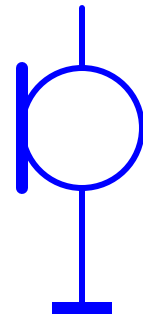


Structured Electronic Design

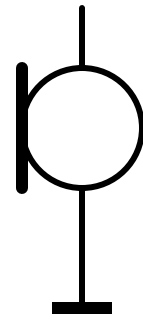
Amplifier Biasing Example

Biasing Example



Microphone:

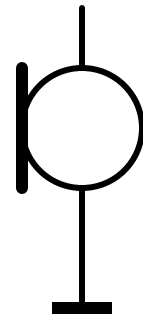
Biasing Example



Microphone:

- one-sided connected to ground

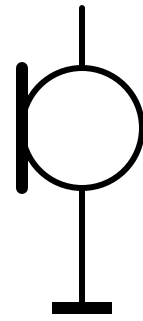
Biasing Example



Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure

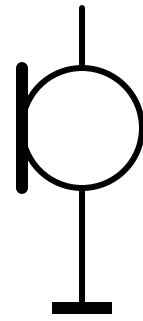
Biasing Example



Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed

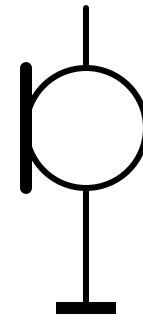
Biasing Example



Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1V \dots + 0.1V$

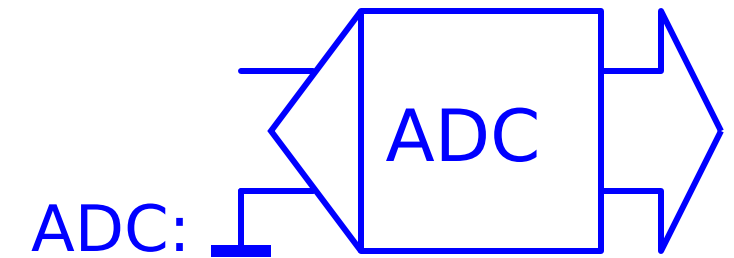
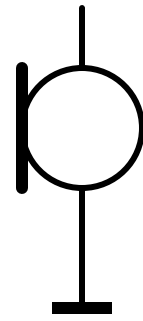
Biasing Example



Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components 20Hz ... 20kHz

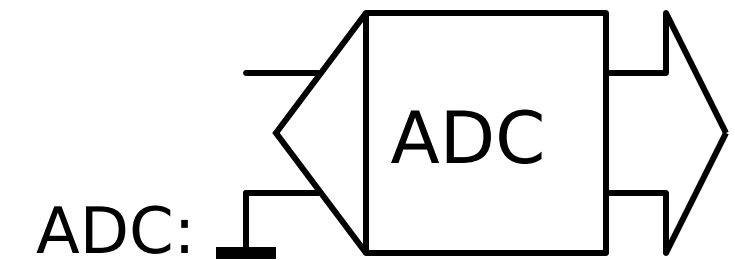
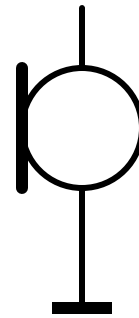
Biasing Example



Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$

Biasing Example

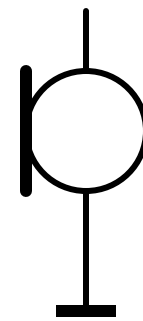


- grounded input

Microphone:

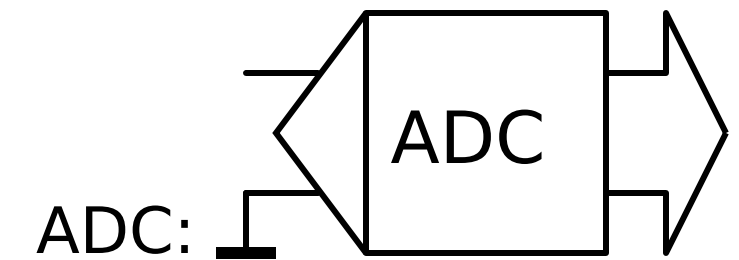
- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$

Biasing Example



Microphone:

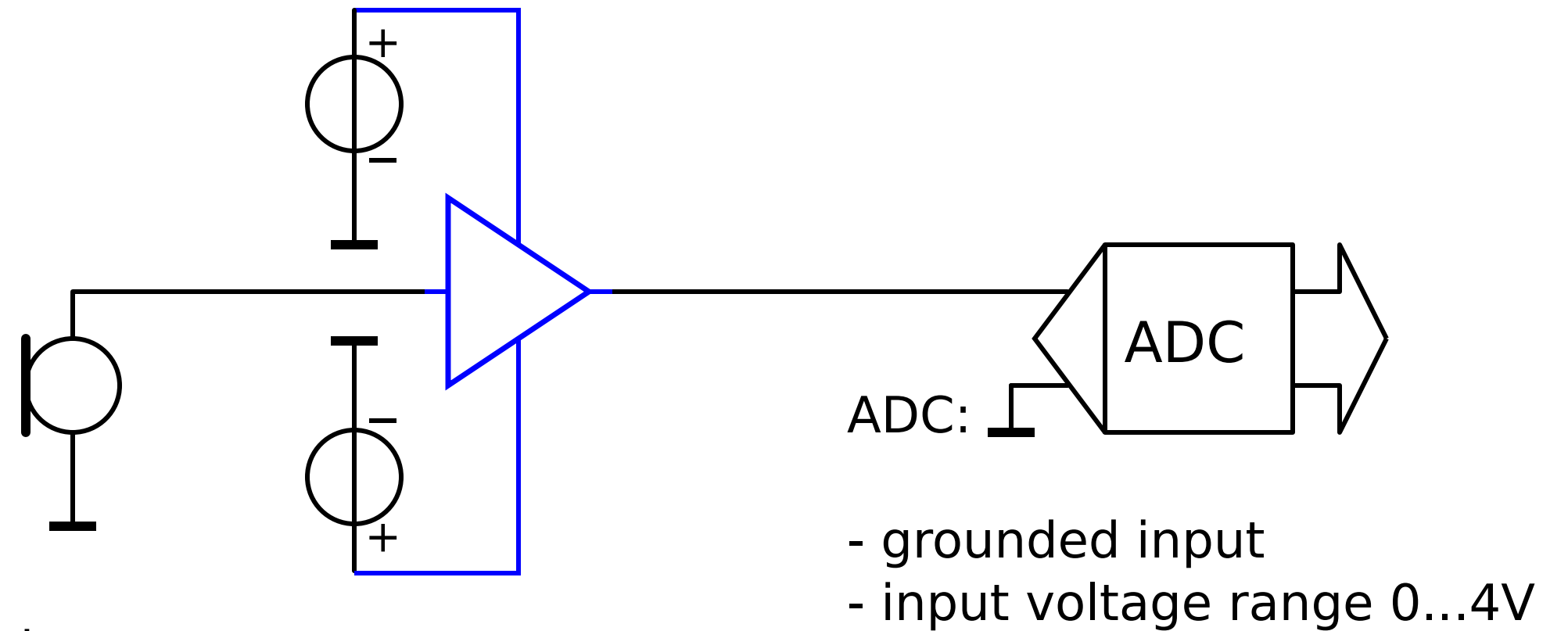
- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$



- grounded input
- input voltage range $0 \dots 4\text{V}$

Biasing Example

Amplifier to be designed:



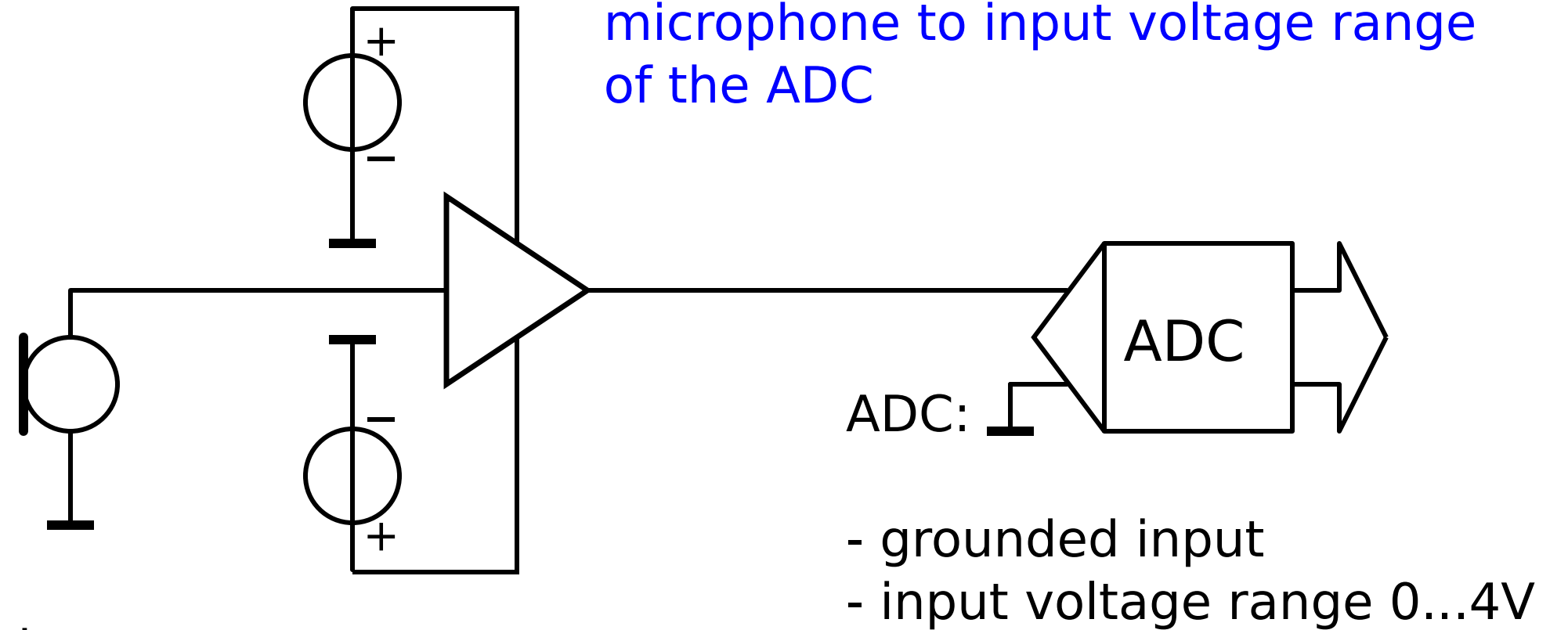
Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$

Biasing Example

Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC



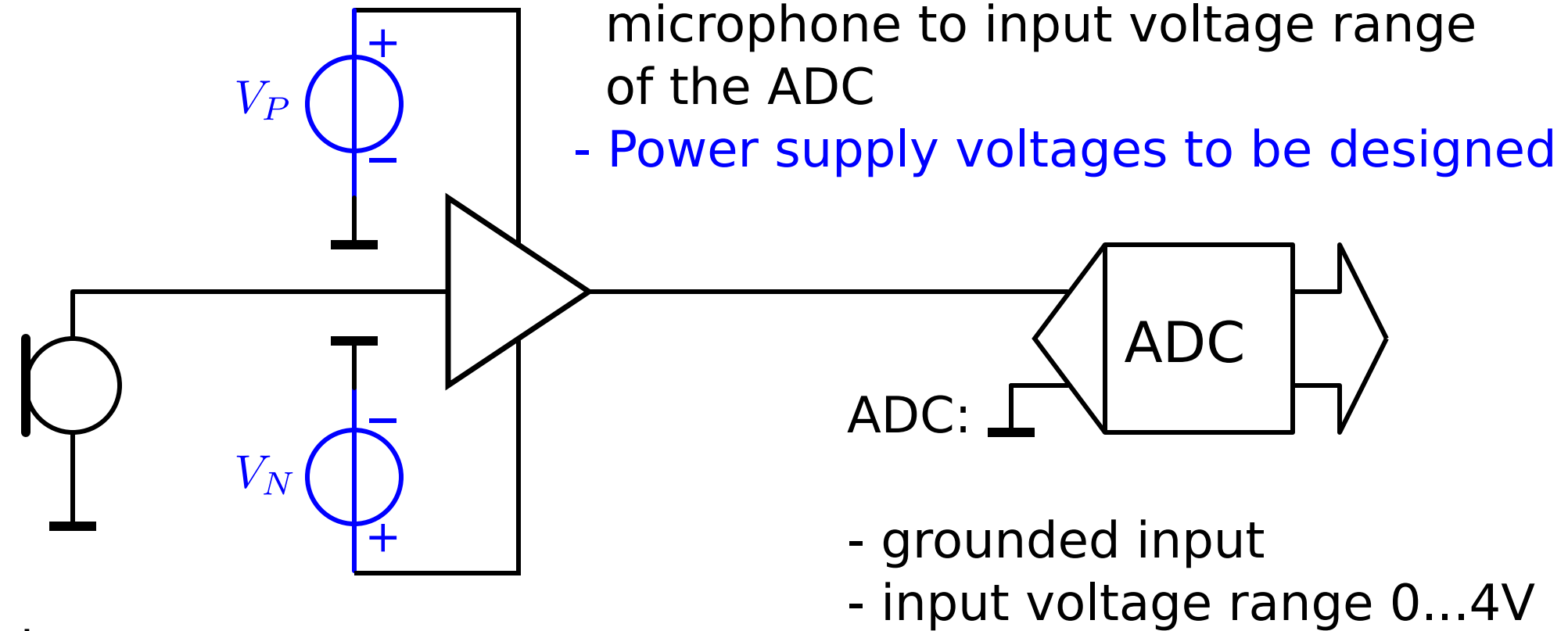
Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$

Biasing Example

Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC
- Power supply voltages to be designed

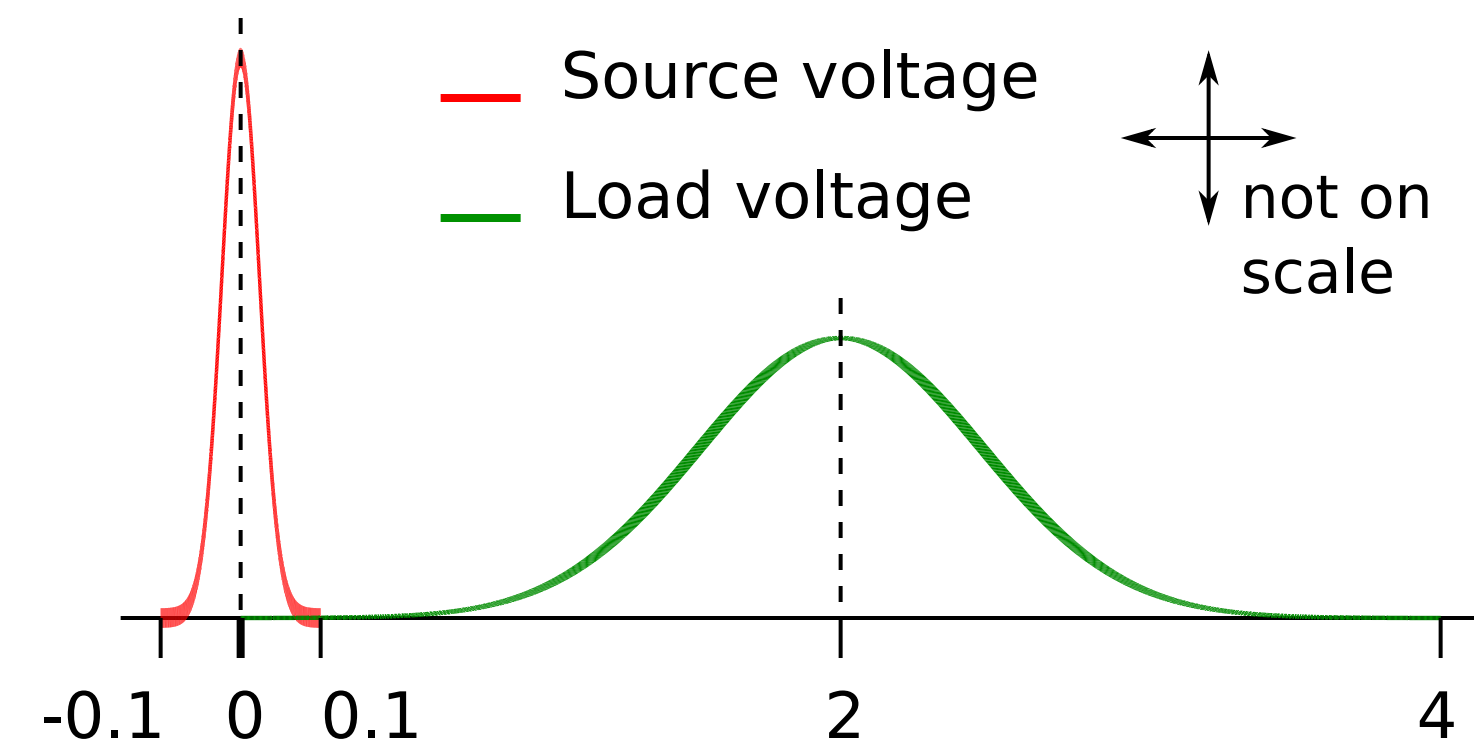


Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range $-0.1\text{V} \dots +0.1\text{V}$
- signal frequency components $20\text{Hz} \dots 20\text{kHz}$

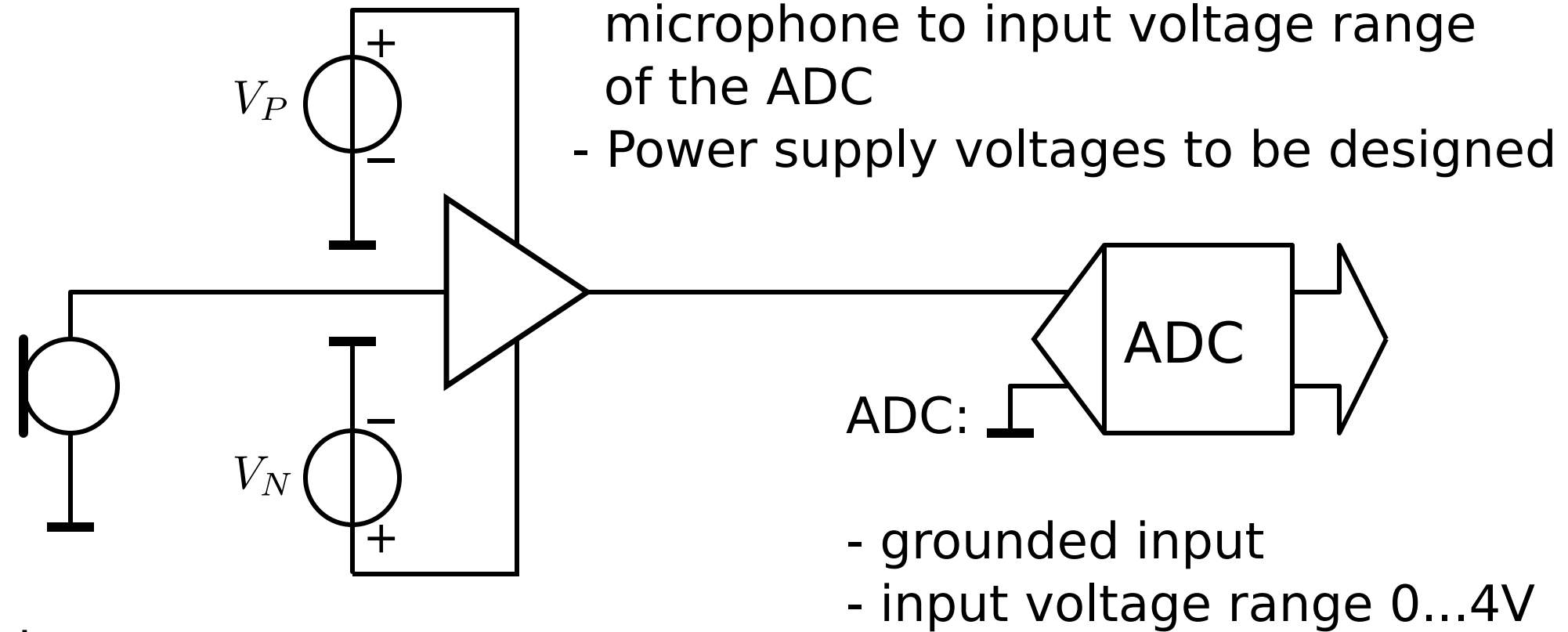
Biasing Example

Probability Density Functions



Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC
- Power supply voltages to be designed

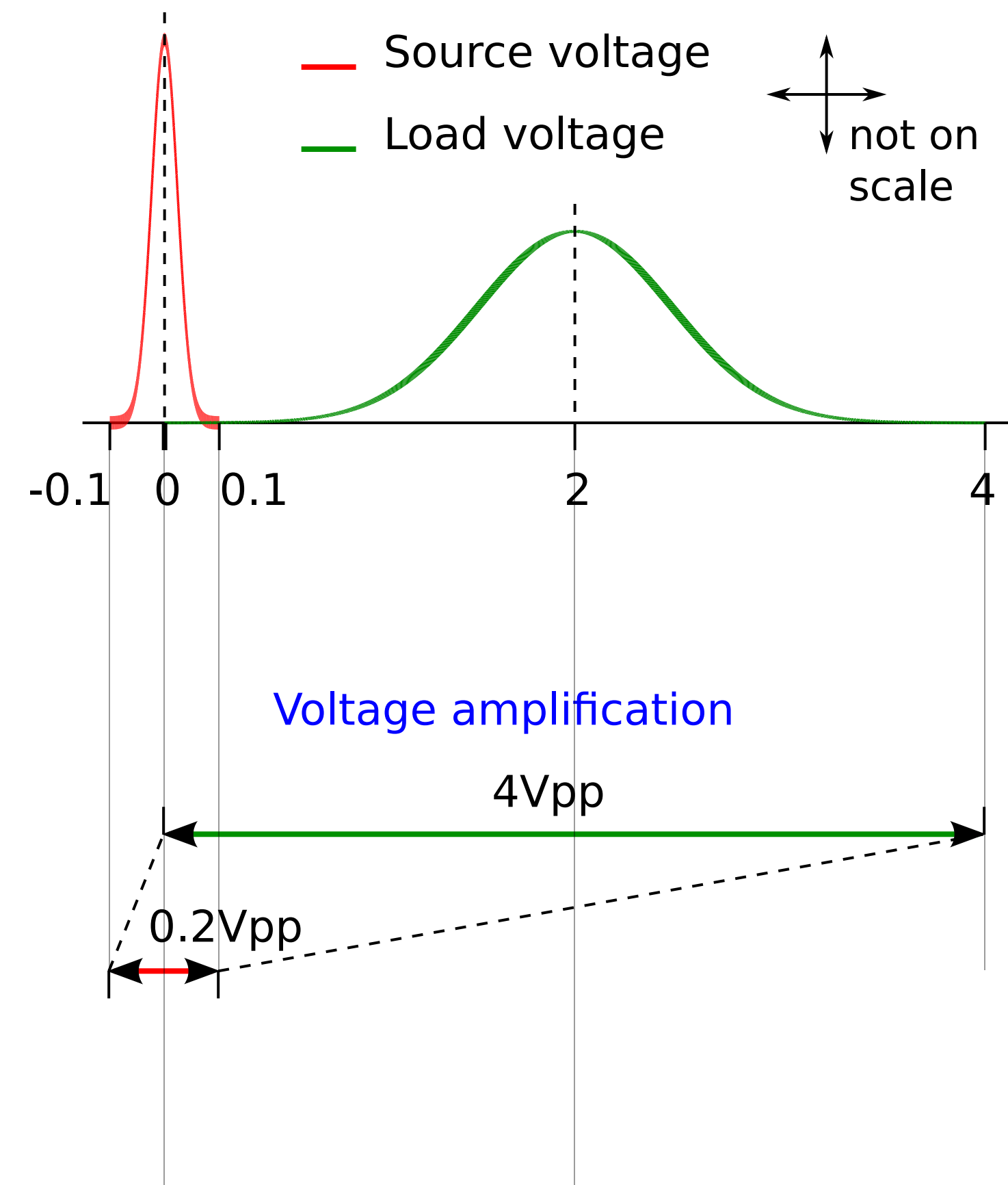


Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range -0.1V ... + 0.1V
- signal frequency components 20Hz ... 20kHz

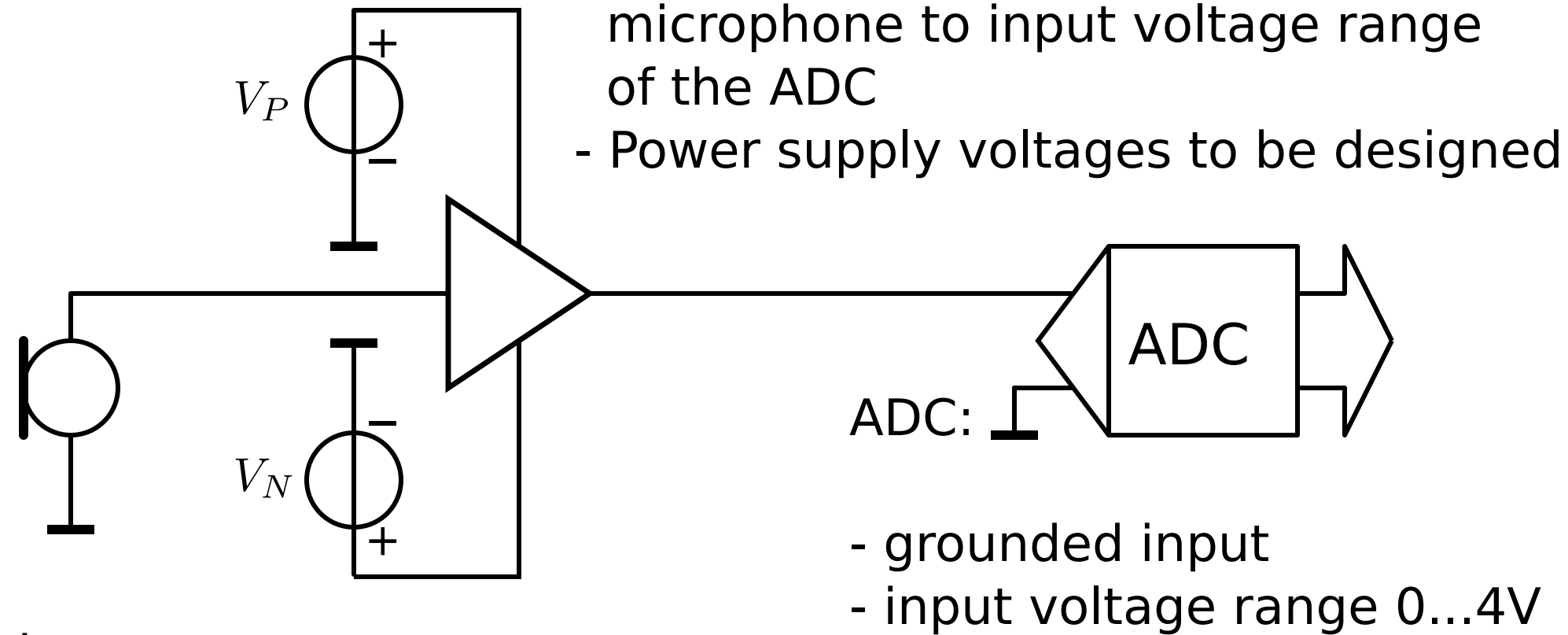
Biasing Example

Probability Density Functions



Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC
- Power supply voltages to be designed



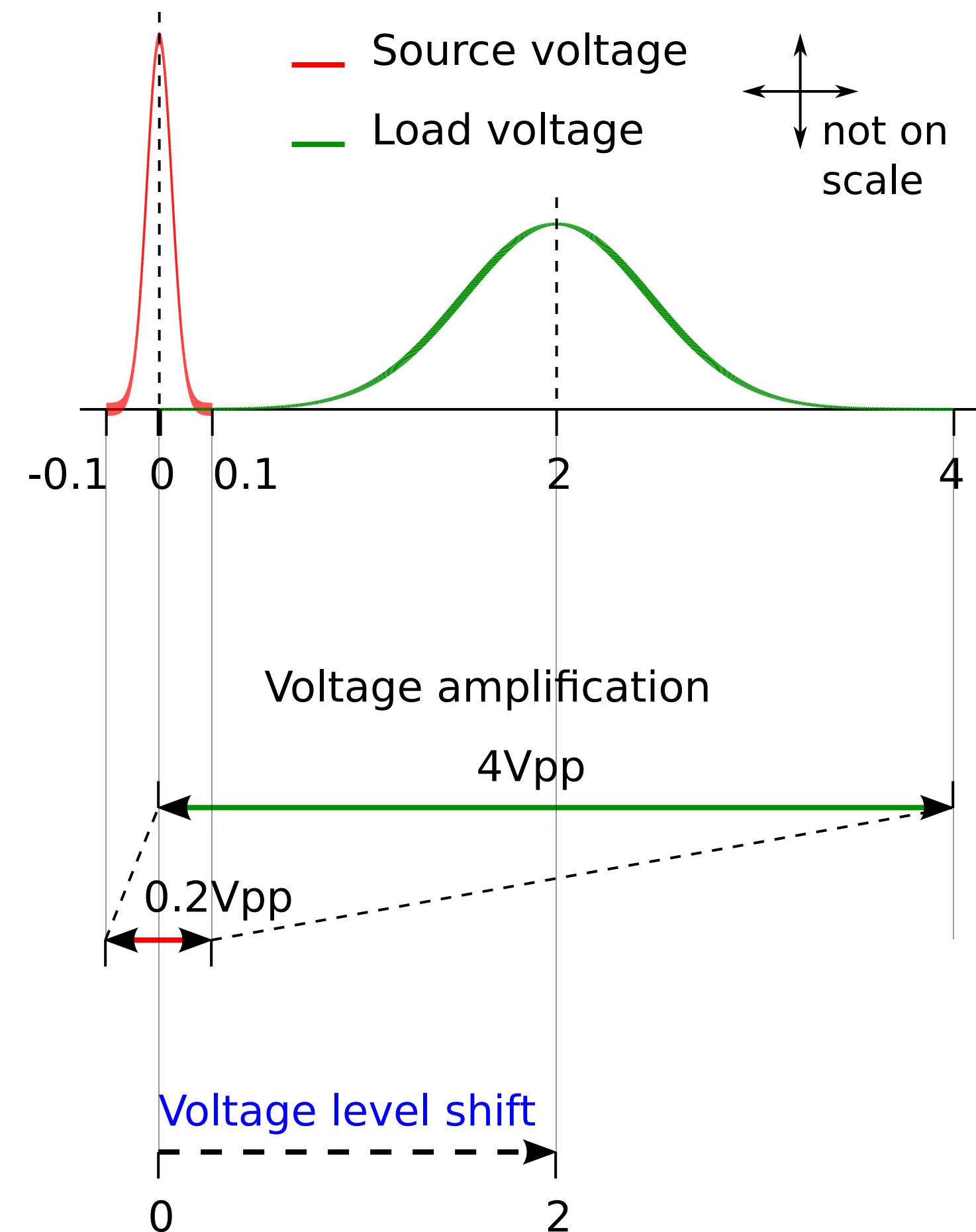
- grounded input
- input voltage range 0...4V

Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range -0.1V ... + 0.1V
- signal frequency components 20Hz ... 20kHz

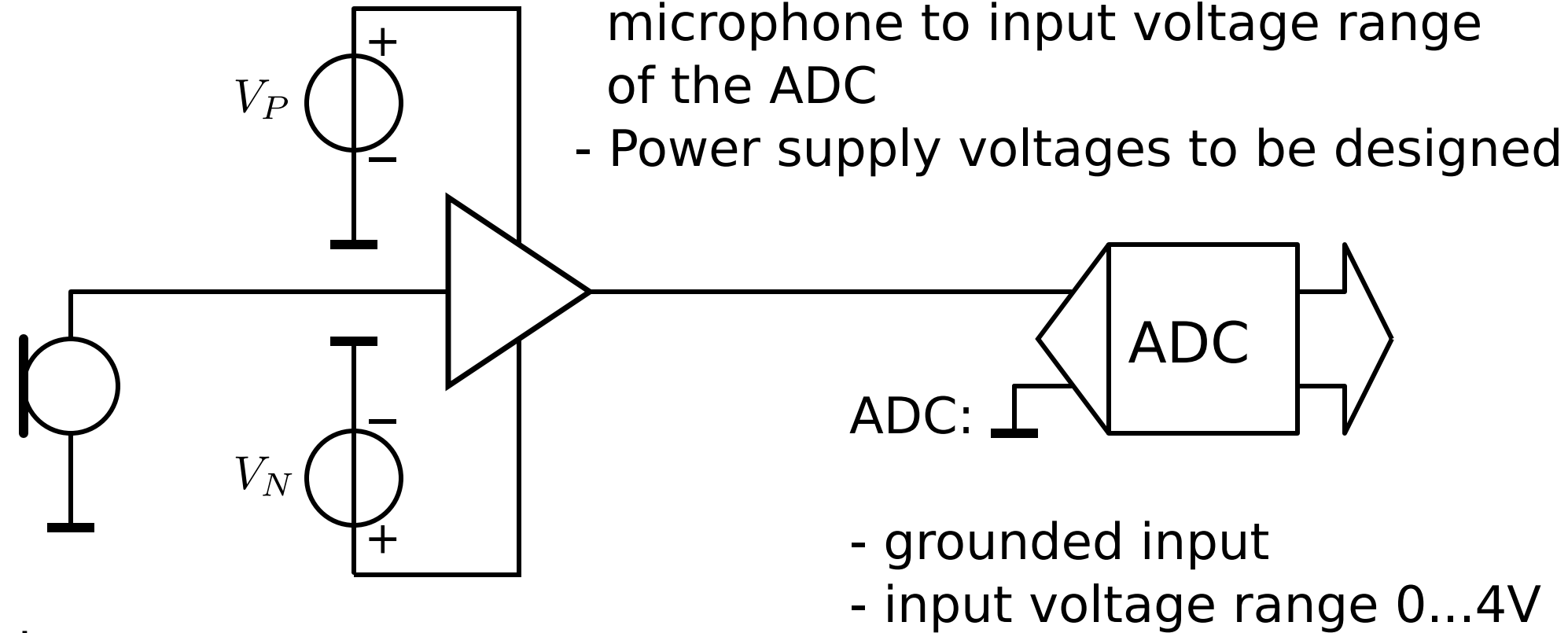
Biasing Example

Probability Density Functions



Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC
- Power supply voltages to be designed

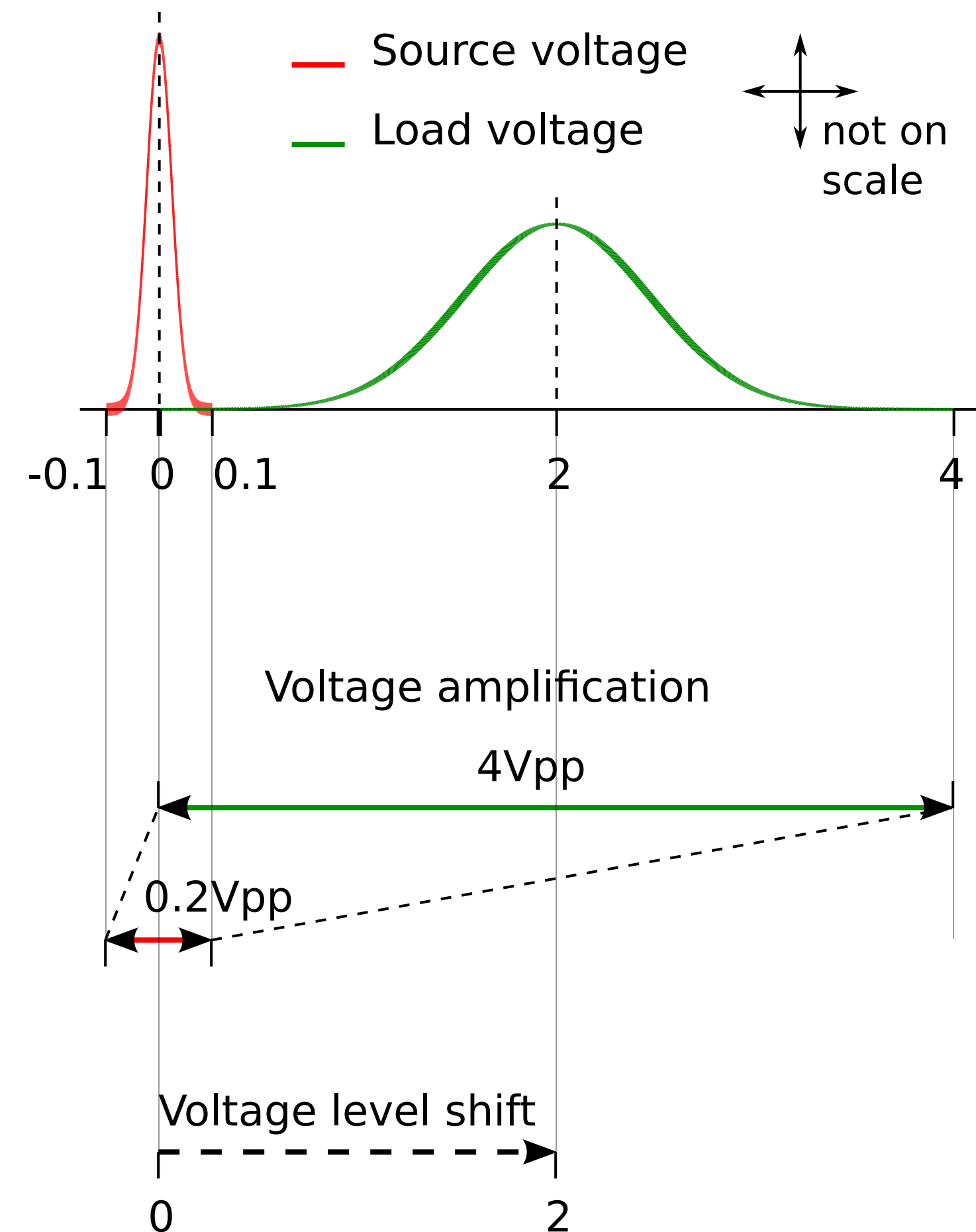


Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range -0.1V ... + 0.1V
- signal frequency components 20Hz ... 20kHz

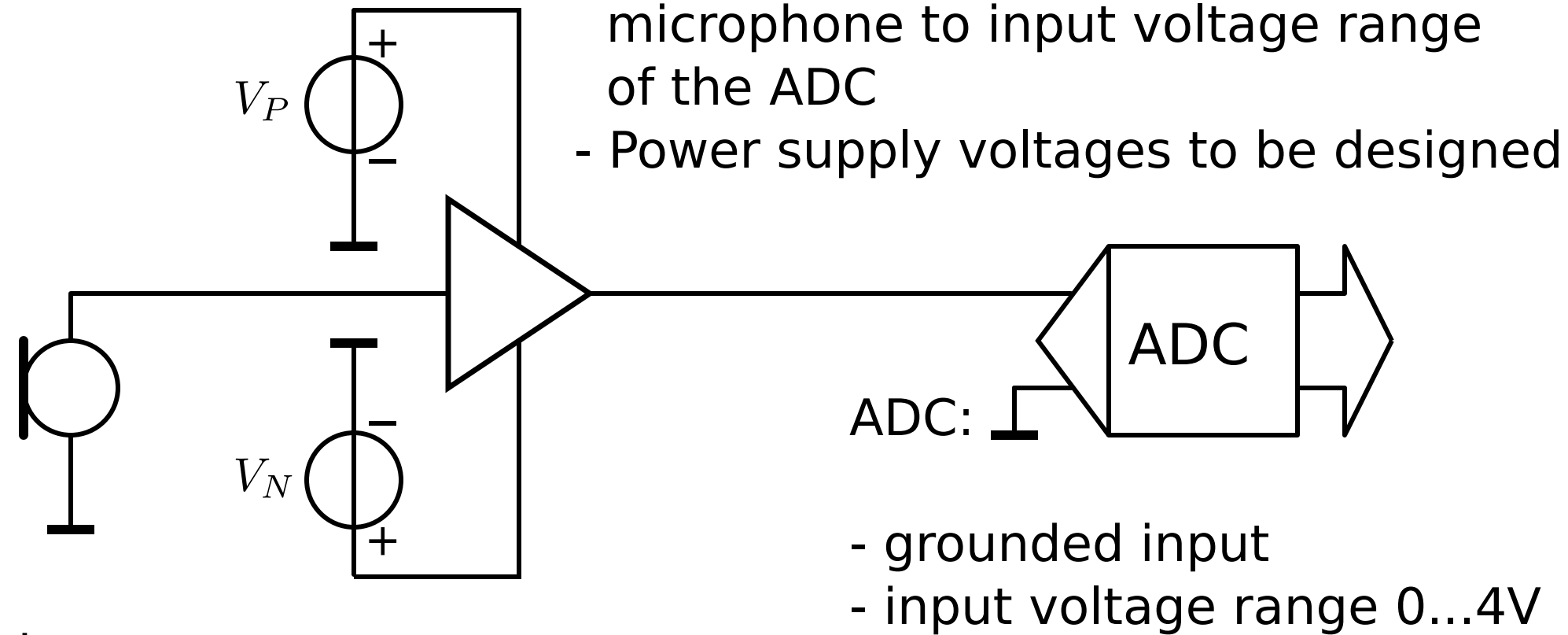
Biasing Example

Probability Density Functions



Amplifier to be designed:

- Adapts output voltage range of the microphone to input voltage range of the ADC
- Power supply voltages to be designed

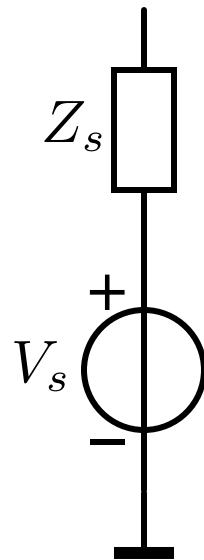


Microphone:

- one-sided connected to ground
- open-circuit output voltage is related to sound pressure
- no DC current allowed
- output voltage range -0.1V ... + 0.1V
- signal frequency components 20Hz ... 20kHz

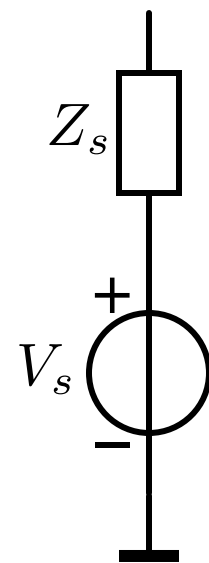
Initial Bias

Initial Bias

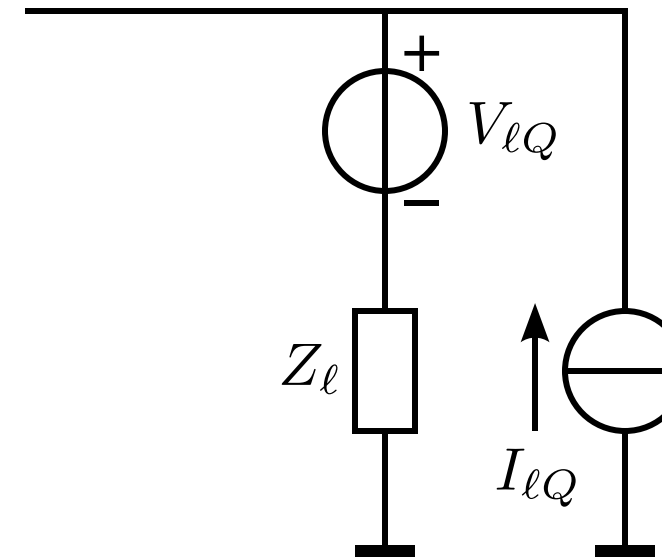


Source
model

Initial Bias

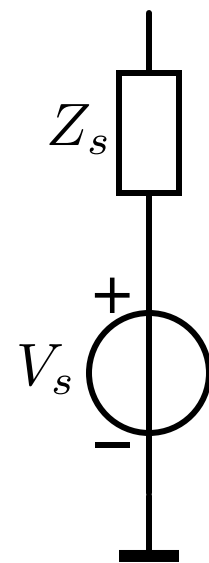


Source
model

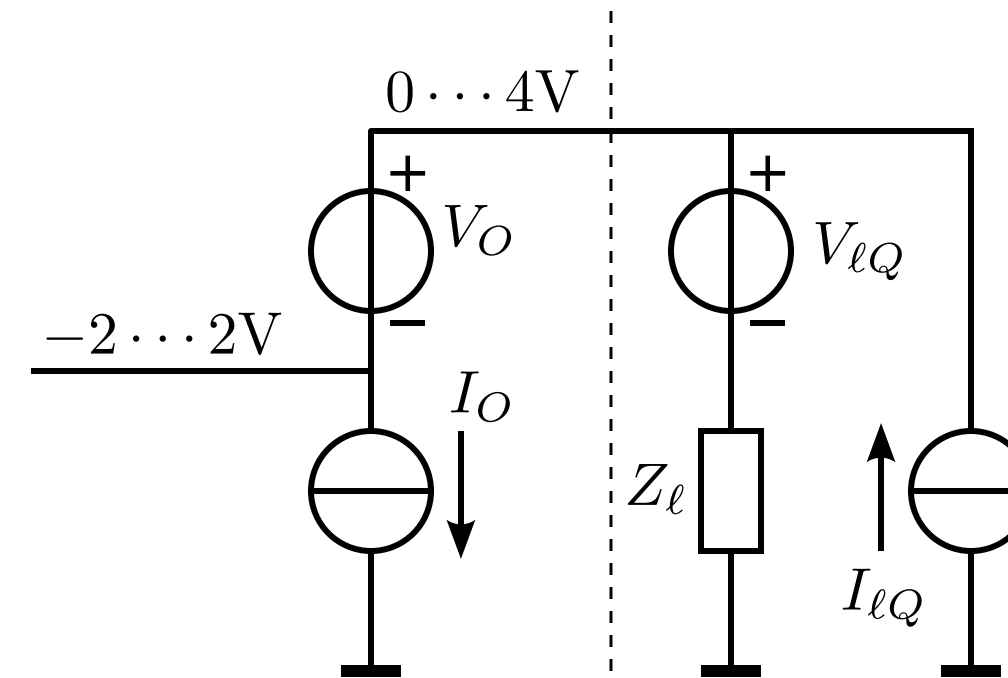


ADC input
model

Initial Bias



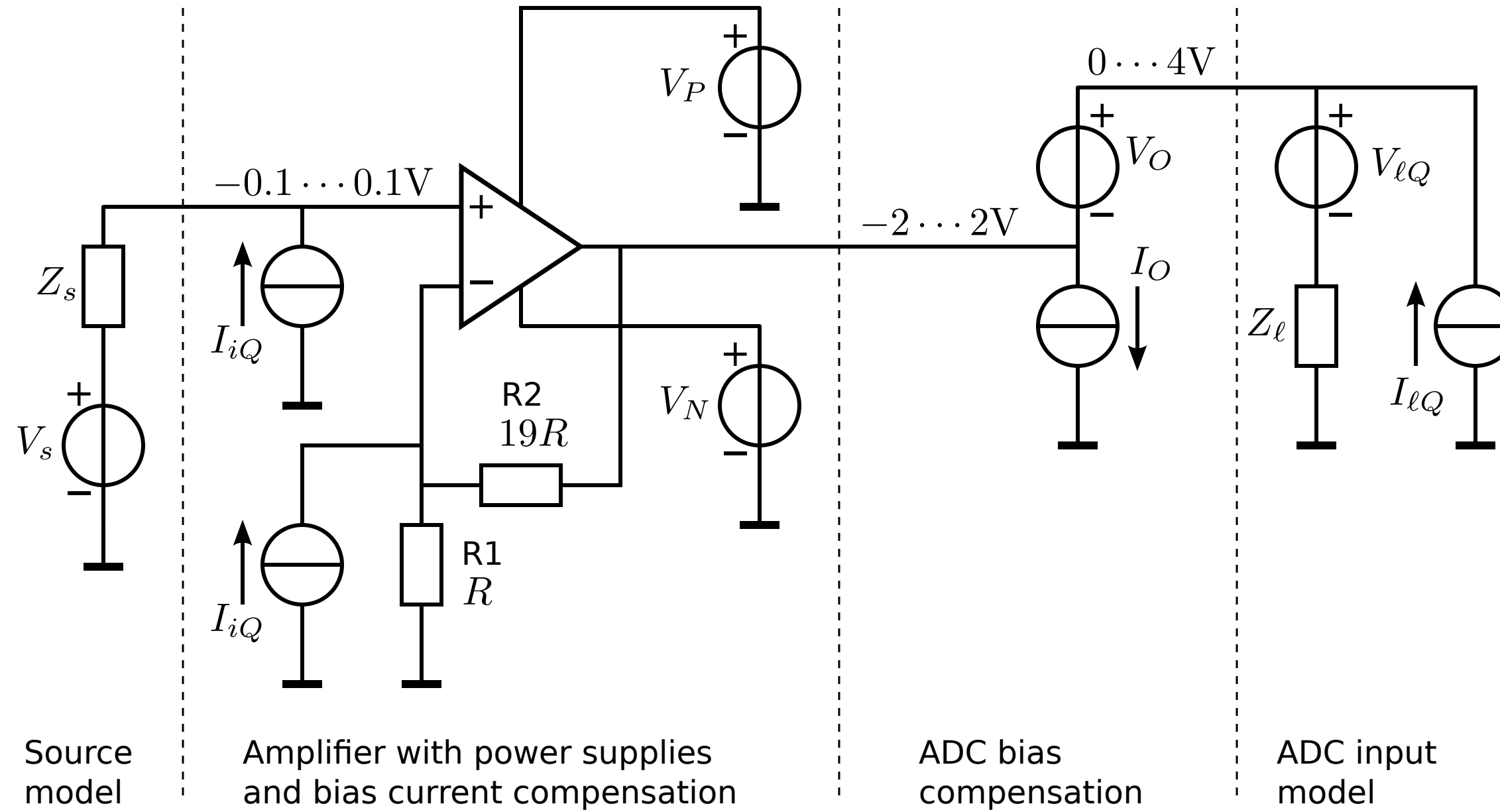
Source
model



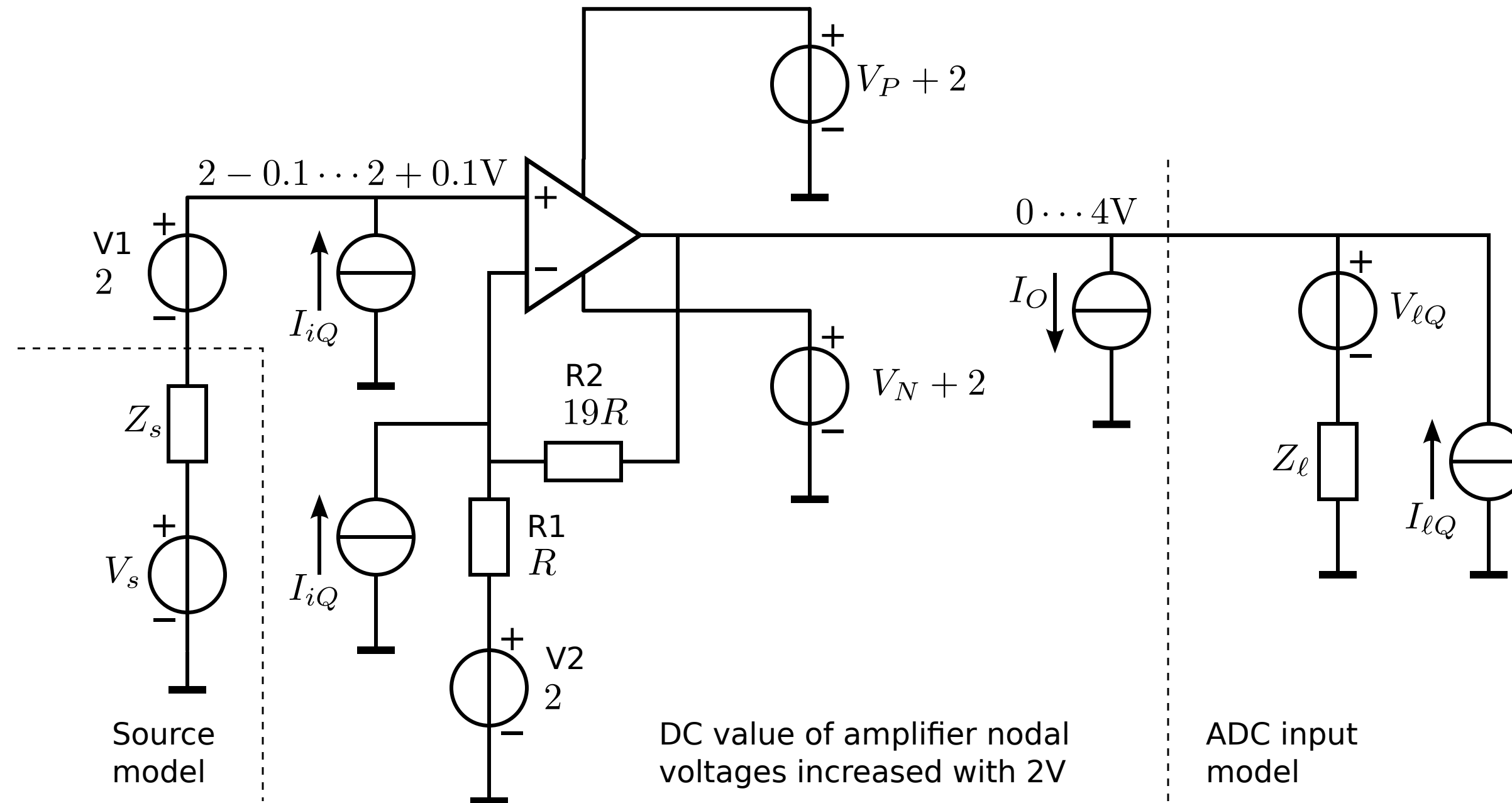
ADC bias
compensation

ADC input
model

Initial Bias

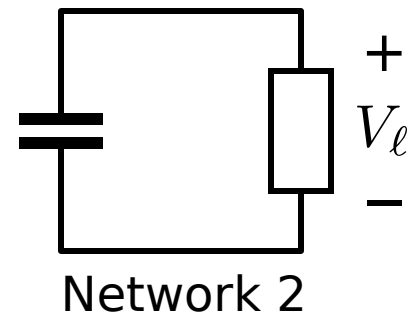
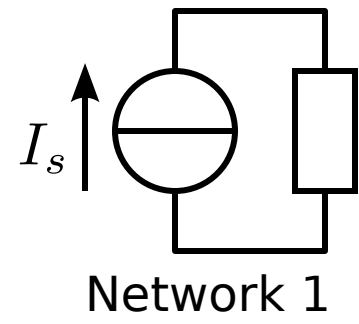


Add level shift



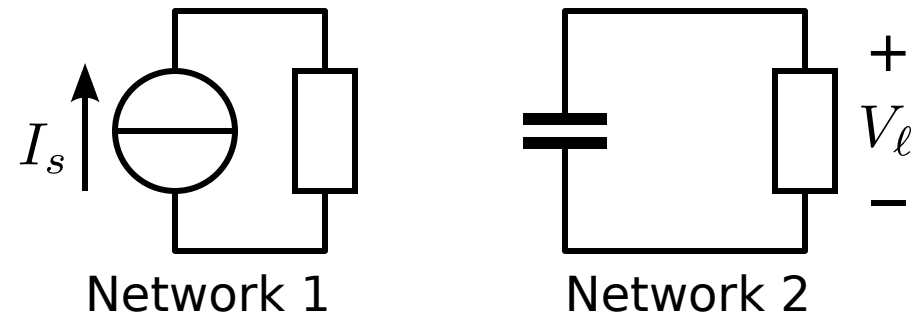
AC coupling

AC coupling

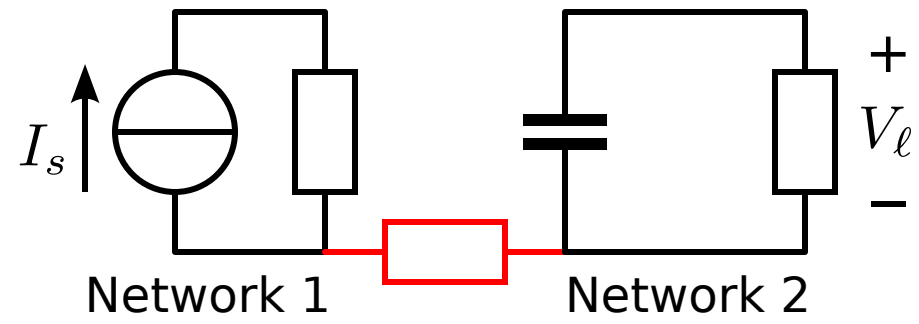


Disconnected
no coupling

AC coupling

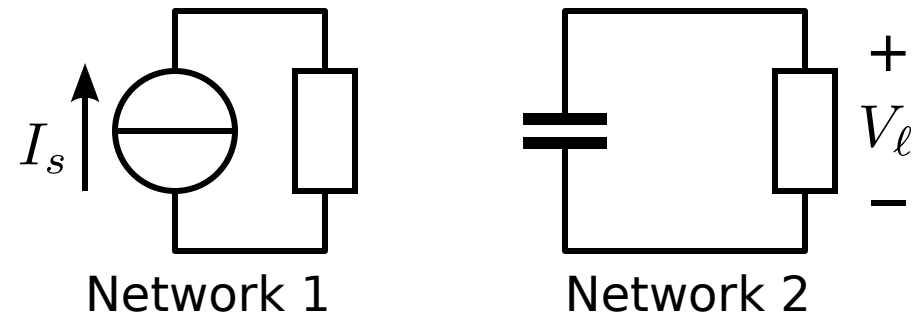


Disconnected
no coupling

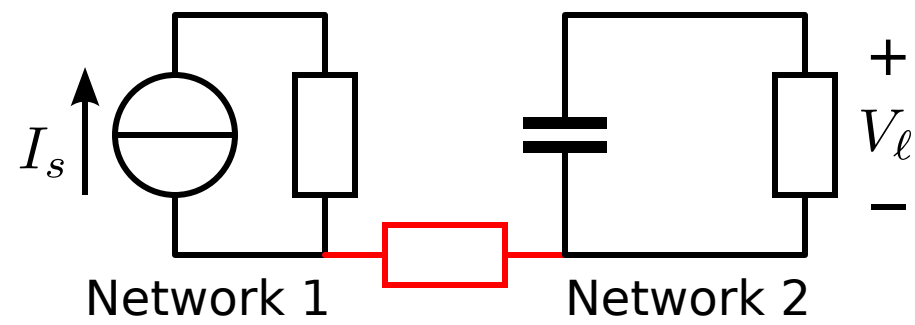


Connected
no coupling

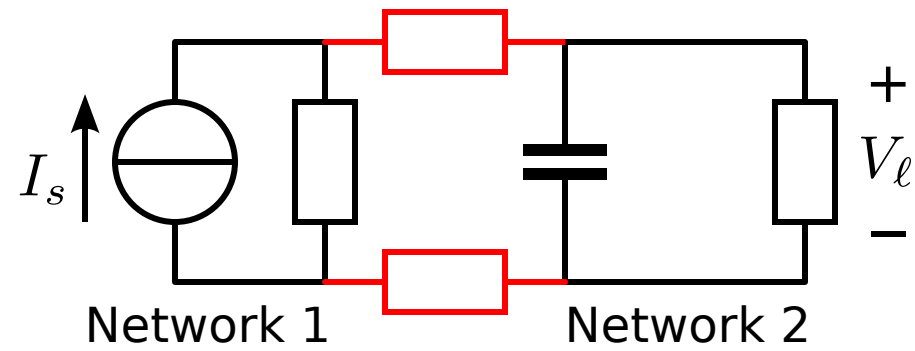
AC coupling



Disconnected
no coupling

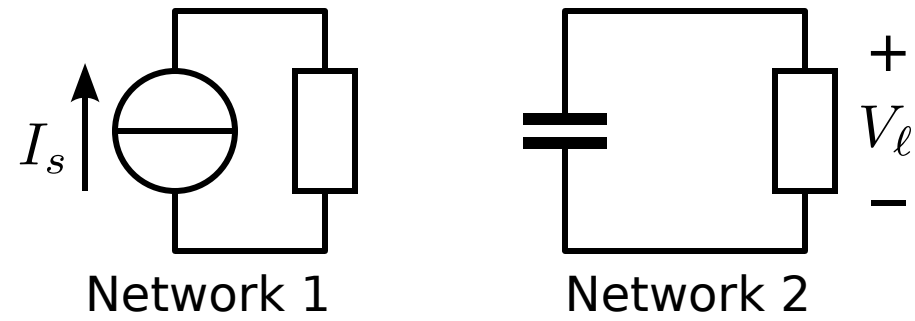


Connected
no coupling

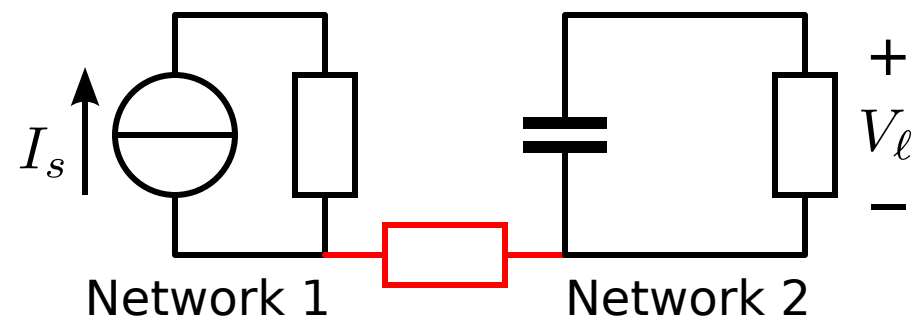


Connected
DC coupling

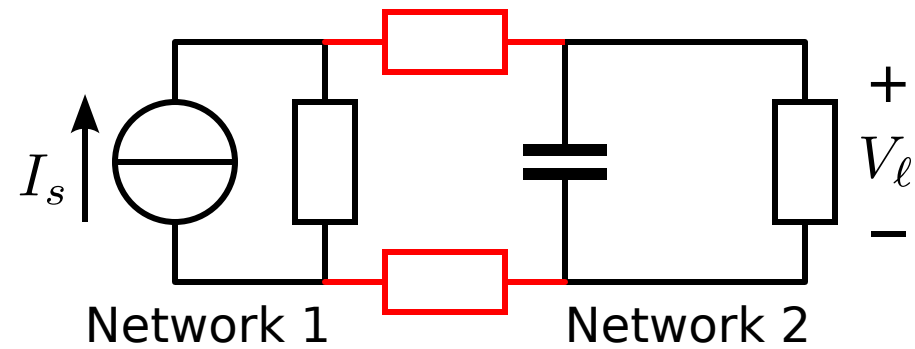
AC coupling



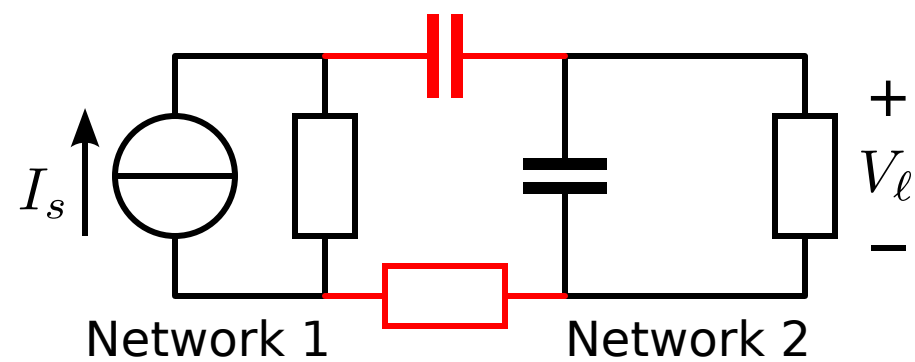
Disconnected
no coupling



Connected
no coupling

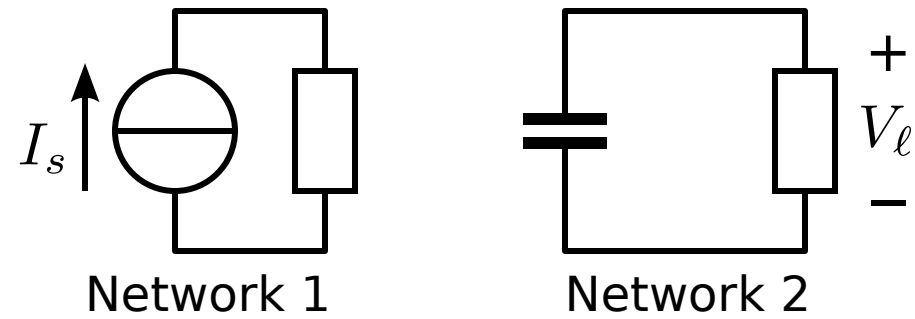


Connected
DC coupling



Connected
AC coupling

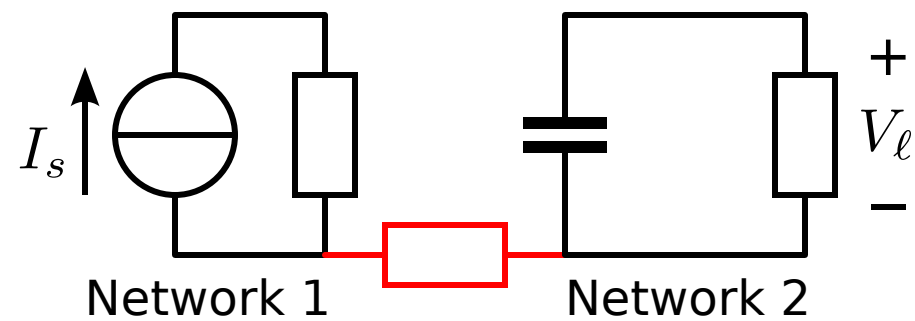
AC coupling



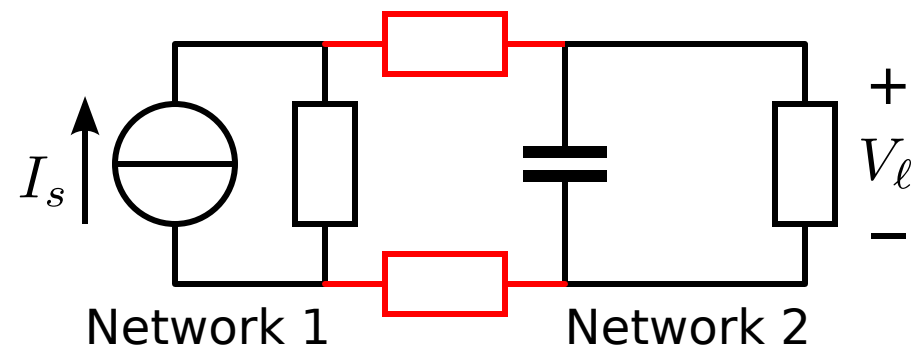
Disconnected
no coupling

AC coupling:

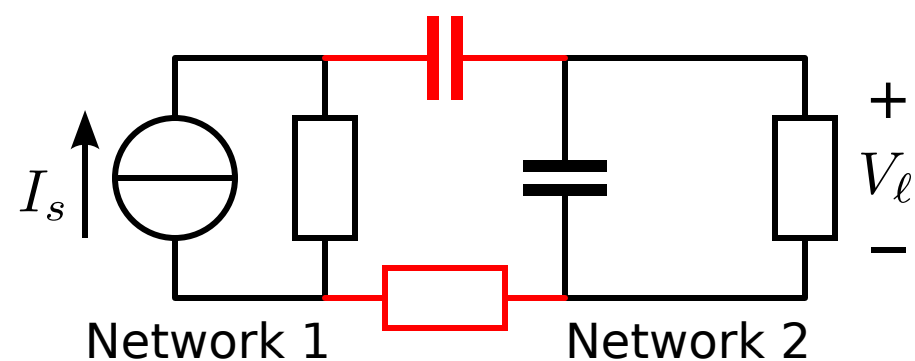
Possible:
If signal components with
very low frequencies are not of
interest



Connected
no coupling

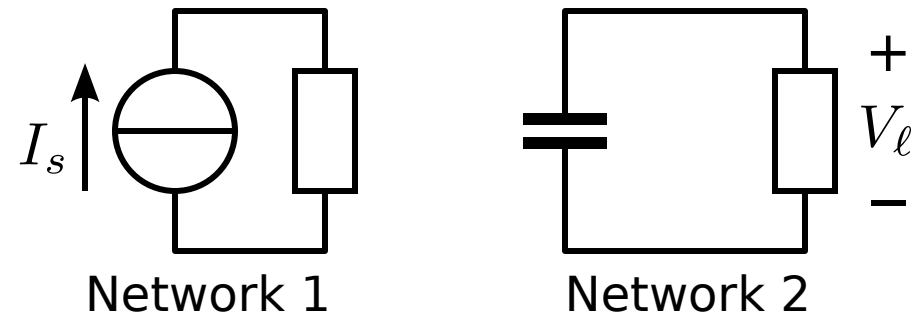


Connected
DC coupling



Connected
AC coupling

AC coupling



Disconnected
no coupling

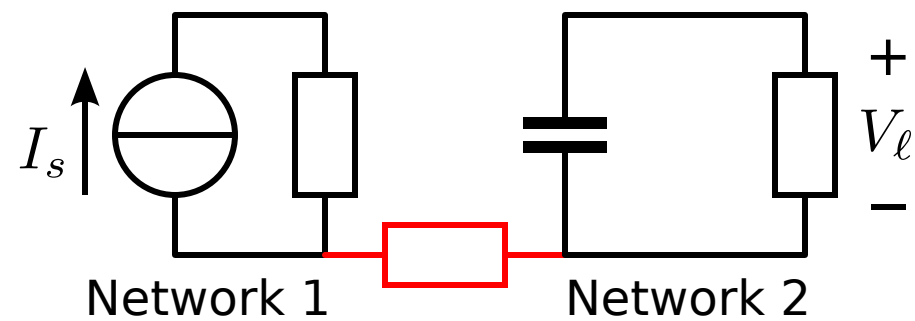
AC coupling:

Possible:

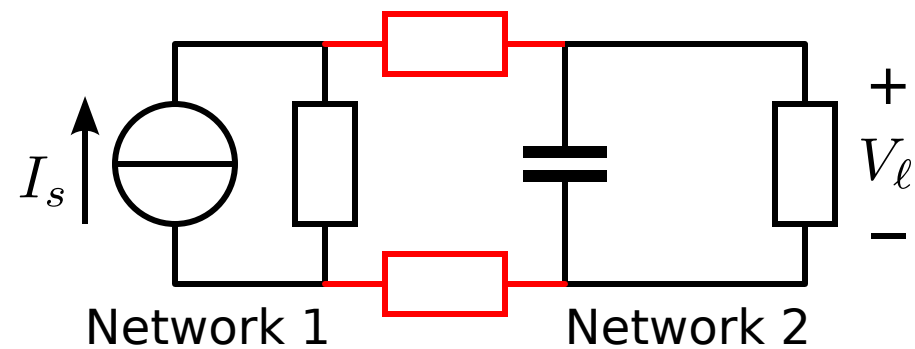
If signal components with
very low frequencies are not of
interest

Required:

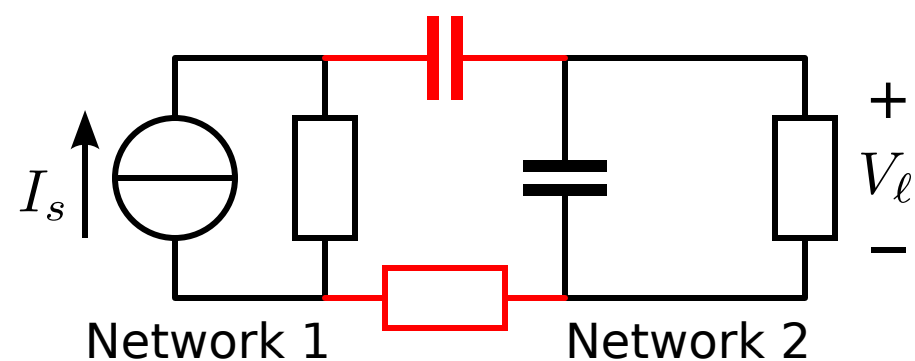
If port bias voltages and/or currents
are not allowed at the source or
at the load



Connected
no coupling

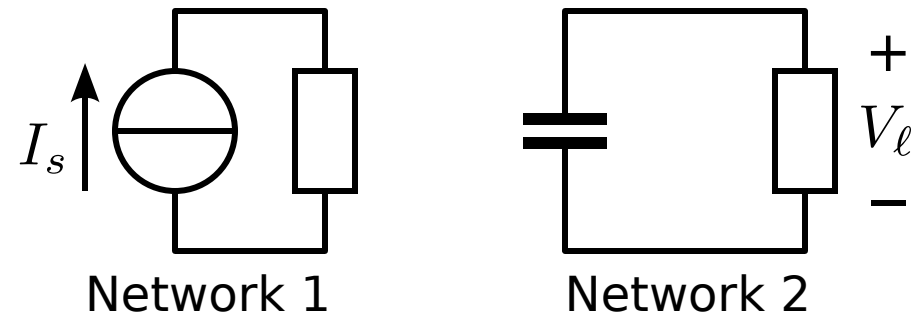


Connected
DC coupling



Connected
AC coupling

AC coupling



Disconnected
no coupling

AC coupling:

Possible:

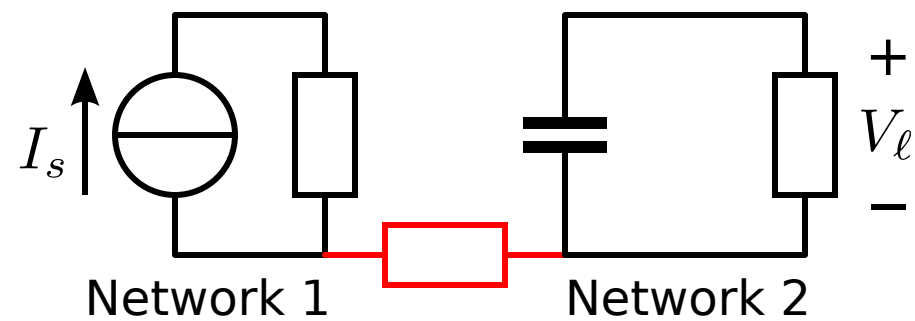
If signal components with
very low frequencies are not of
interest

Required:

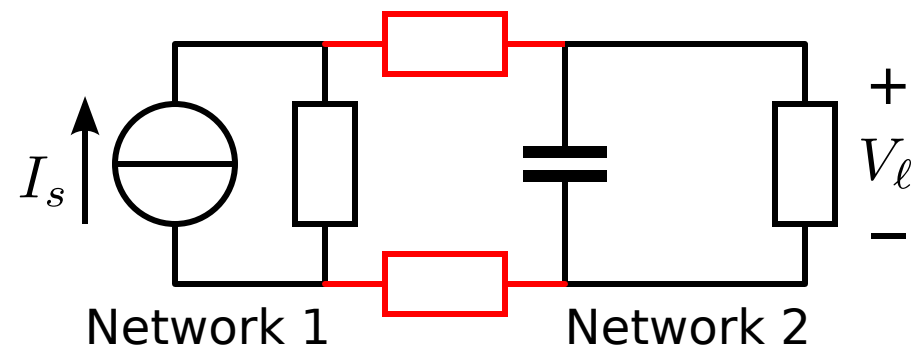
If port bias voltages and/or currents
are not allowed at the source or
at the load

Method:

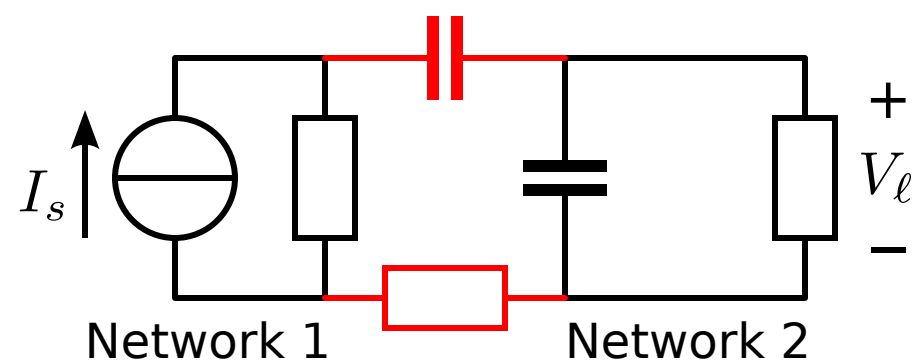
High-pass transfer



Connected
no coupling

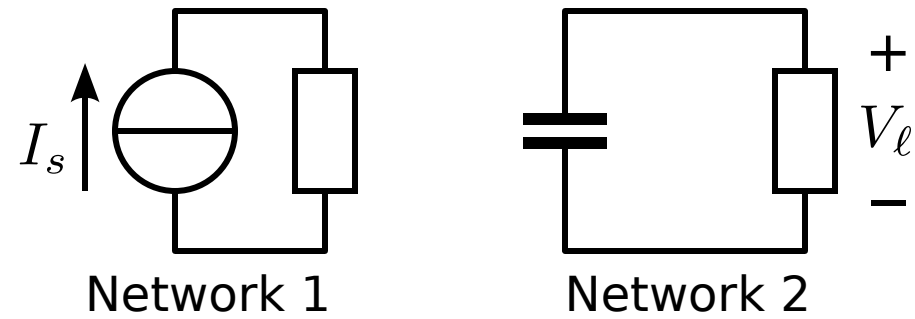


Connected
DC coupling



Connected
AC coupling

AC coupling



Disconnected
no coupling

AC coupling:

Possible:

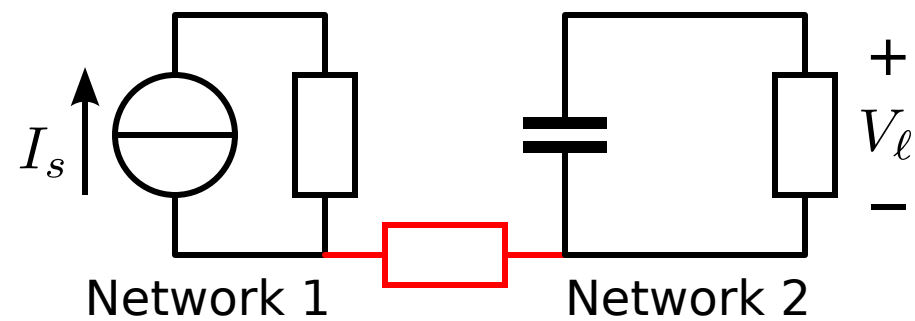
If signal components with
very low frequencies are not of
interest

Required:

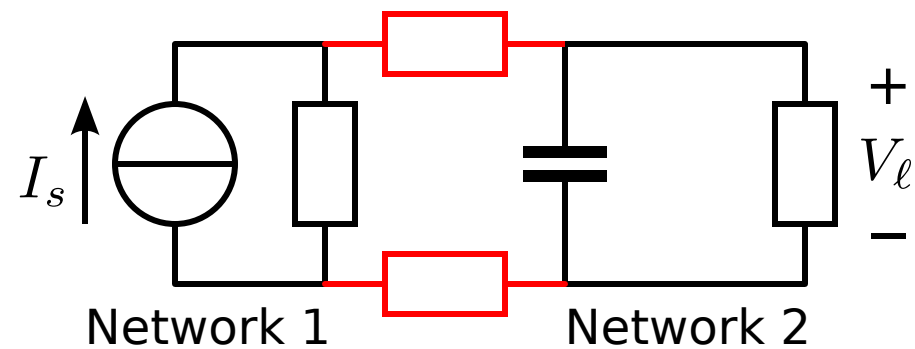
If port bias voltages and/or currents
are not allowed at the source or
at the load

Method:

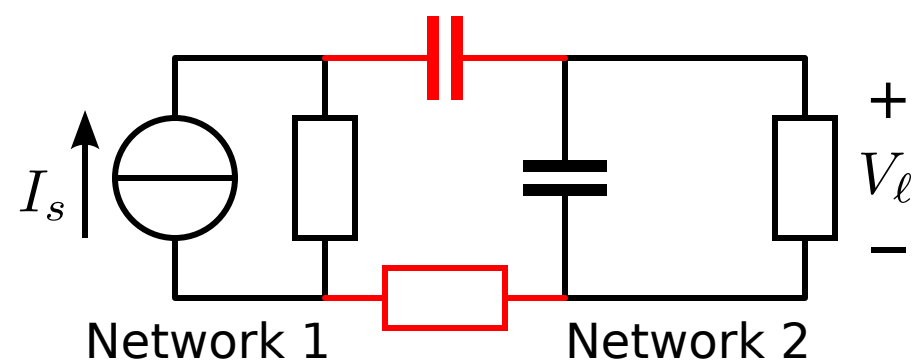
High-pass transfer



Connected
no coupling

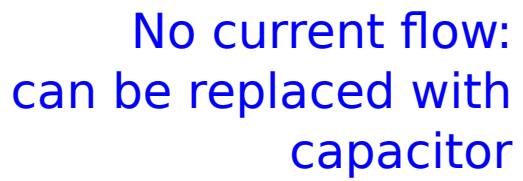


Connected
DC coupling

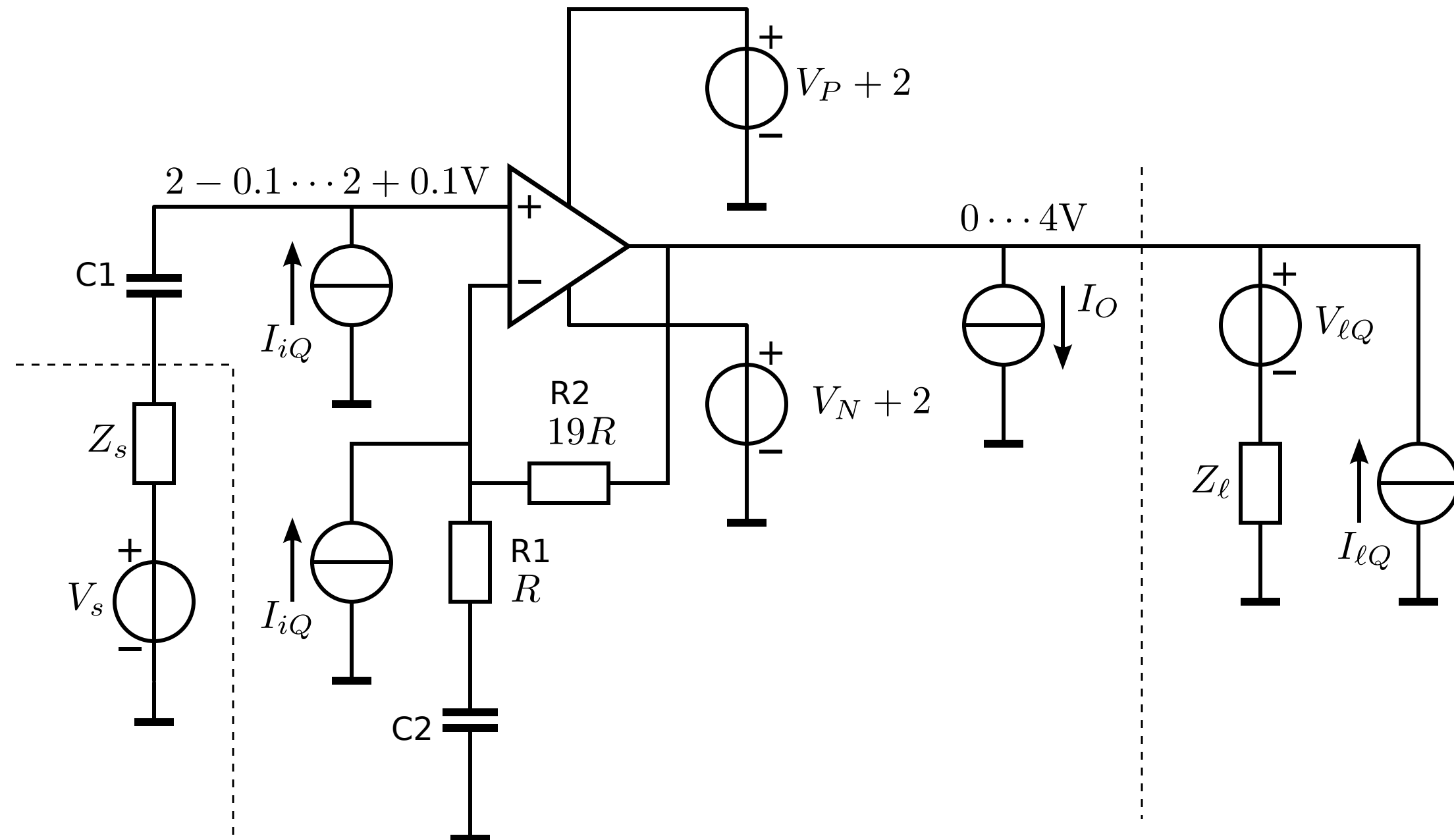


Connected
AC coupling

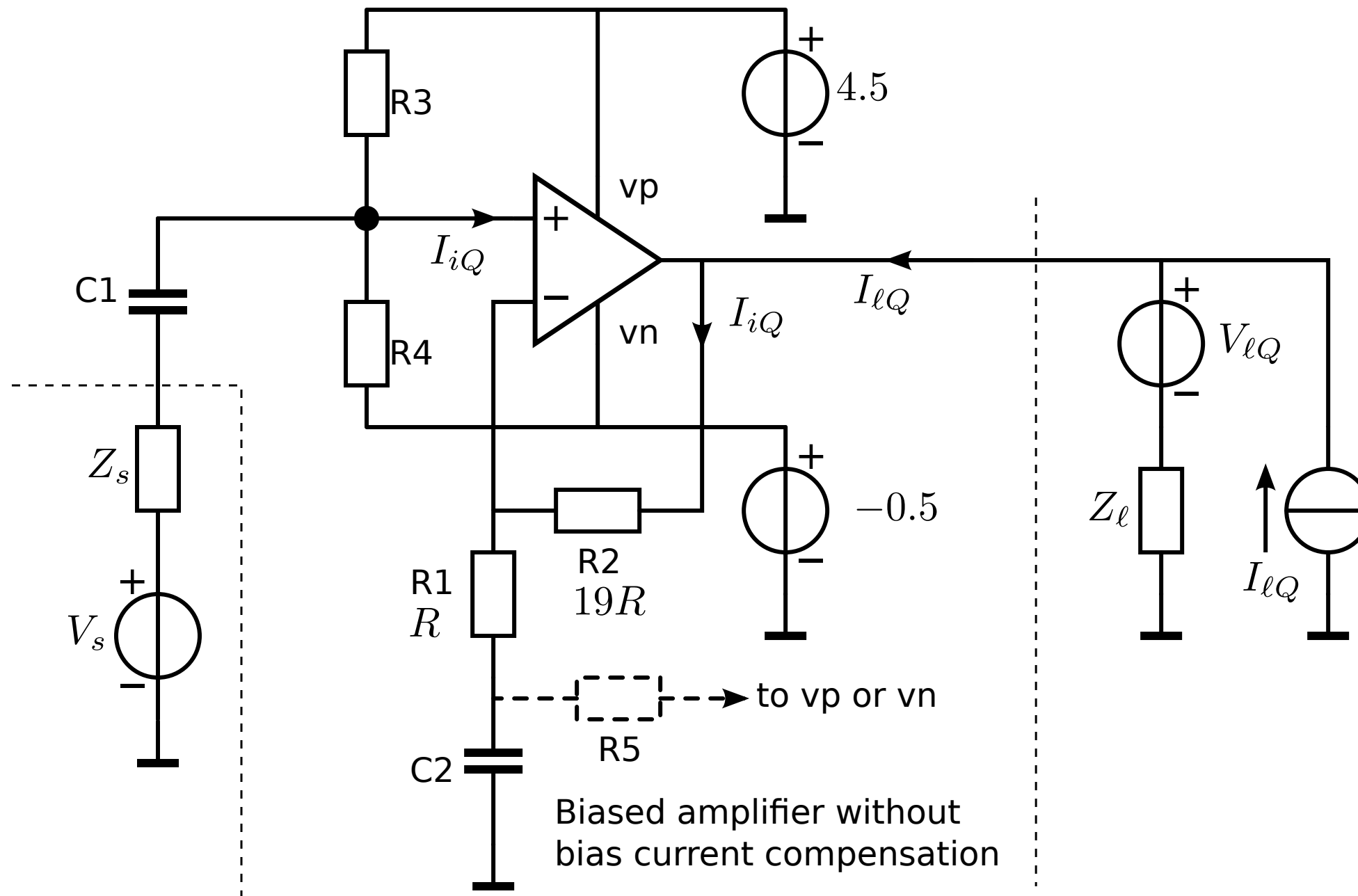
AC coupled amplifier



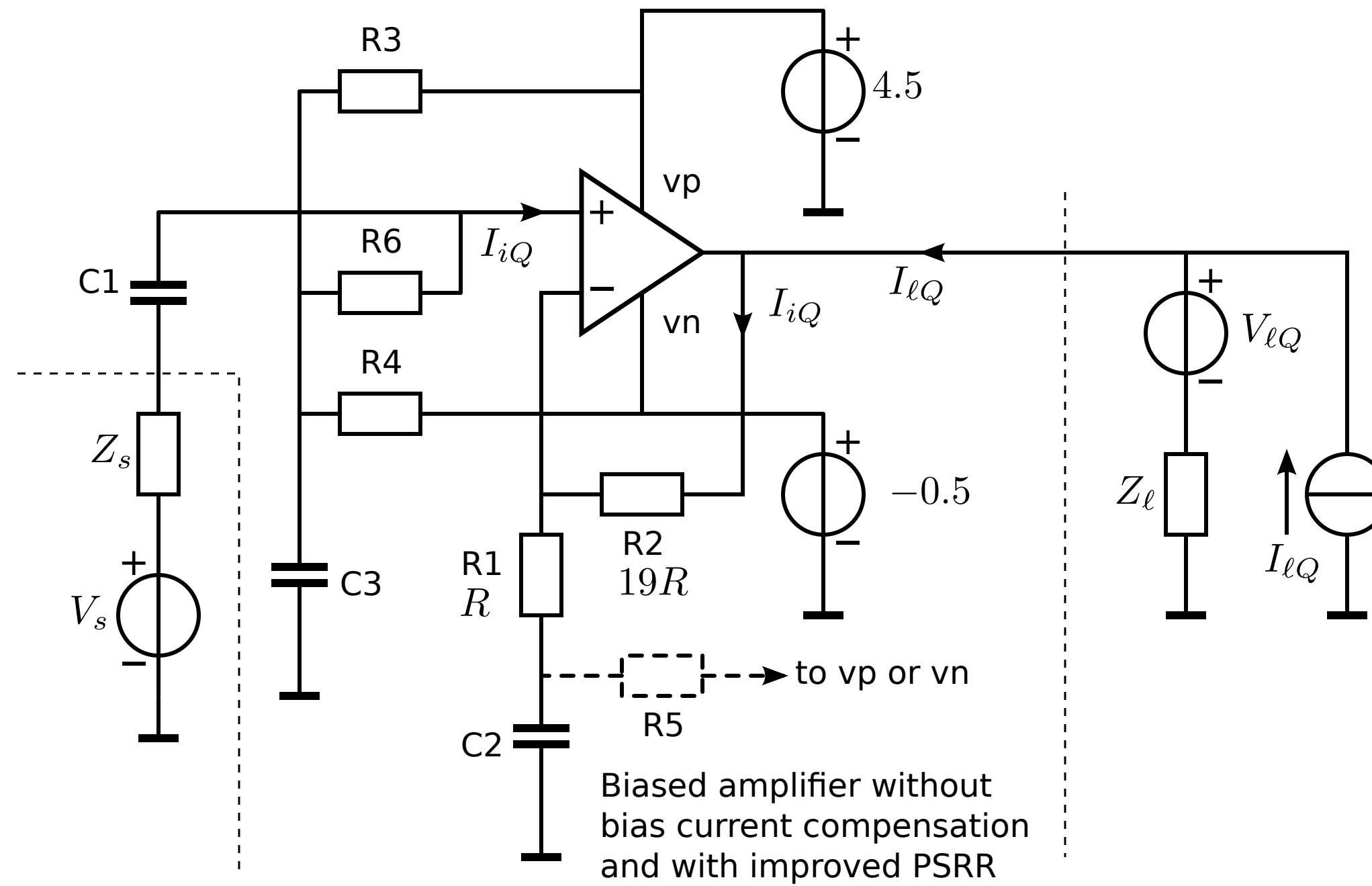
AC coupled amplifier



Biased amplifier

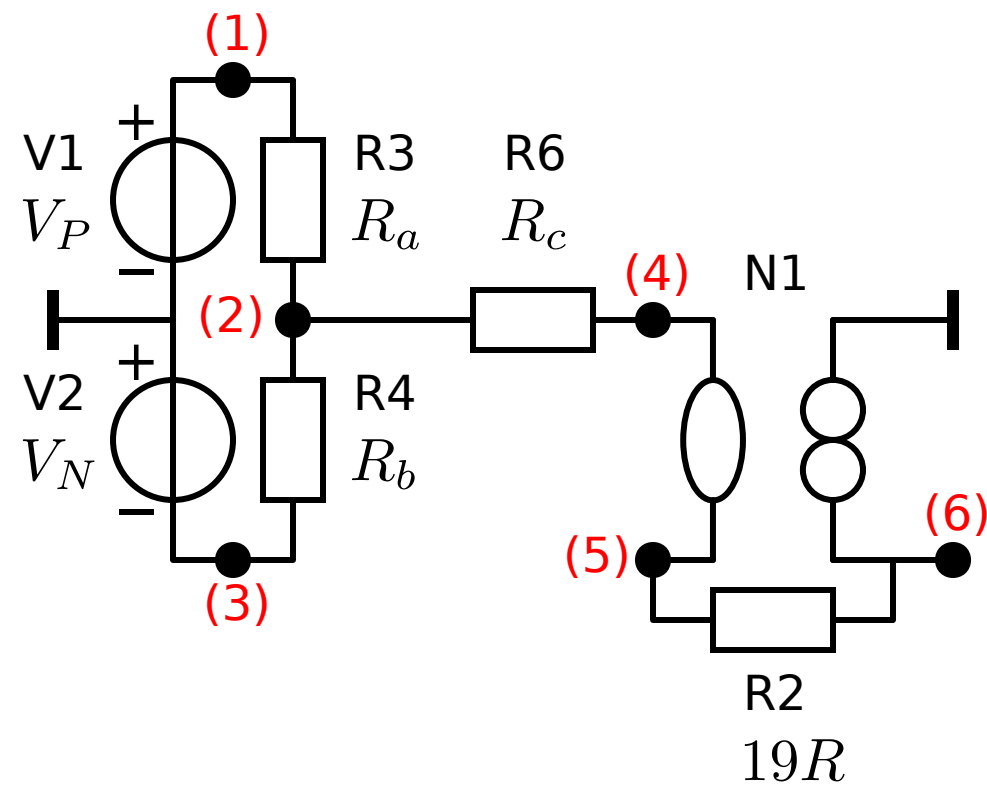


Improved biasing

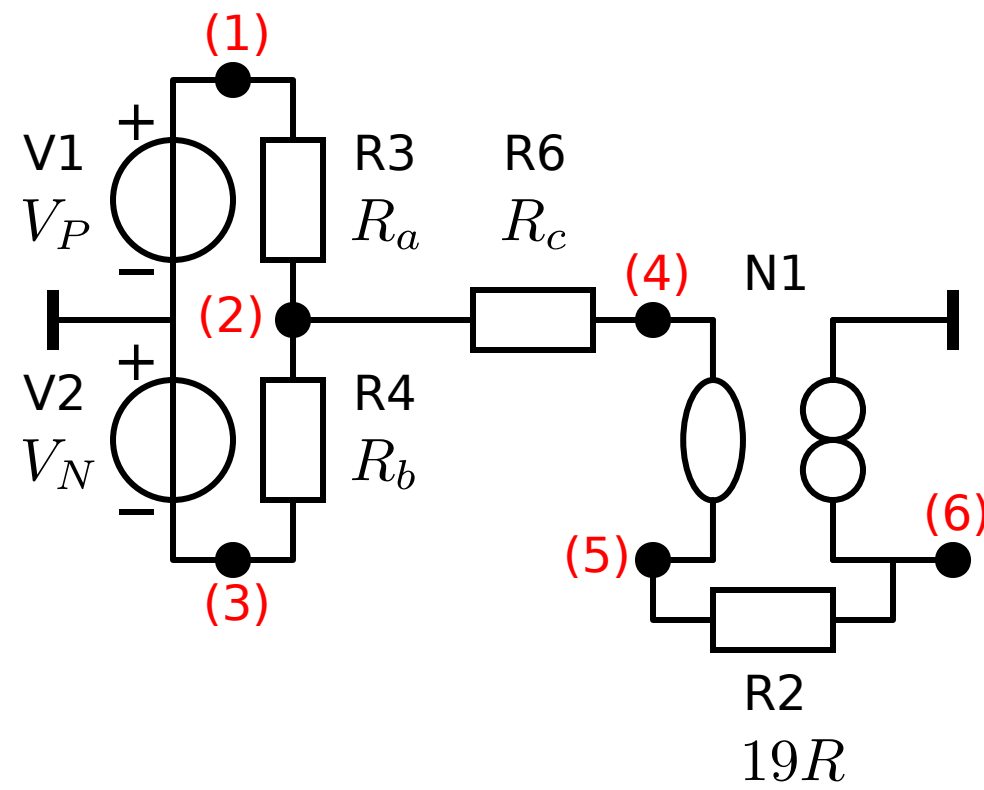


Bias design equations

Bias design equations

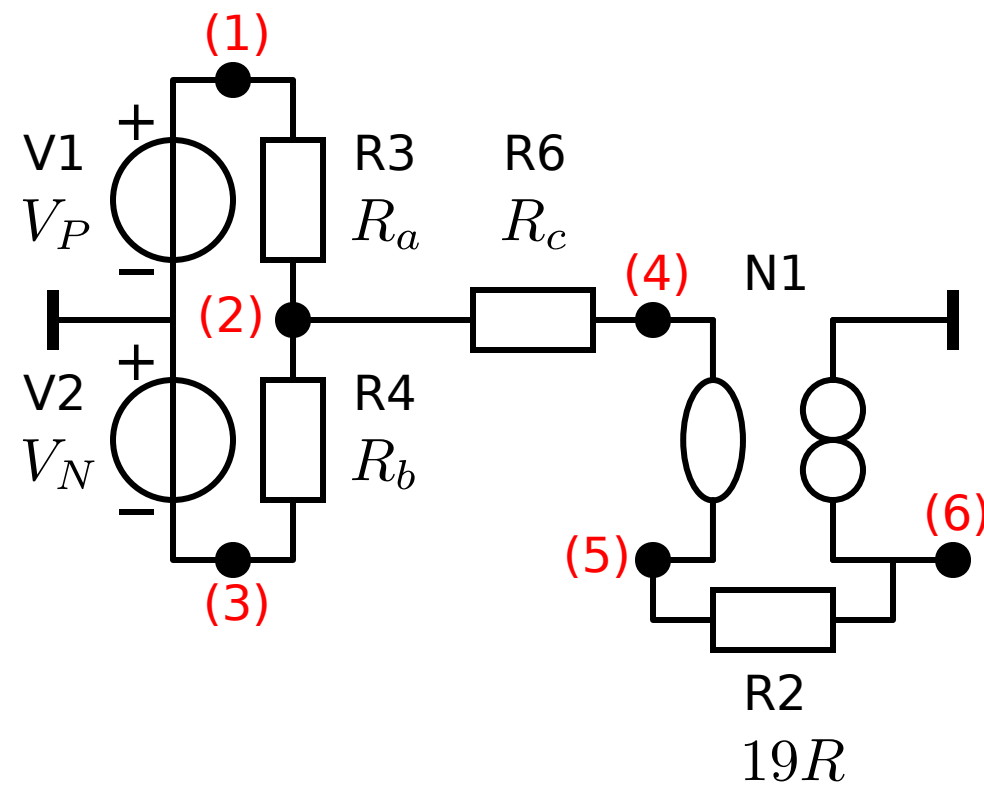


Bias design equations



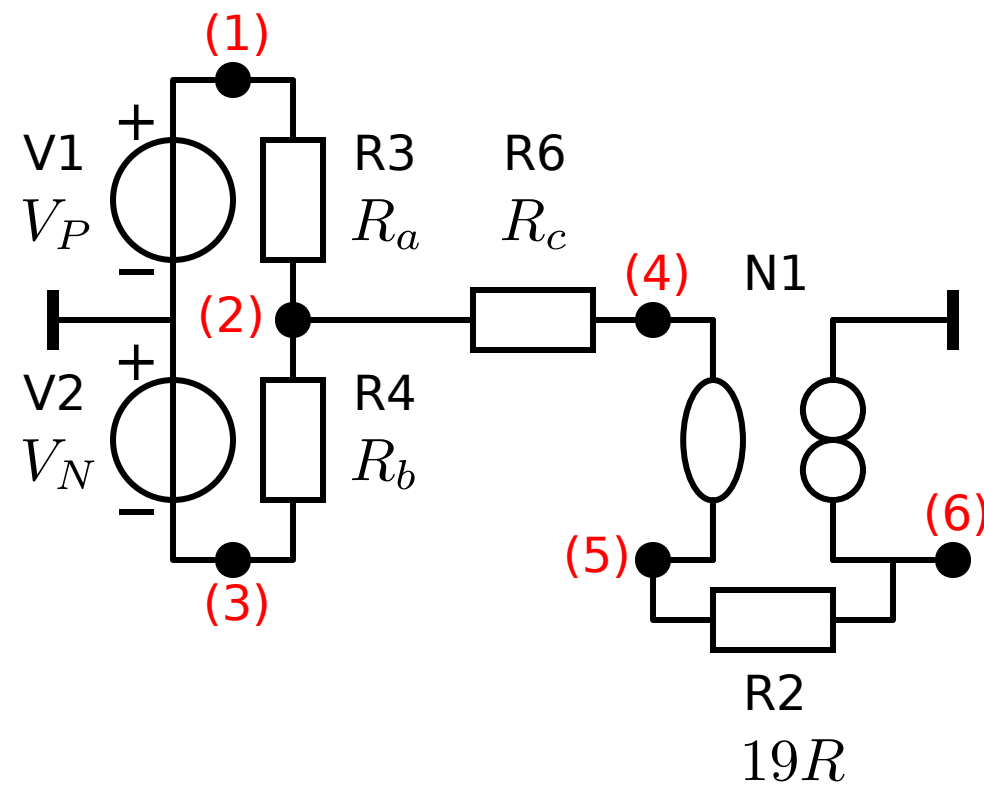
1. DC output voltage at node (6) should be 2V

Bias design equations



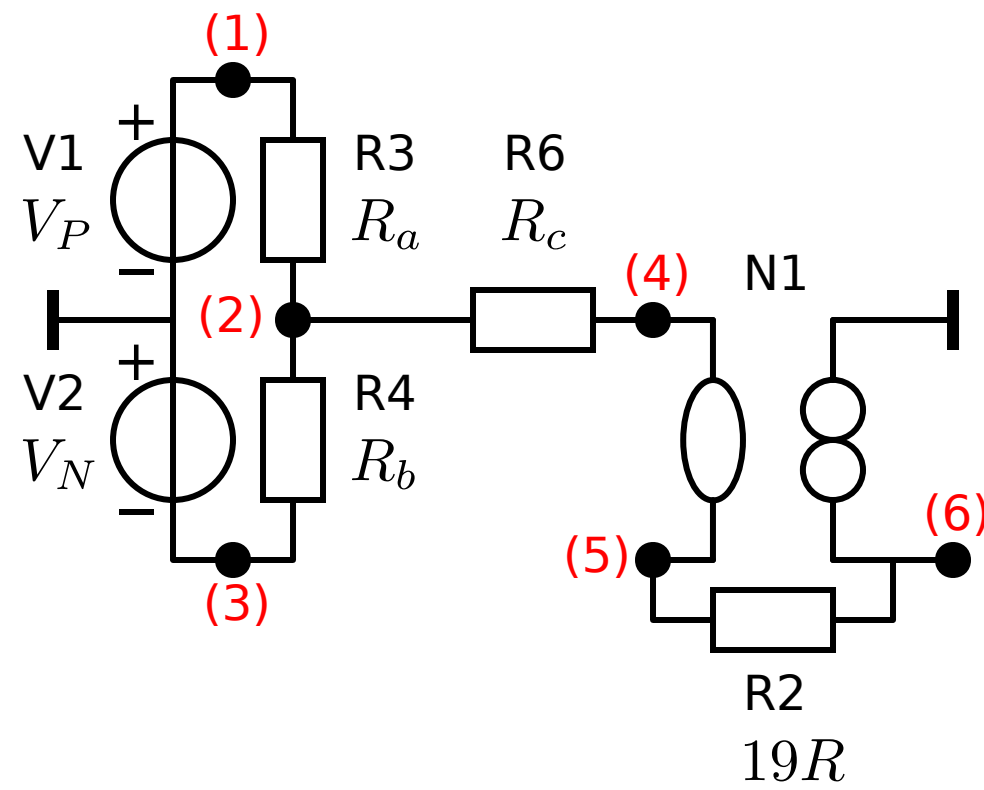
1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:

Bias design equations



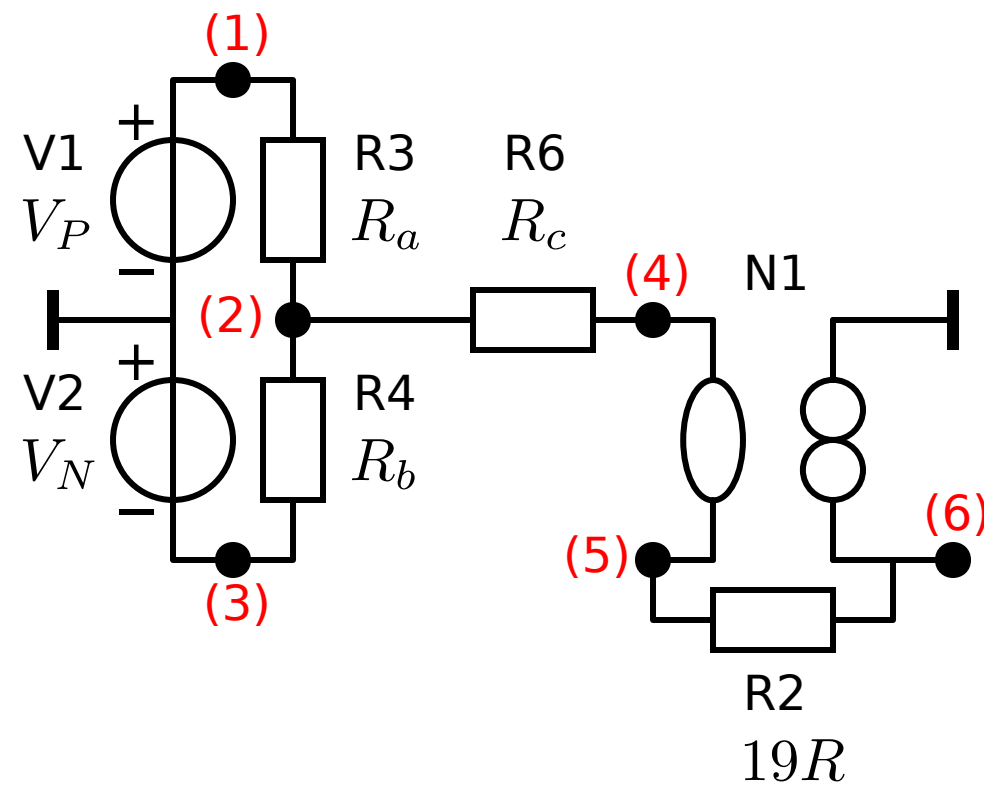
1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:
 - Output voltage range

Bias design equations



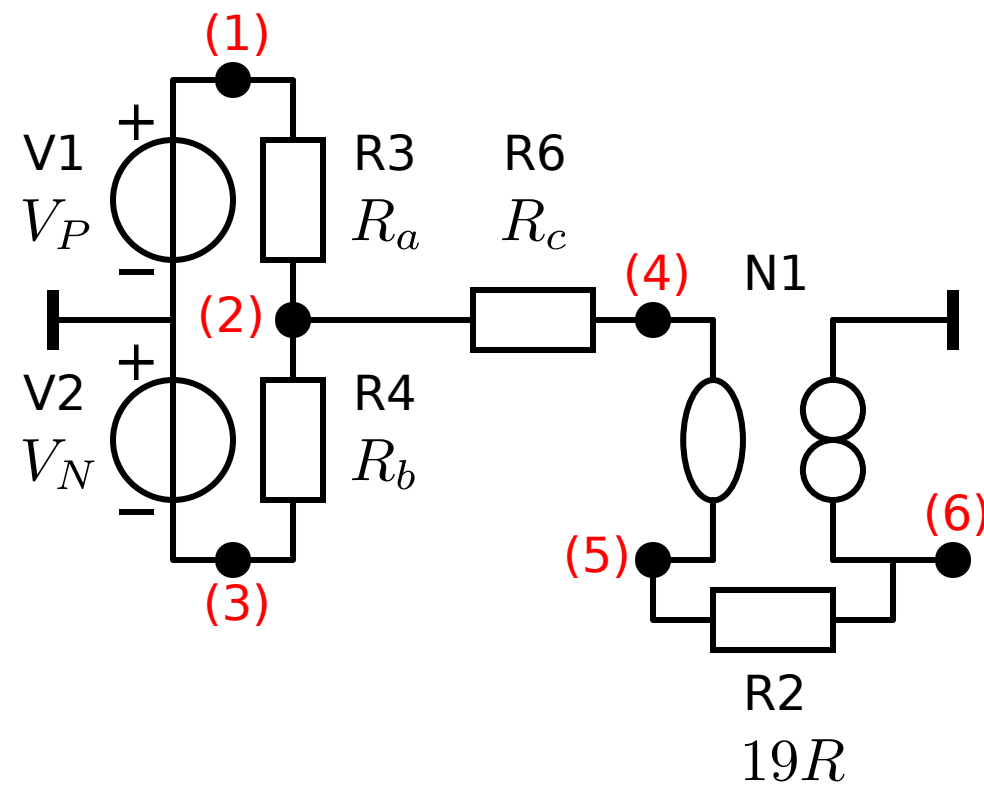
1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:
 - Output voltage range
 - Positive saturation voltage

Bias design equations



1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:
 - Output voltage range
 - Positive saturation voltage
 - Negative saturation voltage

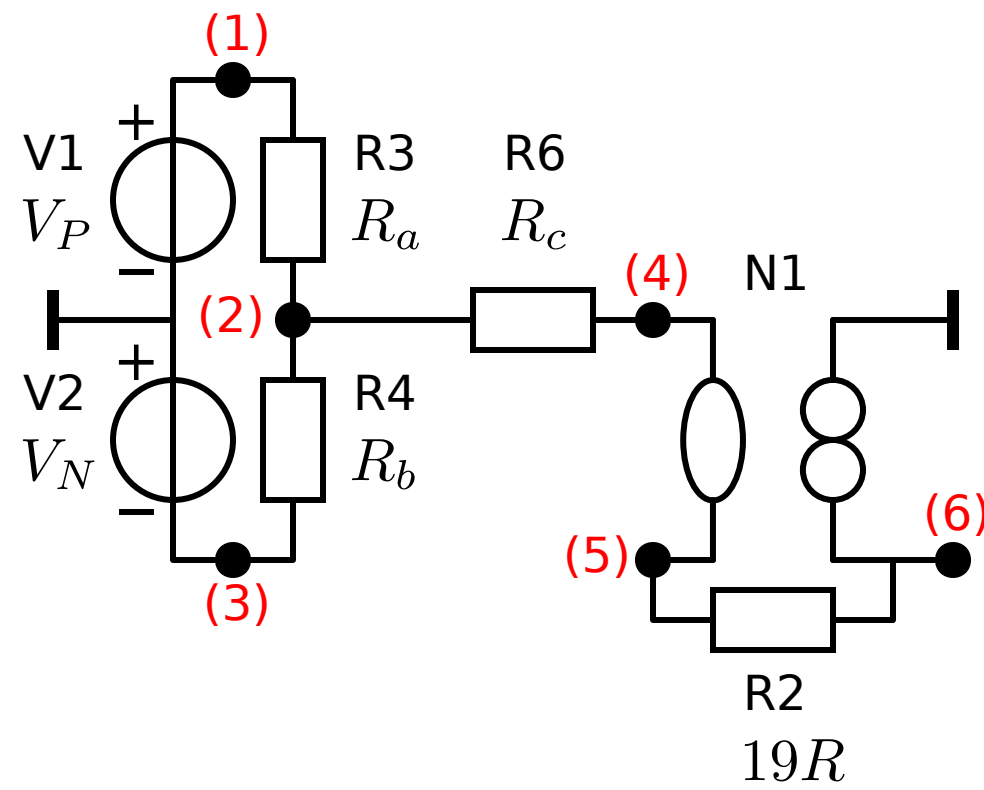
Bias design equations



1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:
 - Output voltage range
 - Positive saturation voltage
 - Negative saturation voltage

$$\frac{R_b}{R_a} = \frac{V_N + V_6}{V_P - V_6}$$

Bias design equations



1. DC output voltage at node (6) should be 2V
2. Supply voltages determined by:
 - Output voltage range
 - Positive saturation voltage
 - Negative saturation voltage

$$\frac{R_b}{R_a} = \frac{V_N + V_6}{V_P - V_6}$$