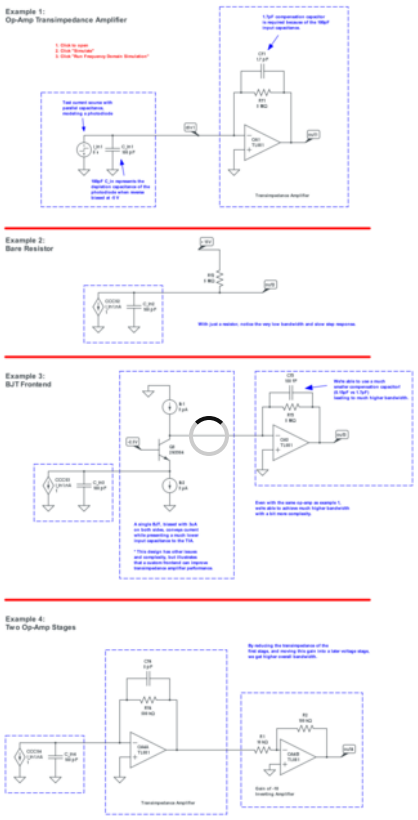
Op-Amp Transimpedance Amplifier - Photodiode Example - Sweep over Rf
circuitlab.com/cw2bp62jnrs9u

Edit - Simulate



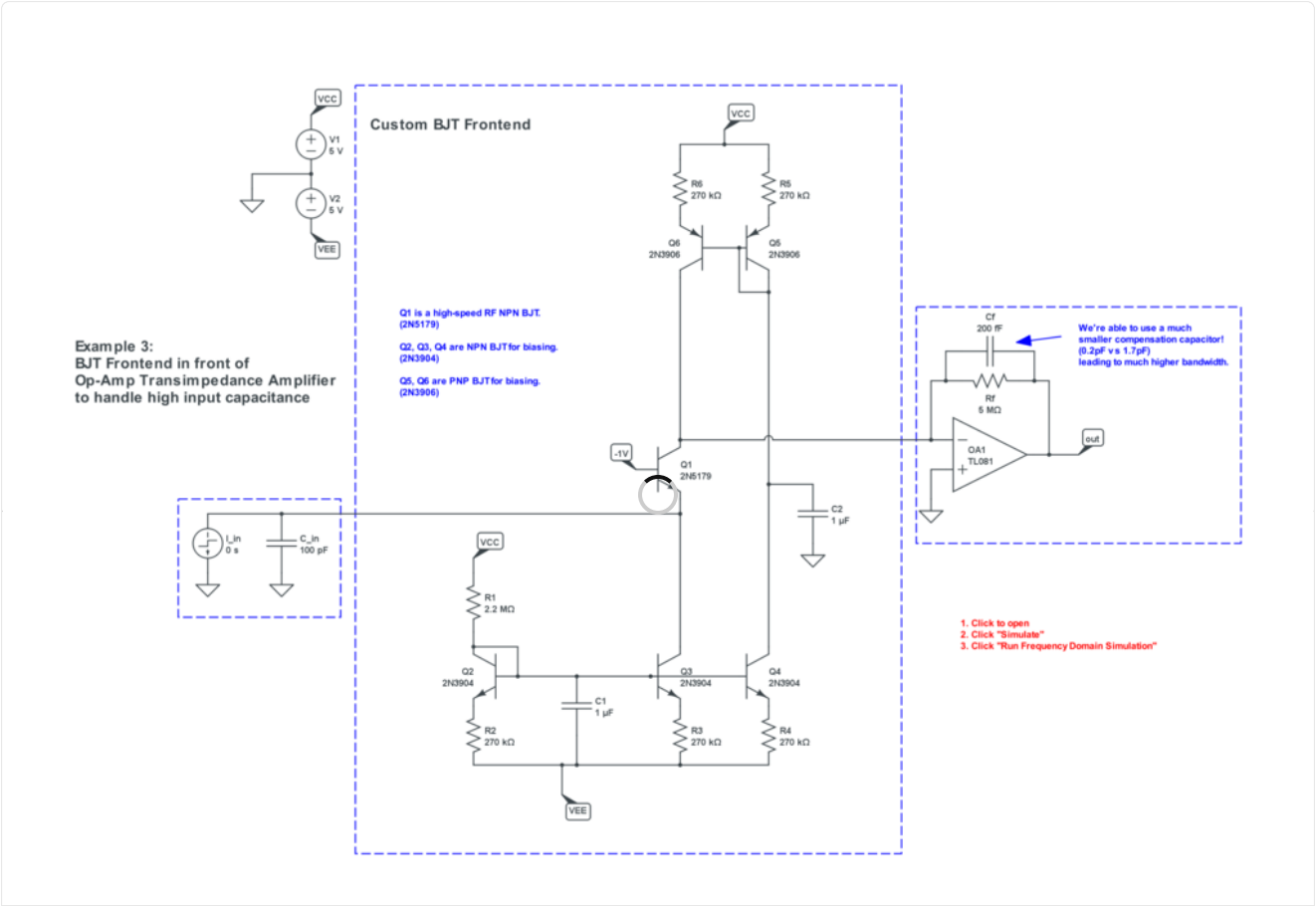
Op-Amp Transimpedance Amplifier - Photodiode Example - Sweep over GBW
circuitlab.com/c3wdb33g7f7r4

Edit - Simulate



Op-Amp Transimpedance Amplifier - Photodiode Example - Alternatives
circuitlab.com/c8ypf3766ubz3

Edit - Simulate



Op-Amp Transimpedance Amplifier - Photodiode Example - BJT Frequency Extension
circuitlab.com/cue38246z862s Edit - Simulate
