OPERATIONAL AMPLIFIER

INTRODUCTION

prepared by:

Gyro A. Madrona
Electronics Engineer

TOPIC OUTLINE

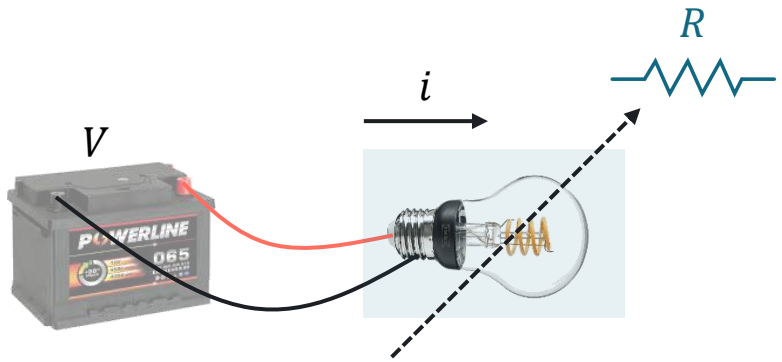
Op-Amp Abstaction

Ideal Op-Amp

Non-inverting Op-Amp

LUMPED CIRCUIT ABSTRACTION

Physics Law



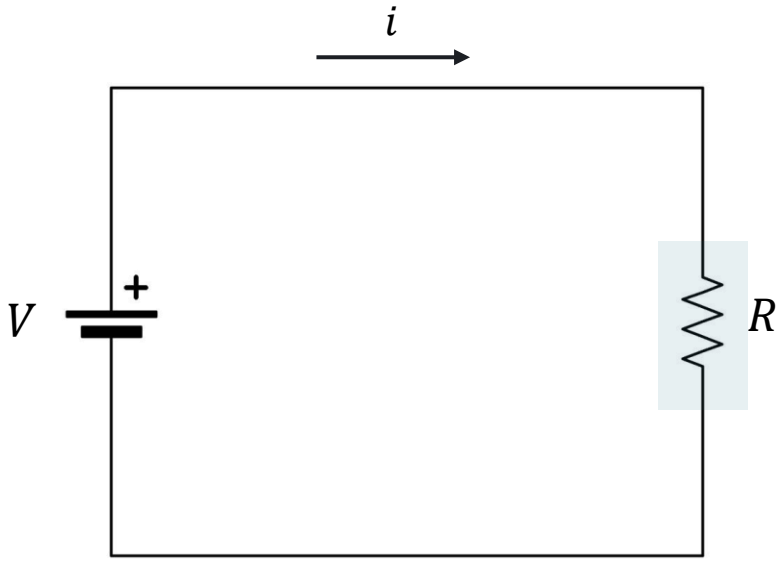
Maxwell's Equation

$$\nabla \cdot E = -\frac{\partial B}{\partial t}^{0}$$

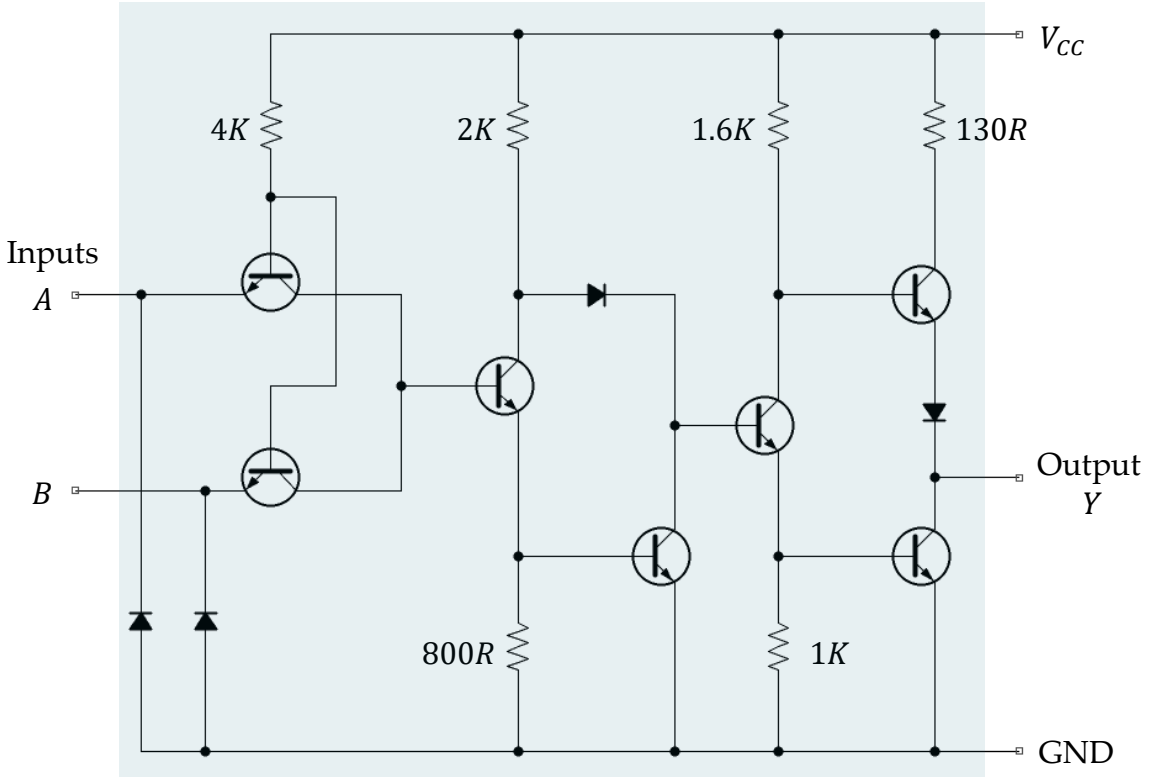
$$\nabla \cdot J = -\frac{\partial \rho}{\partial t}^{0}$$

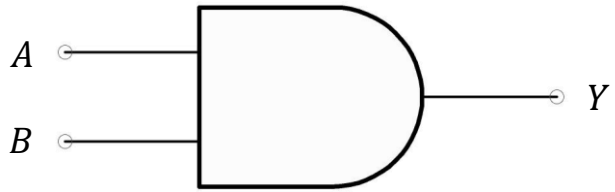
$$\nabla \cdot E = \frac{\rho}{\varepsilon_0}^{0}$$

R is a lumped element abstraction for the bulb



DIGITAL ABSTRACTION



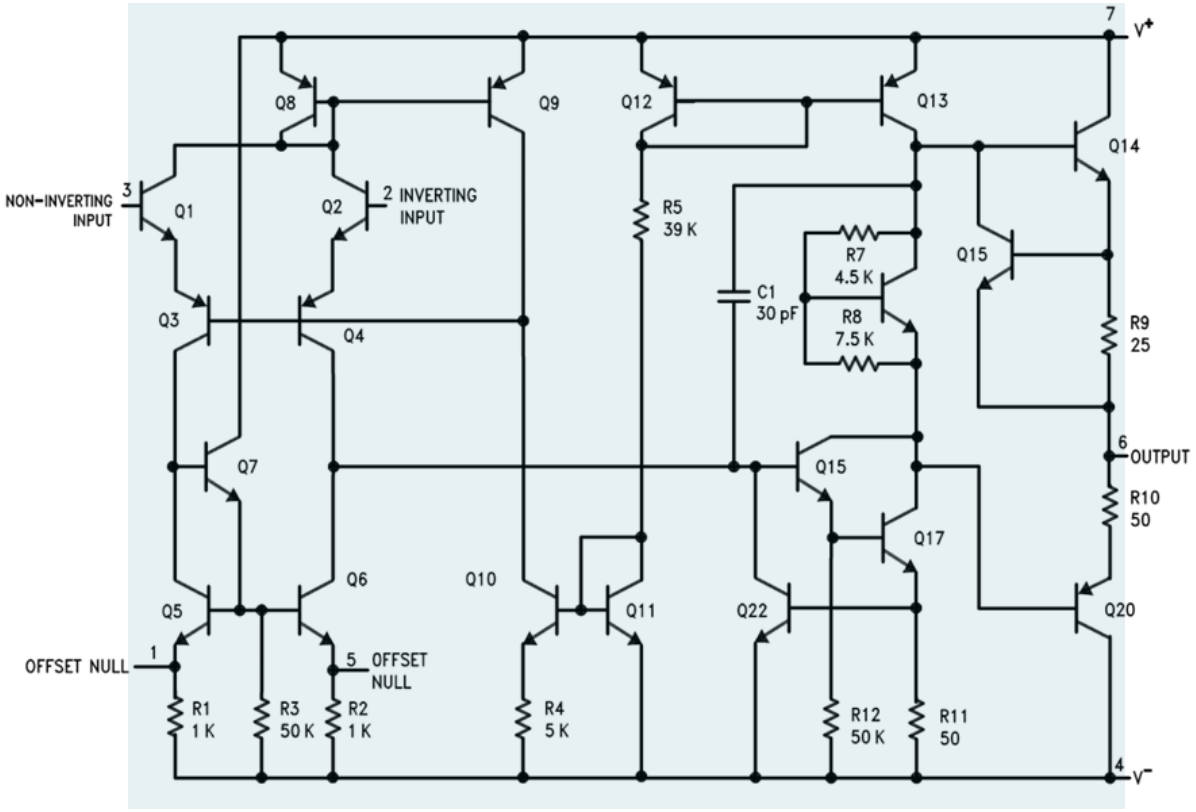


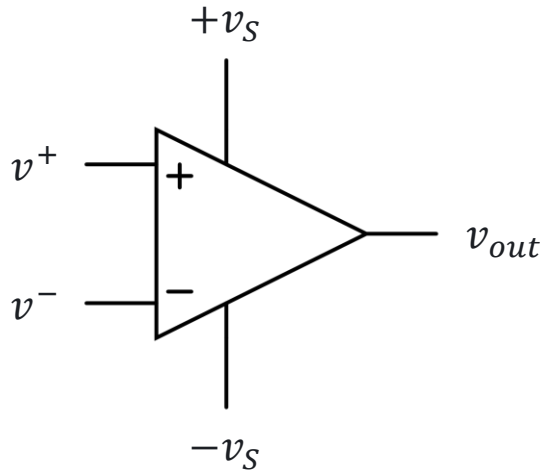
LANGUAGE ABSTRACTION

```
#include <libioP.h>
#include <stdarg.h>
#include <stdio.h>

#undef printf

/* Write formatted output to stdout from the format string
FORMAT.  */
/* VARARGS1 */
int
__printf (const char *format, ...)
{
  va_list arg;
  int done;

  va_start (arg, format);
  done = vfprintf (stdout, format, arg);
  va_end (arg);

  return done;
}

#undef _IO_printf
ldbl_strong_alias (__printf, printf);
/* This is for libg++.  */
ldbl_strong_alias (__printf, _IO_printf);
```

-------→ **printf()**

OP-AMP ABSTRACTION

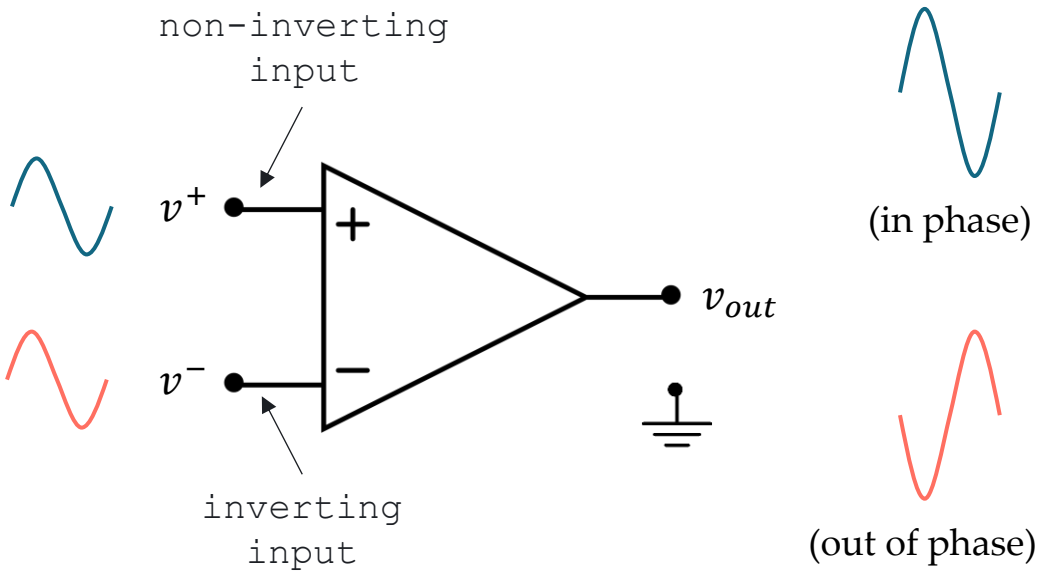




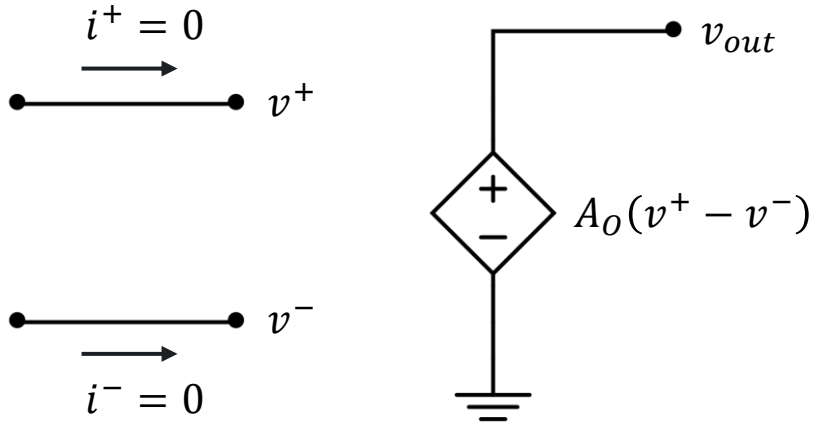
IDEAL OP-AMP

IDEAL OP-AMP

Abstract representation



Circuit model

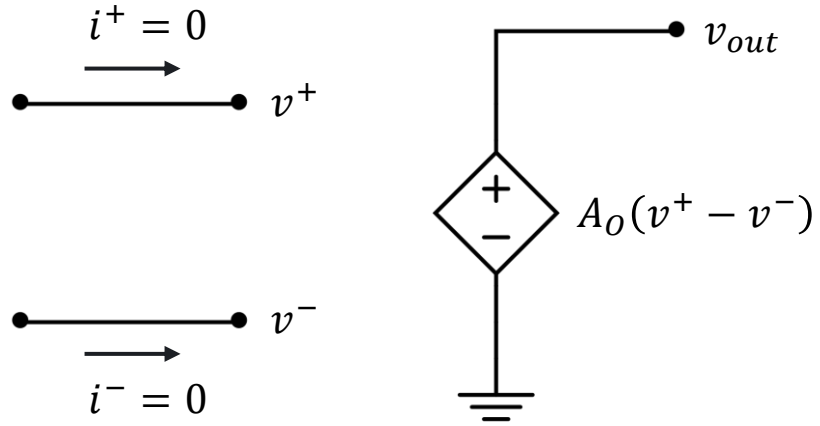


IDEAL OP-AMP

Properties of an ideal op-amp

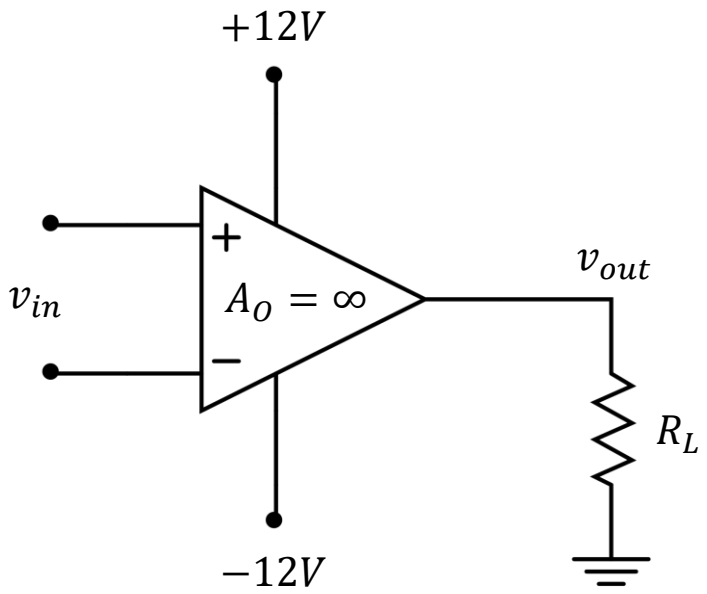
- $(R_{in} \to \infty)$ Infinite input resistance
- (R_{out}) Zero output resistance
- $(A_O \to \infty)$ Infinite open-loop gain
- $(v_{out} \to \infty)$ No saturation

Circuit model

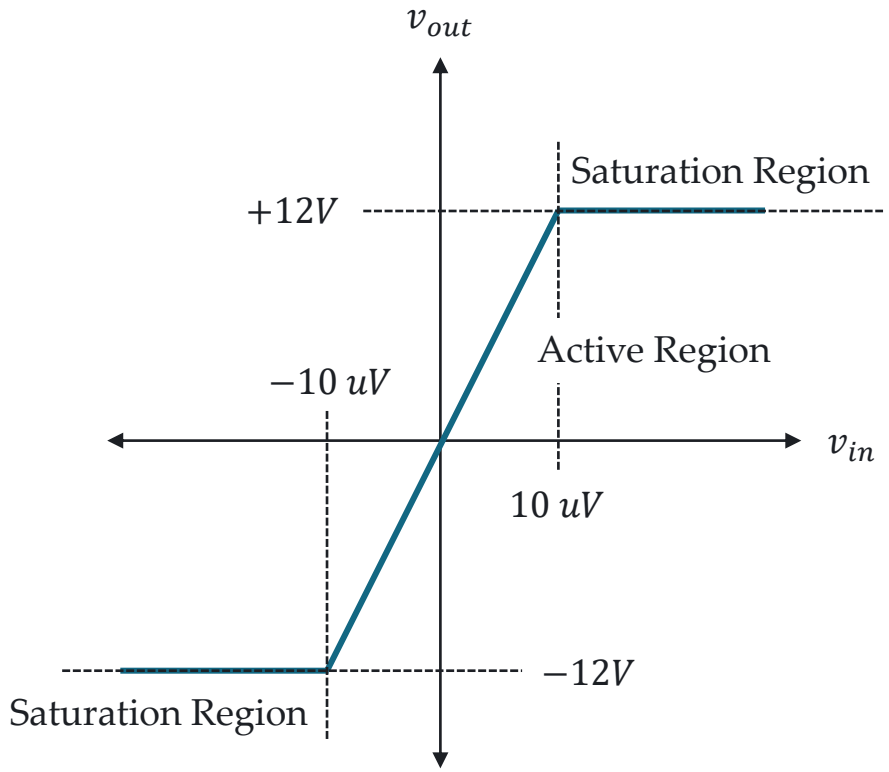


SATURATION REGION

Abstract representation



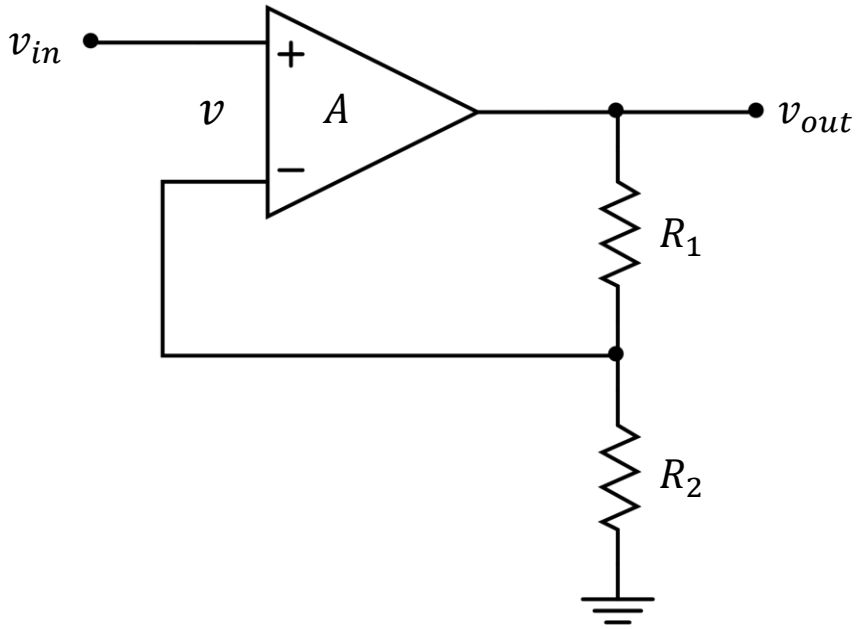
Transfer characteristic



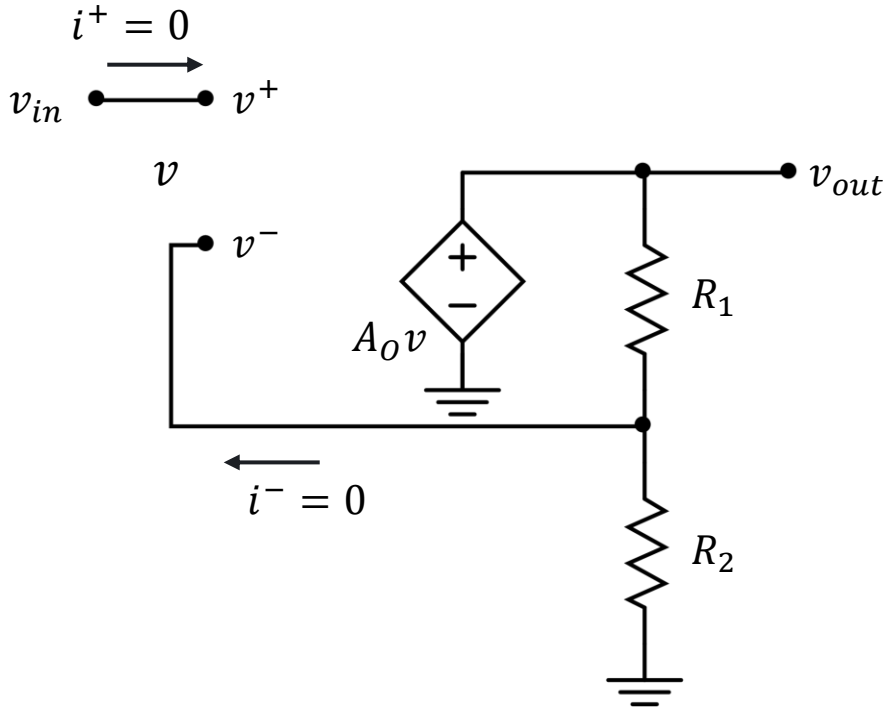
NON-INVERTING OP-AMP

NON-INVERING OP-AMP

Abstract representation



Circuit model



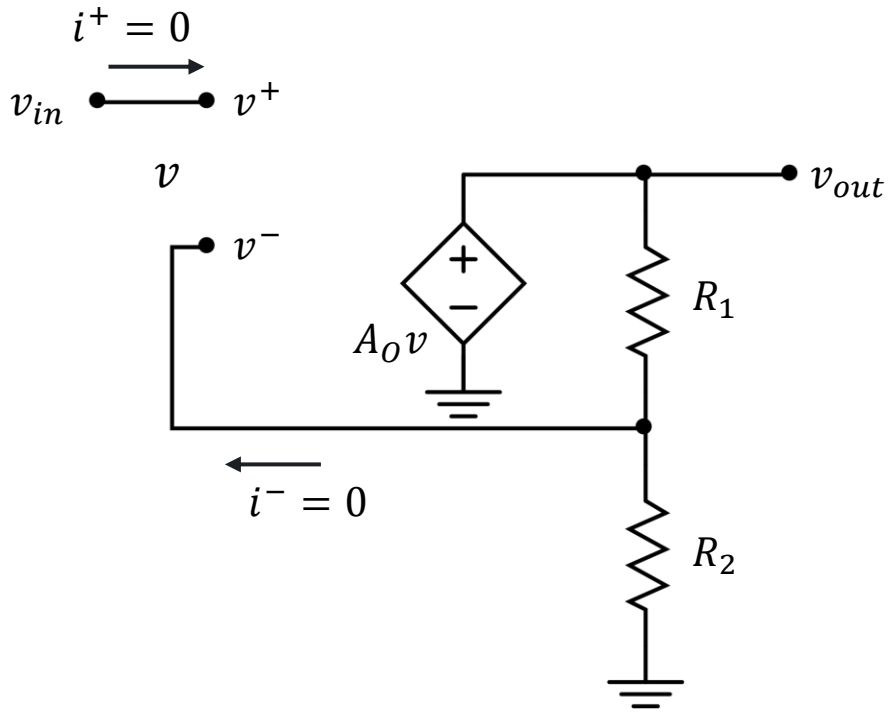
note

A = closed-loop gain

A_O =open-loop gain (∞)

NON-INVERING OP-AMP

Circuit model



Closed-loop gain

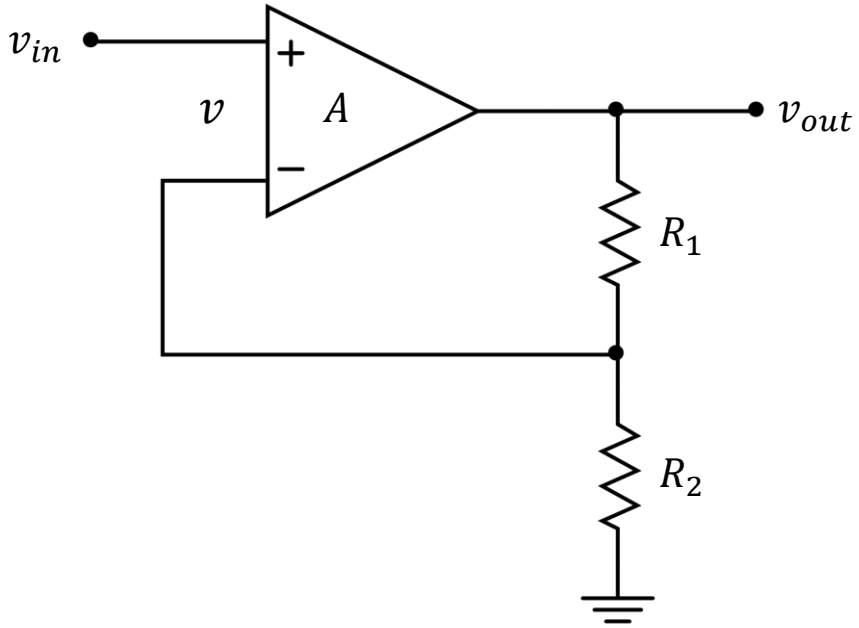
note

A = closed-loop gain

A_O =open-loop gain (∞)

NON-INVERING OP-AMP

Abstract representation



Closed-loop gain

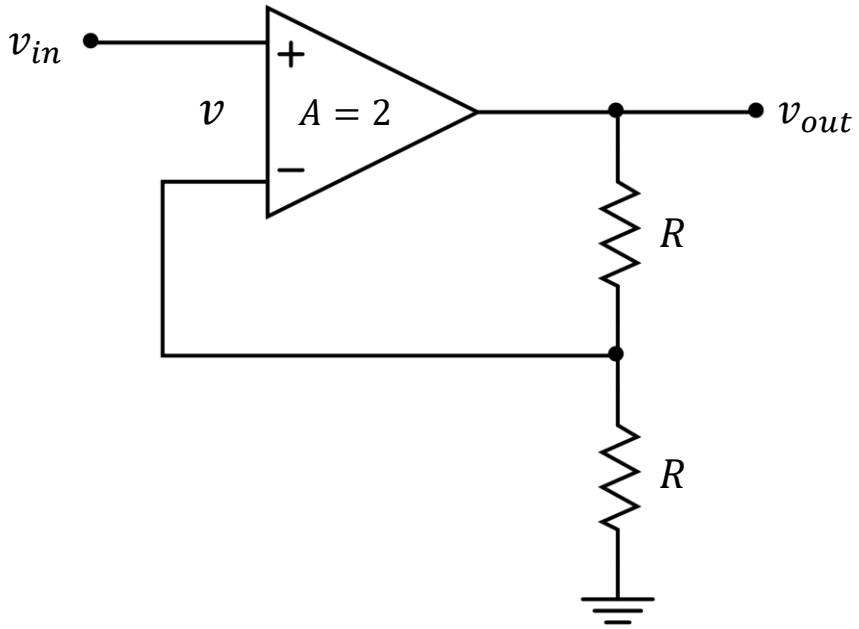
note

A = closed-loop gain

A_O =open-loop gain (∞)

NEGATIVE FEEDBACK

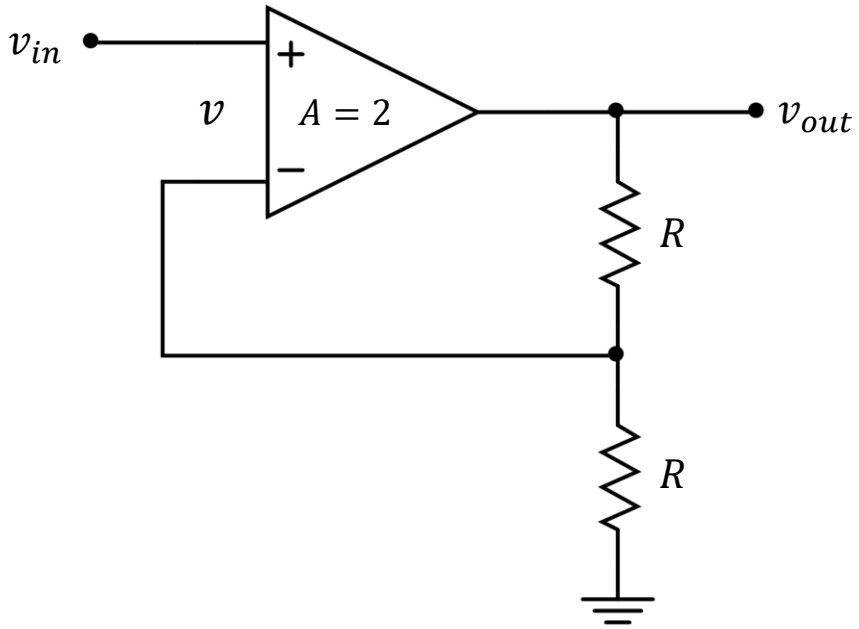
Abstract representation



Differential inputs

NEGATIVE FEEDBACK

Abstract representation



Insightful analysis

- $v^+ \approx v^-$
- $i^+ = 0$
- $i^- = 0$

LABORATORY