EE 101: Basic Electronics

Amplifier Basics

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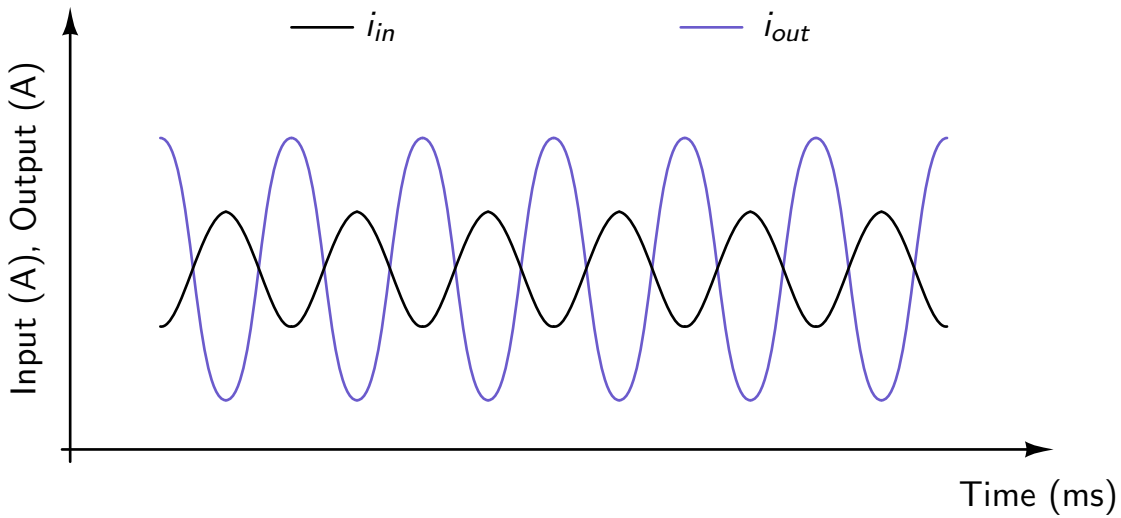
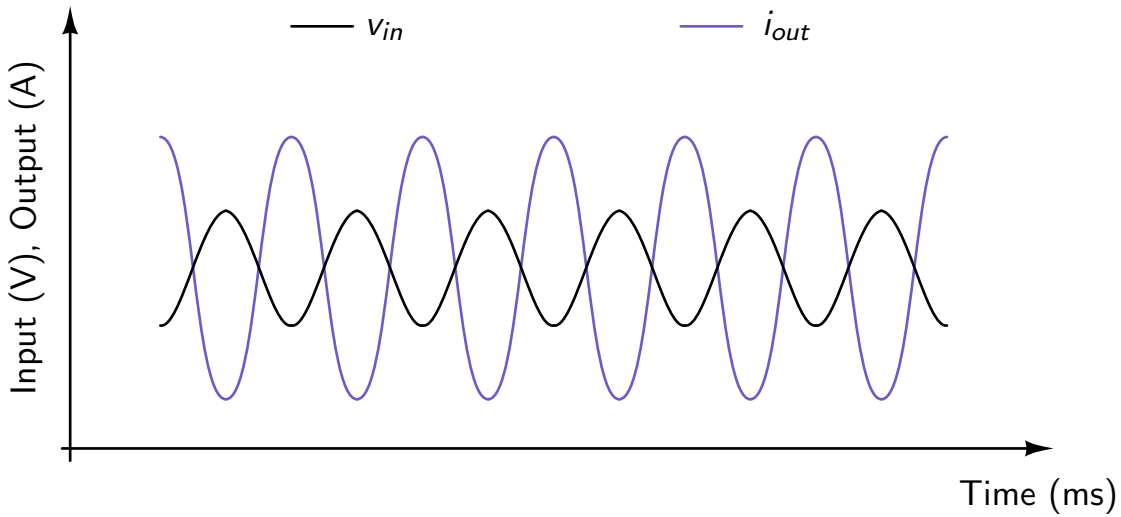
A — amplifier



A — amplifier



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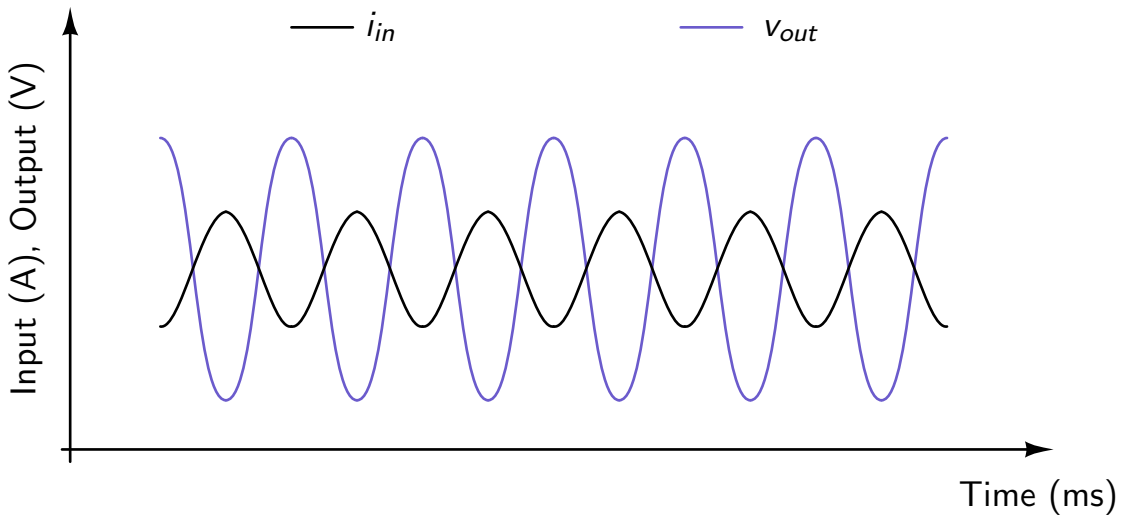
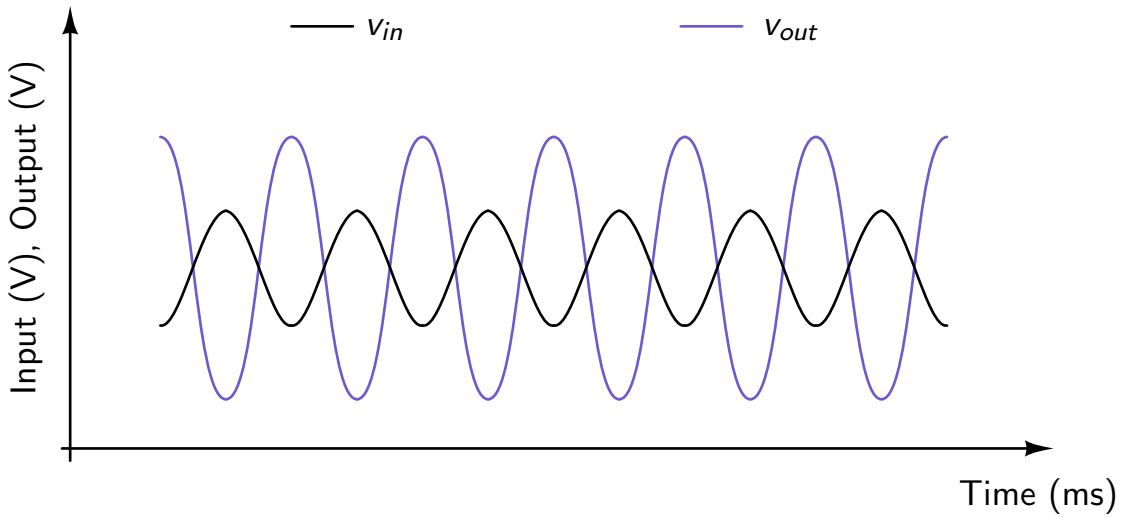
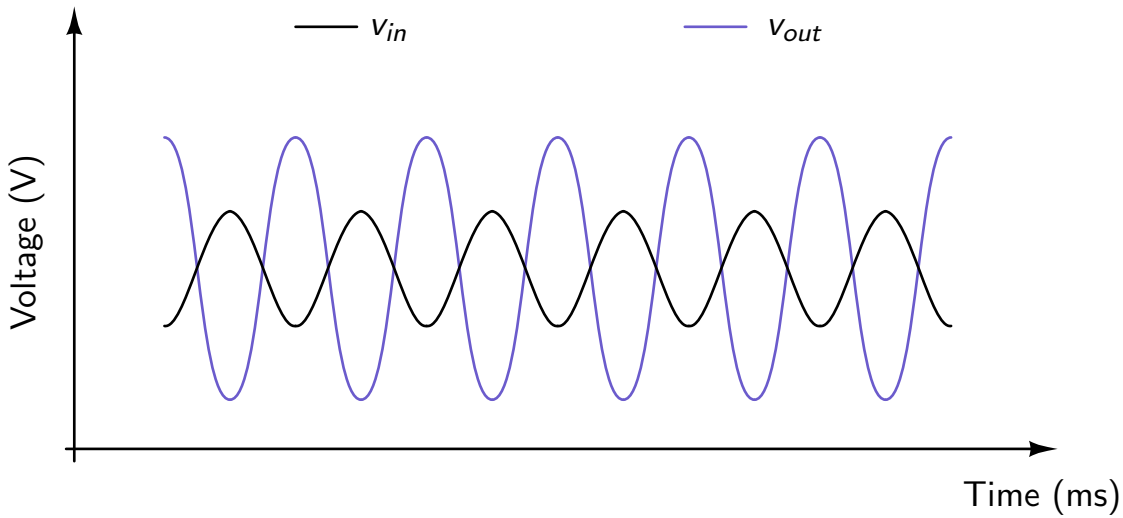
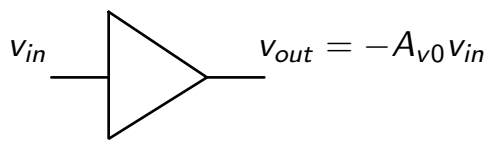


A — amplifier

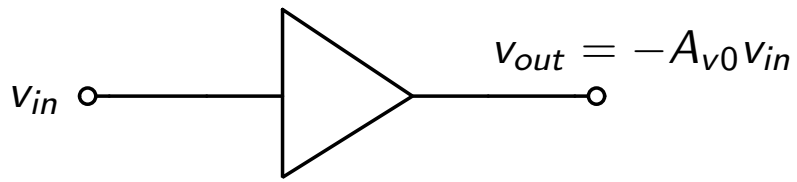


An ideal amplifier



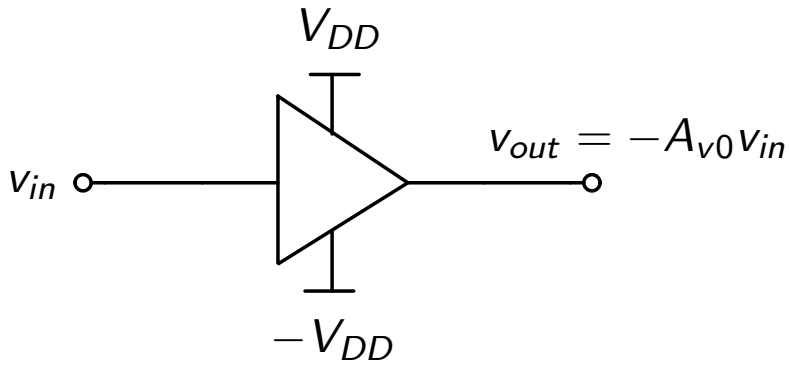


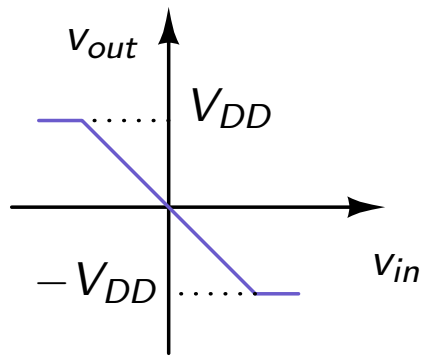
A voltage amplifier



What is the voltage gain as $v_{in} \rightarrow \infty$?

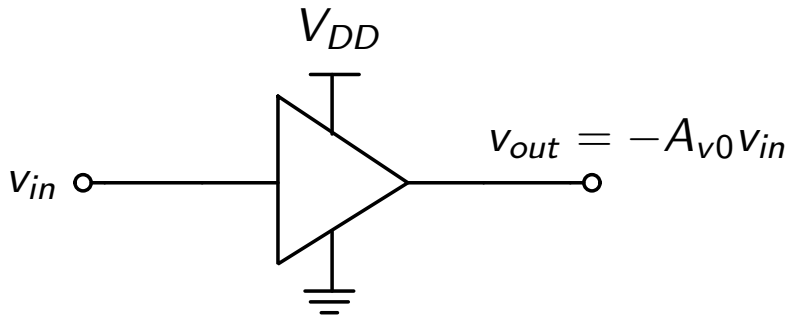
A voltage amplifier

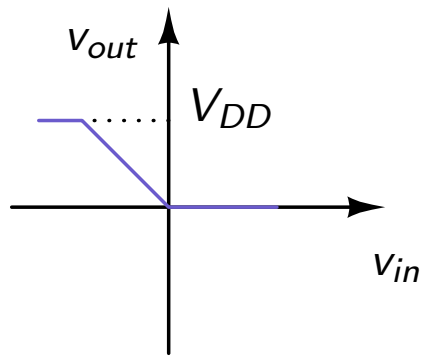




What is the voltage gain as $v_{in} \rightarrow \infty$?

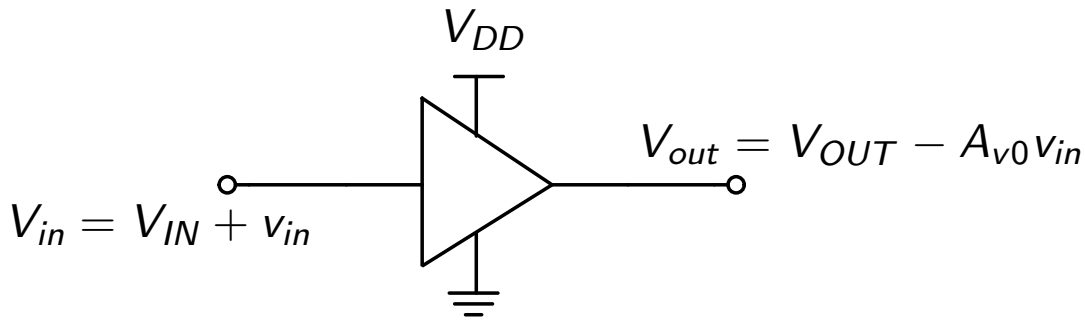
A voltage amplifier

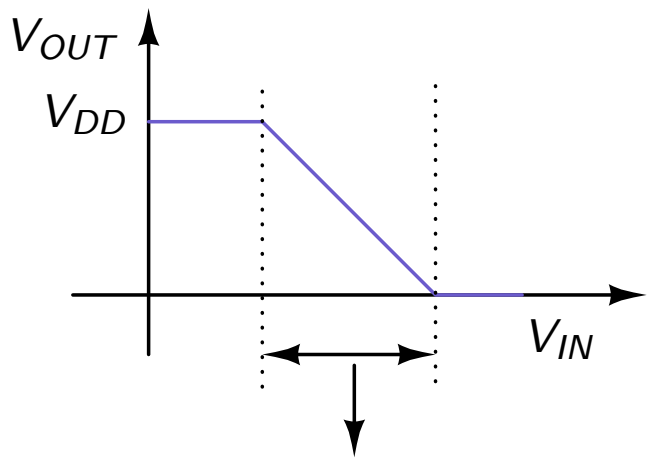




What is the voltage gain as $v_{in} \rightarrow \infty$?

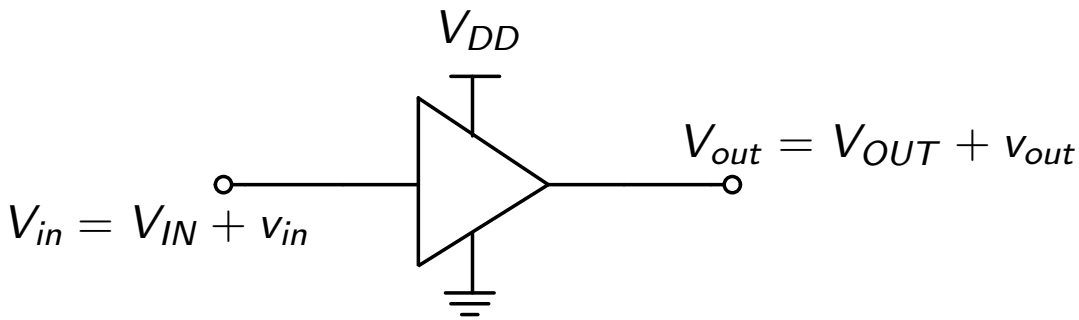
Transfer characteristics

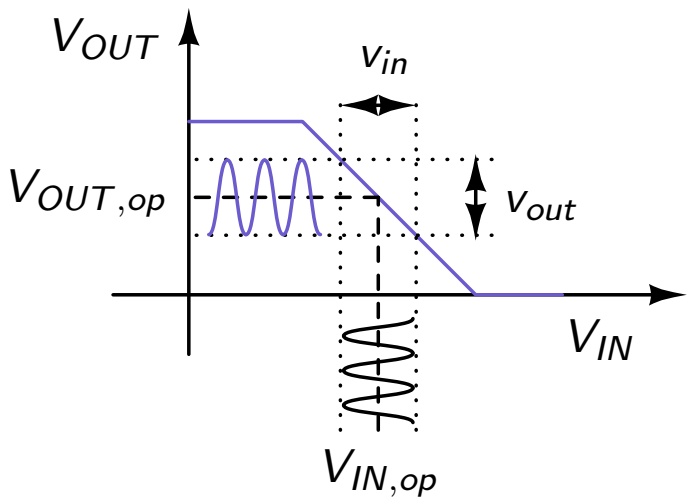




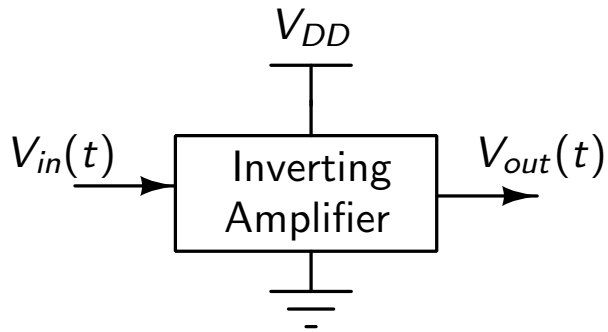
Usable input DC voltage range

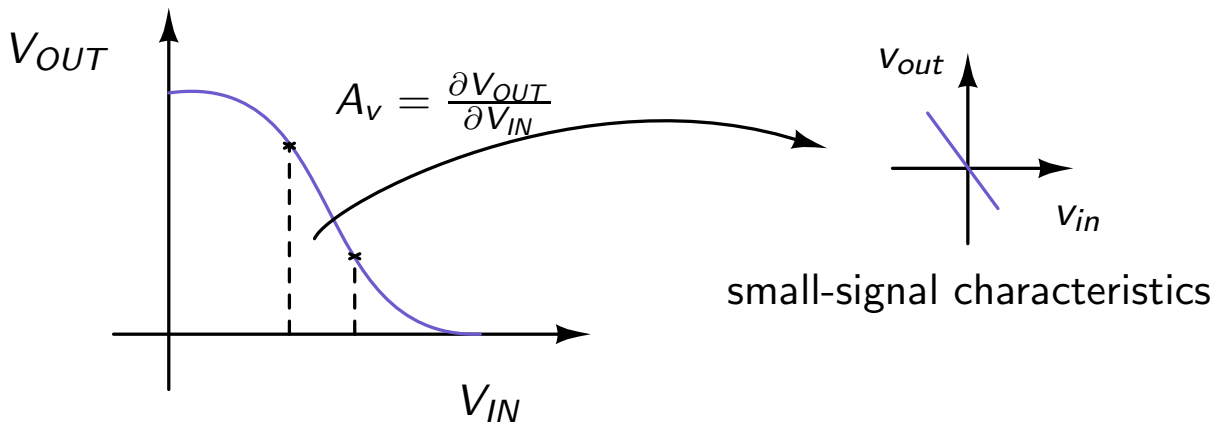
Transfer characteristics





Transfer characteristics of a practical amplifier

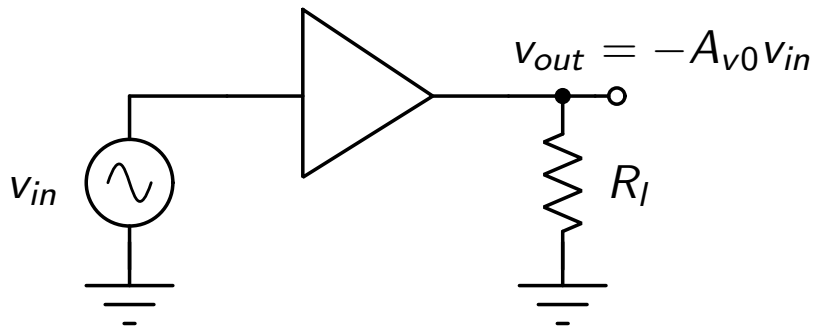




small-signal characteristics

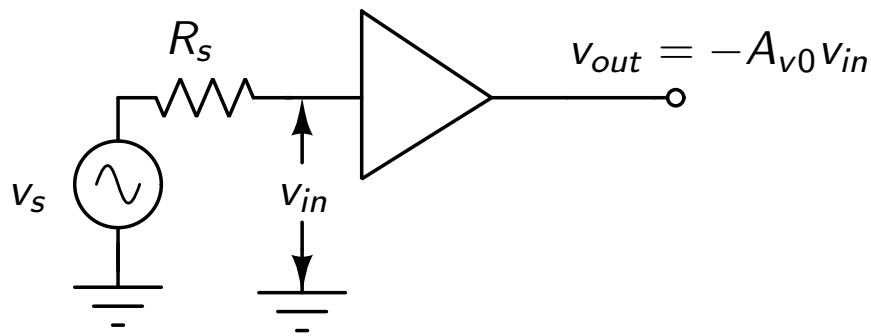
Large-signal characteristics

A voltage amplifier



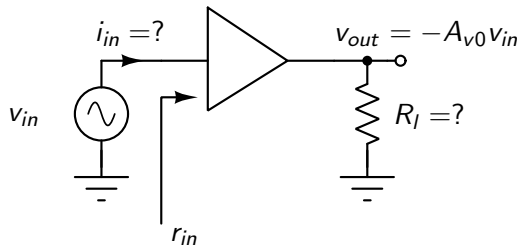
What is the voltage gain when $R_l \rightarrow 0$?

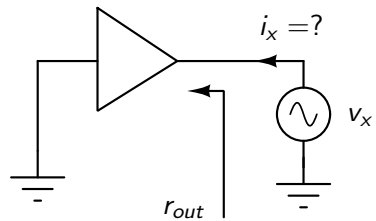
A voltage amplifier



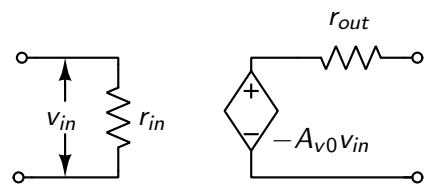
What is the voltage gain when $R_s \rightarrow \infty$?

A two-port model of a voltage amplifier



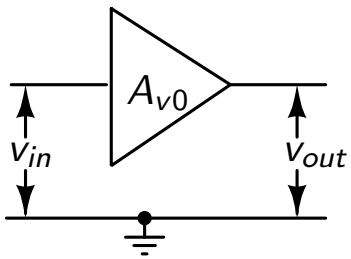


1. $A_{v0} = \frac{v_{out}}{v_{in}}\big|_{R_l=\infty}$
2. $r_{in} = \frac{v_{in}}{i_{in}}\big|_{R_l=\infty}$
3. $r_{out} = \frac{v_x}{i_x}\big|_{v_{in}=0}$

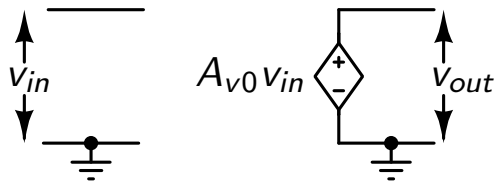


$$\text{Voltage gain } A_v = A_{v0} \times \frac{r_{in}}{r_{in}+R_s} \times \frac{R_l}{R_l+r_{out}}$$

An ideal single-ended amplifier



An ideal voltage amplifier

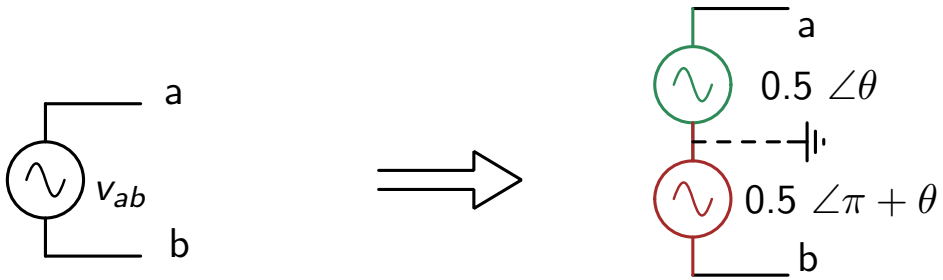


Equivalent model

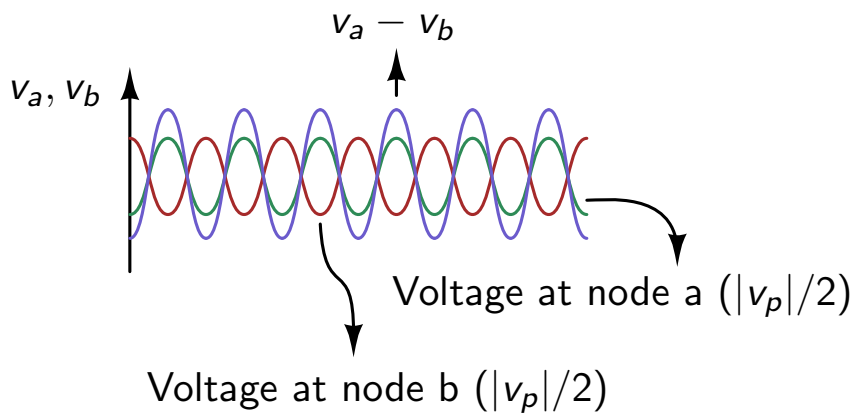
$$r_{in} = \infty$$

$$r_{out} = 0$$

Differential signal

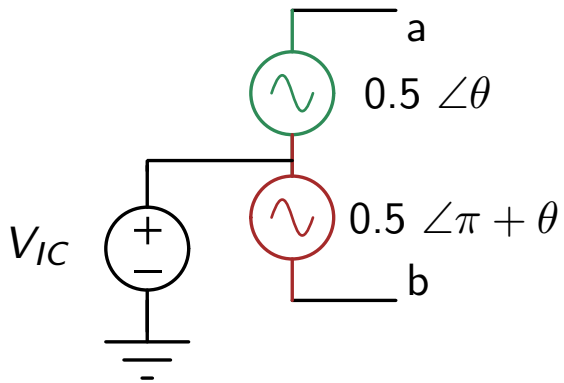


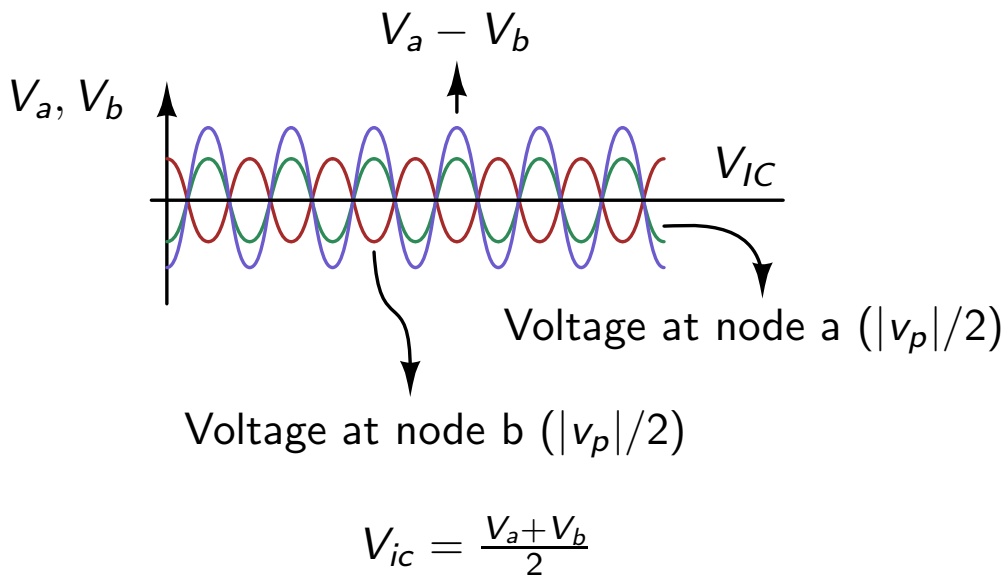
Special case of a floating signal



Differential potential/signal: referenced with respect to each other terminal.

Common-mode signal



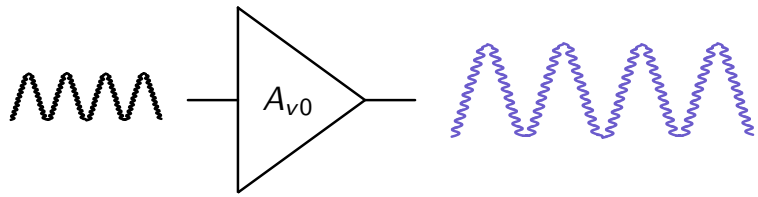


$$V_{ic} = \frac{V_a + V_b}{2}$$

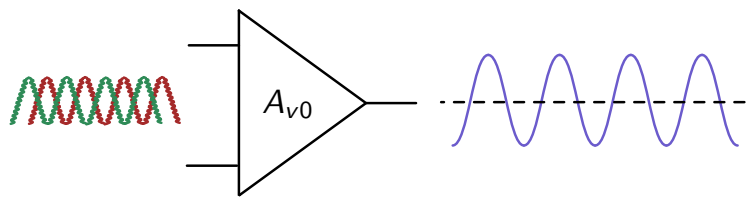
Common-mode potential/signal: present in both the signals

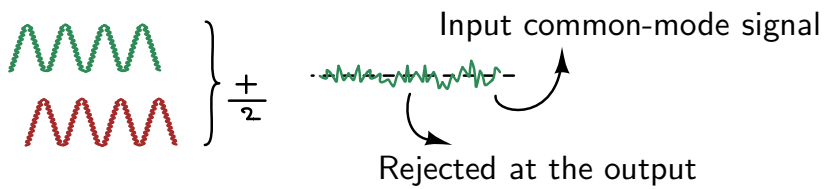
Need for differential processing

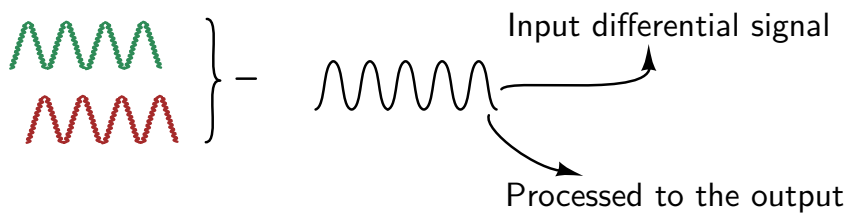
Single-ended signal processing:



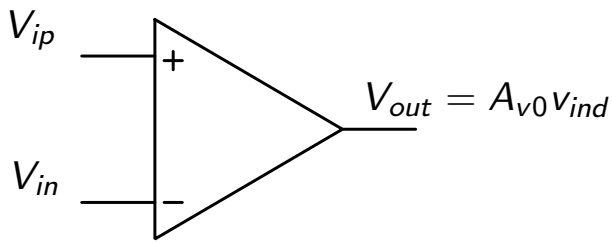
Differential signal processing:



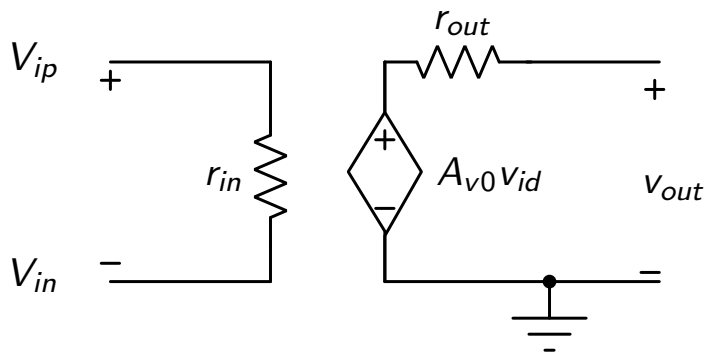




An ideal opamp



A differential amplifier



An equivalent model of a differential amplifier

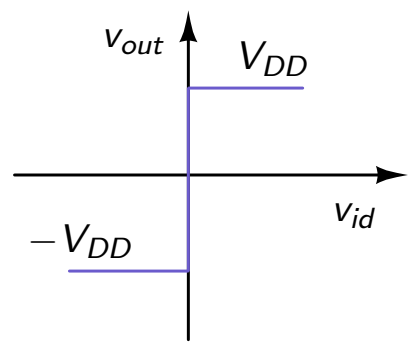
Differential input $v_{id} = V_{ip} - V_{in}$

An ideal opamp is an ideal differential amplifier with

$r_{in} = \infty$

$r_{out} = 0$

$A_{v0} \to \infty$



Summary

- Amplifiers: V-V, I-I, V-I, and I-V
- Small signal Vs. Large signal
- Amplifier parameters: A_{v0}, r_{in}, and r_{out}
- A two-port model of the amplifier
- Effect of source and load resistances on the voltage gain
- Differential and Common-mode signals
- An ideal OpAmp

Reference Book

[1] A. Sedra and K. C. Smith, "Microelectronic Circuits," 6th Ed., Oxford university press, 2011.