Lecture23: Operational amplifier (2)

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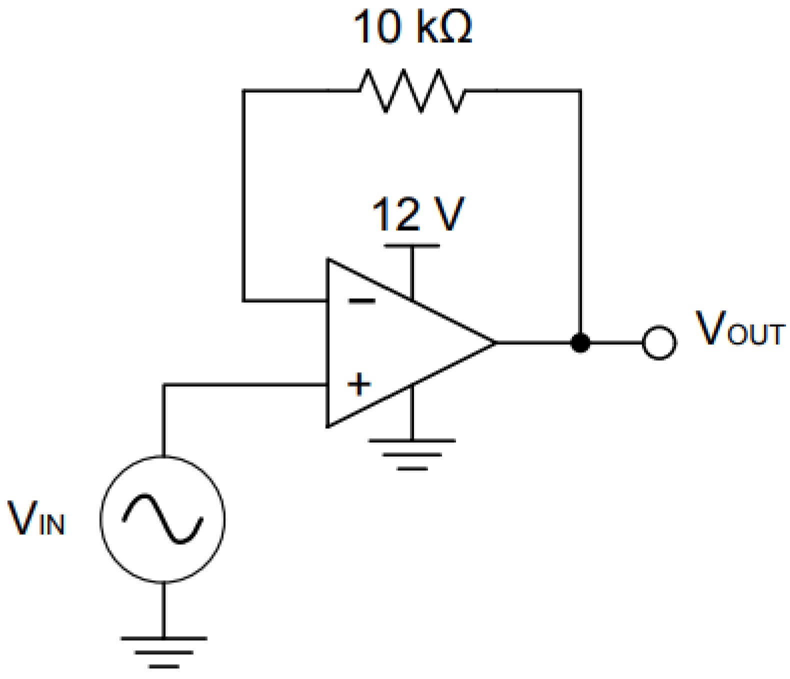
Unit-gain buffer

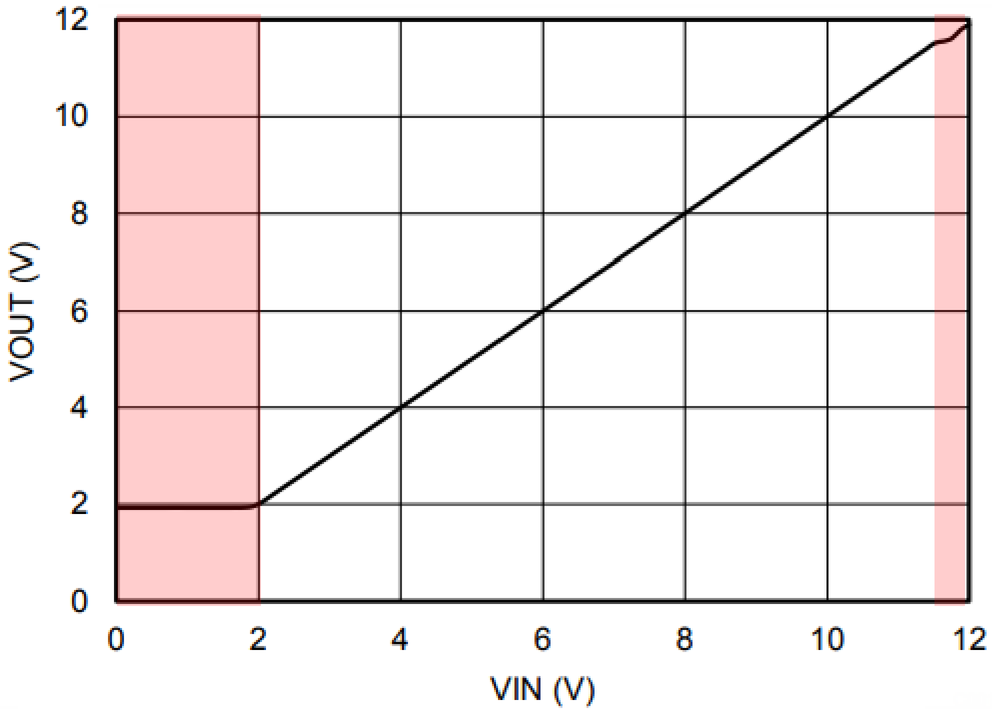
- Driving a relatively high current load
  - The output resistance of the op amp is almost negligible.
  - So, the resistance can provide as much current as necessary to the output load.



Schematic of a unit-gain buffer (Texas Instruments)

Its output characteristics

- Realisitic curve
  - Using a negative voltage on the lower rail (rather than ground) allows the amplifier to maintain linearity for inputs below 2 V.

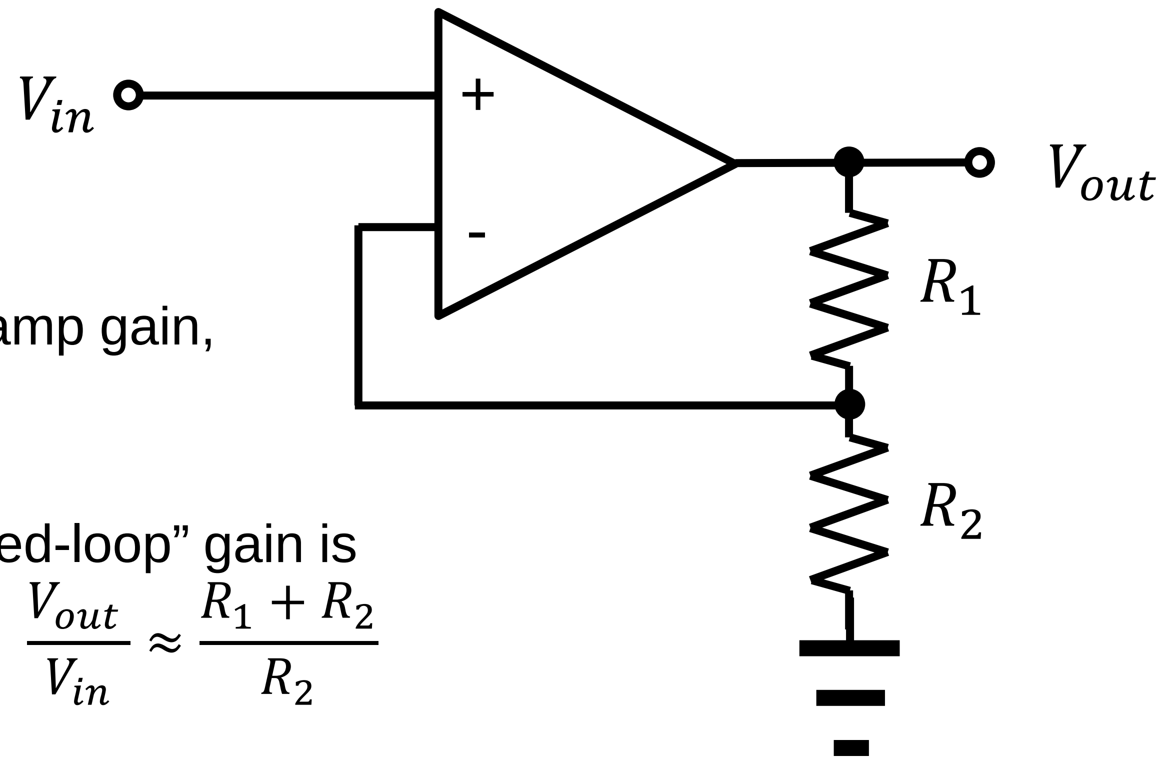


Output voltage versus input voltage (Texas Instruments)

Noninverting amplifier (1)

- Calculate the gain.
  - The input resistance of the op amp is large.

$$V_{in2} = \frac{R_2}{R_1 + R_2} V_{out}$$



  - Due to the high op amp gain,

$$V_{in2} \approx V_{in}$$

  - Therefore, the “closed-loop” gain is

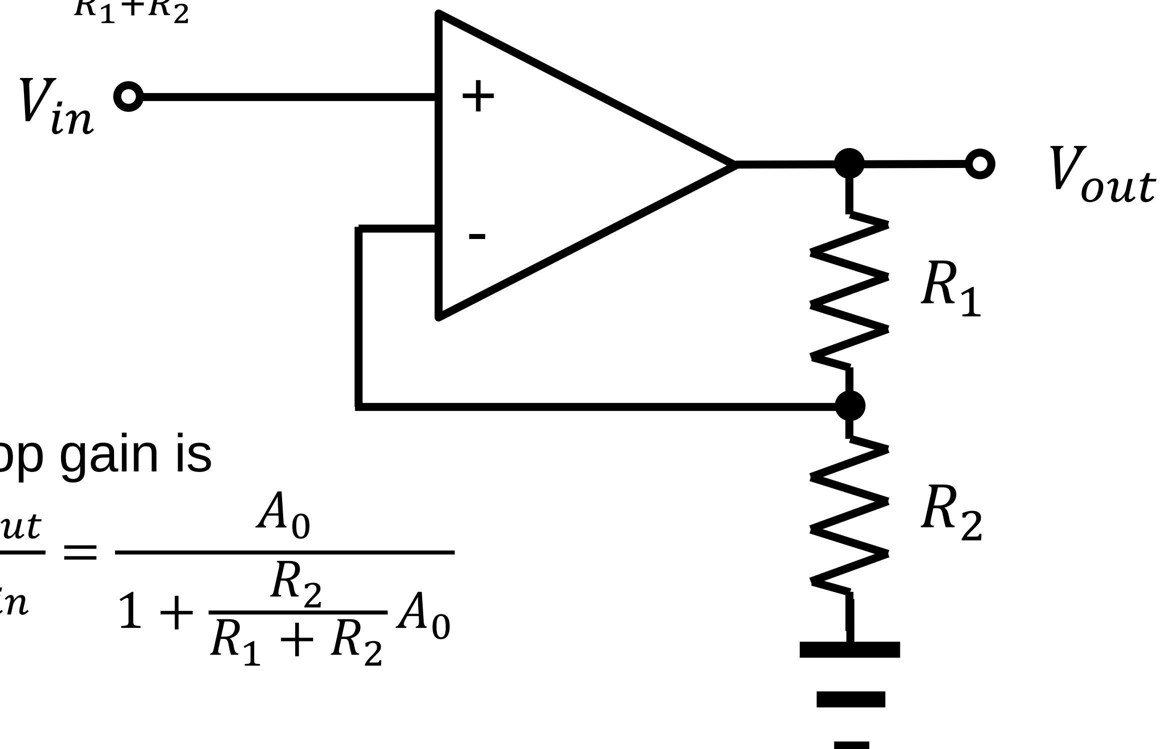
$$\frac{V_{out}}{V_{in}} \approx \frac{R_1 + R_2}{R_2}$$

Noninverting amplifier (2)

- Repeat it again with a finite A_0.
  - Now,

$$V_{out} = A_0(V_{in} - V_{in2})$$

  - Remember that $V_{in2} = \frac{R_2}{R_1+R_2} V_{out}$.



  - Then, the closed-loop gain is

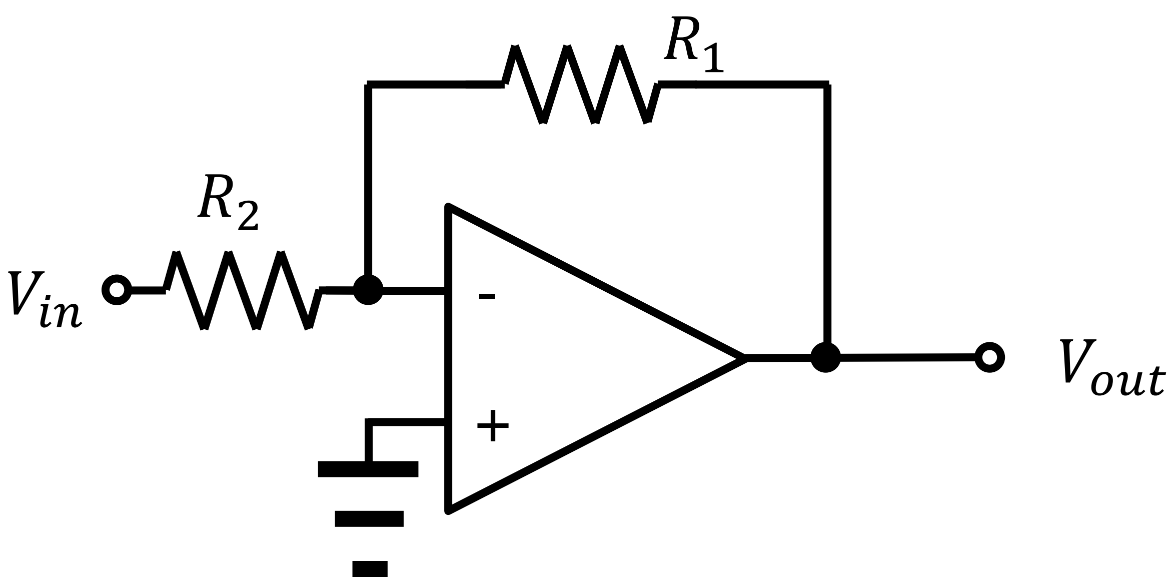
$$\frac{V_{out}}{V_{in}} = \frac{A_0}{1 + \frac{R_2}{R_1 + R_2} A_0}$$

Inverting amplifier

- The inverting input is called a “virtual ground.”
  - Then, the output voltage is

$$V_{out} = -R_1 \frac{V_{in}}{R_2}$$

  - Its input impedance is equal to R_2.



Integrator

- Instead of a resistor, a capacitor is introduced.
  - In the time domain,

$$\frac{V_1}{R_1} = -C_1 \frac{dV_{out}}{dt}$$