Welcome To The Audio Workshop

Dr. Arjuna Madanayake – University of Akron
Dr. Makarand Deo- Norfolk State University

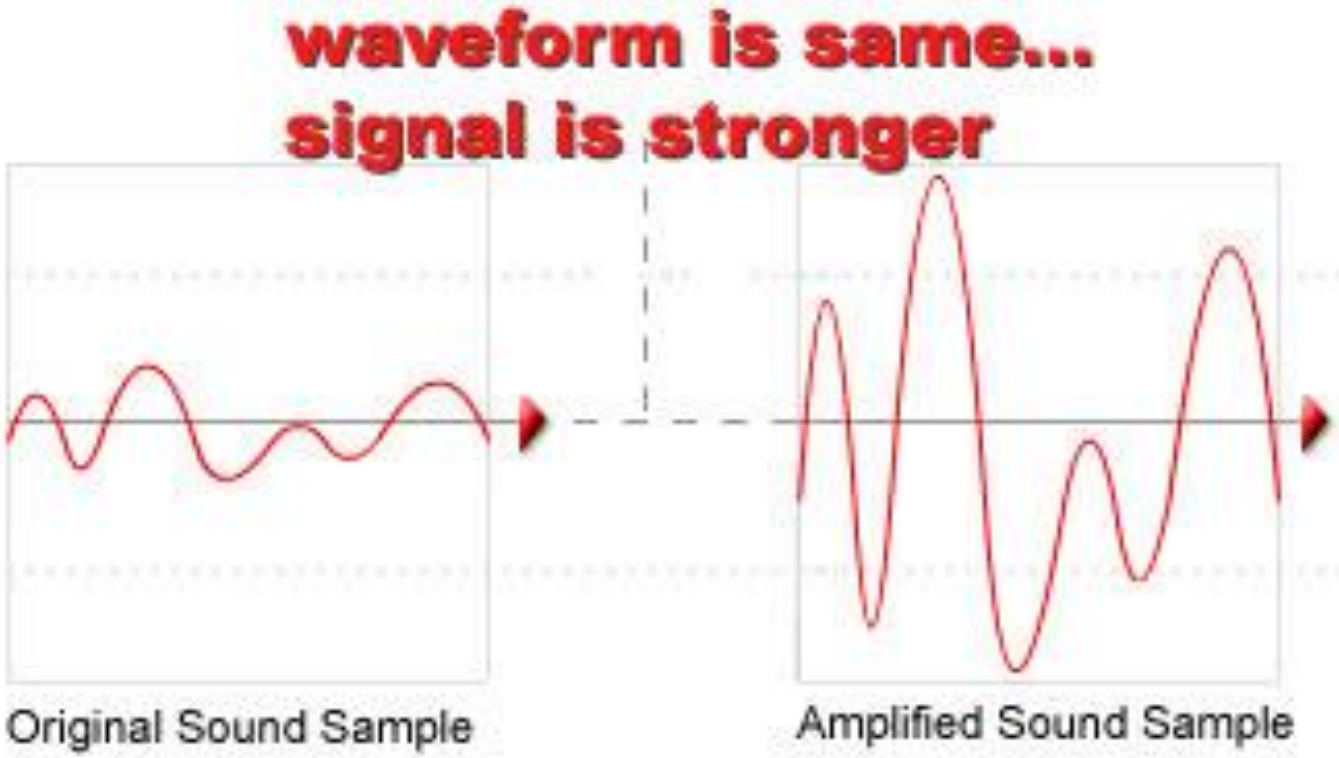
Norfolk State University
9.00 am – Noon

Grant #1247940 EARS: Enhancing Spectral Access via Directional Spectral Sensing…

We are the
Advanced Signal Processing Circuits Group

- Dr. Arjuna Madanayake – Adviser and Principal Investigator
- Sewwandi Wijayaratna - Graduate student
- Arindam Sengupta - Graduate student
- Nilan Udayanga - Graduate student
- DeGrafth palmore - Undergraduate student
- Nathn Dornback - Undergraduate student
- Julia Hariharan – Summer research intern

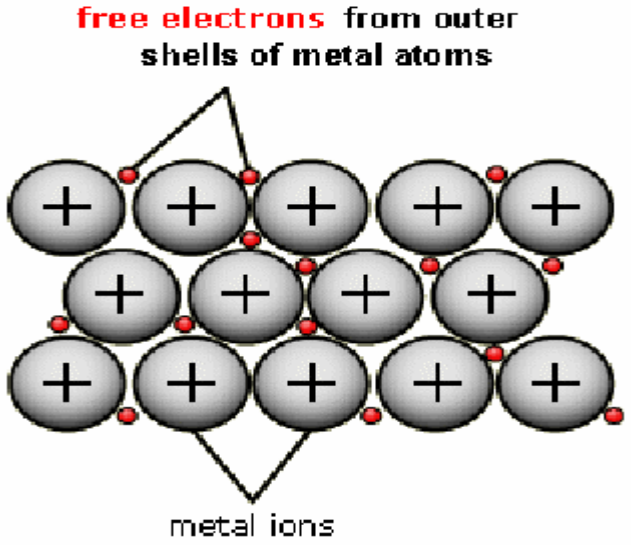
Overview



- Introduction to circuits
- Becoming familiar with components and terms
- Task A: building a power amplifier
- Task B: building a transistor amplifier
- Task C: cascading amplifiers and building a low pass and high pass filter.

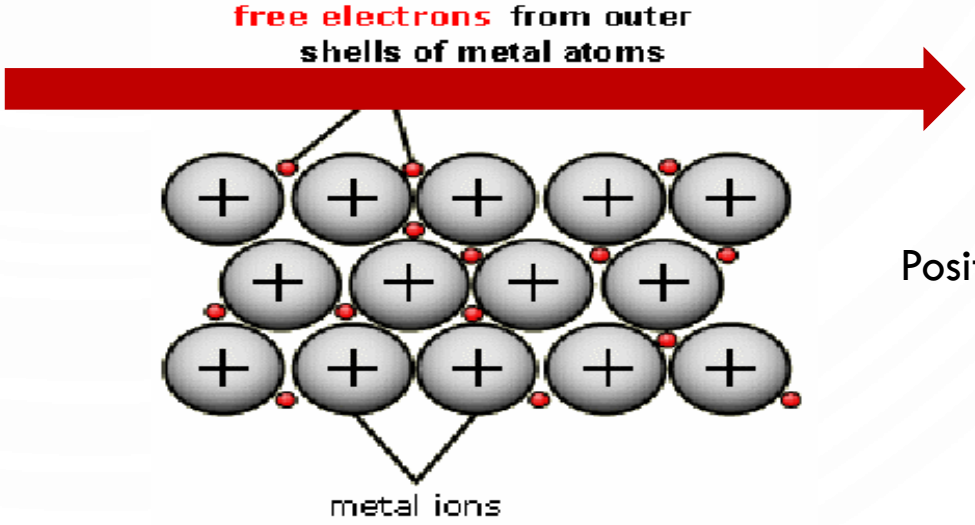
Circuits Fundamentals

- All things are made up of atoms
- Atoms have electrons
- Some have more free electrons than others (Conductors-metals)



like charges repll!

Negative -

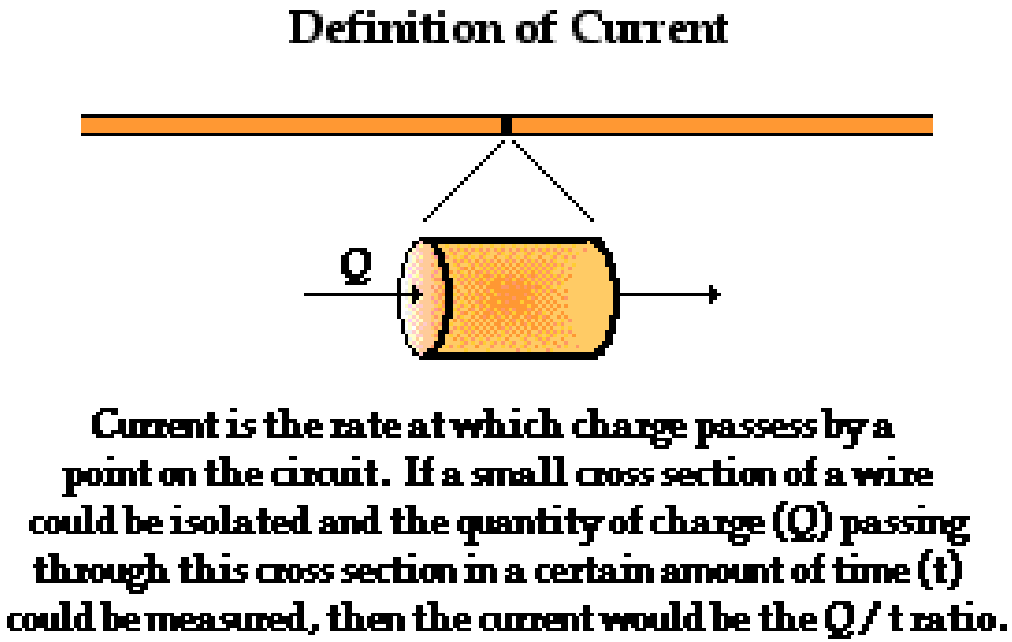


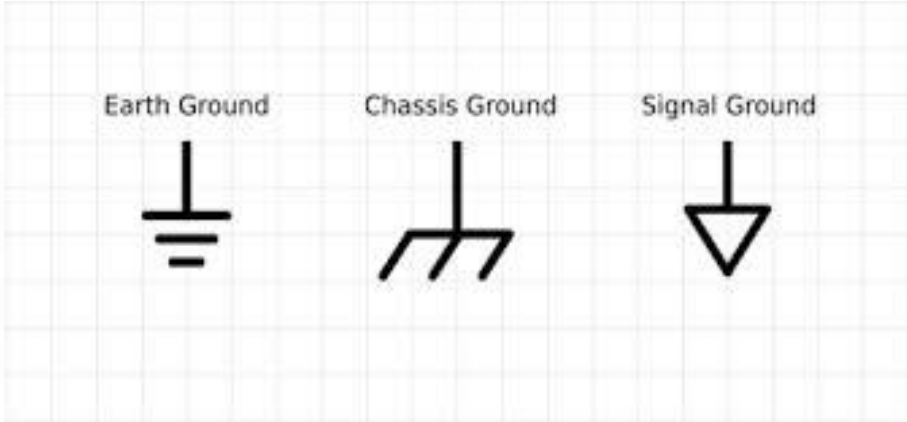
Positive +

Current and Ground

- Current is the flow of electrons
- Conventionally, current moves from positive to negative
- It is measured in Amperes (A)

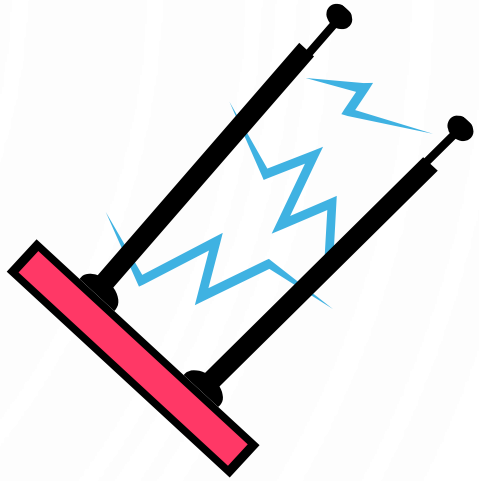
- Ground is the negative side of the battery
- It lets you complete the circuit
- Ground in circuit diagram looks like

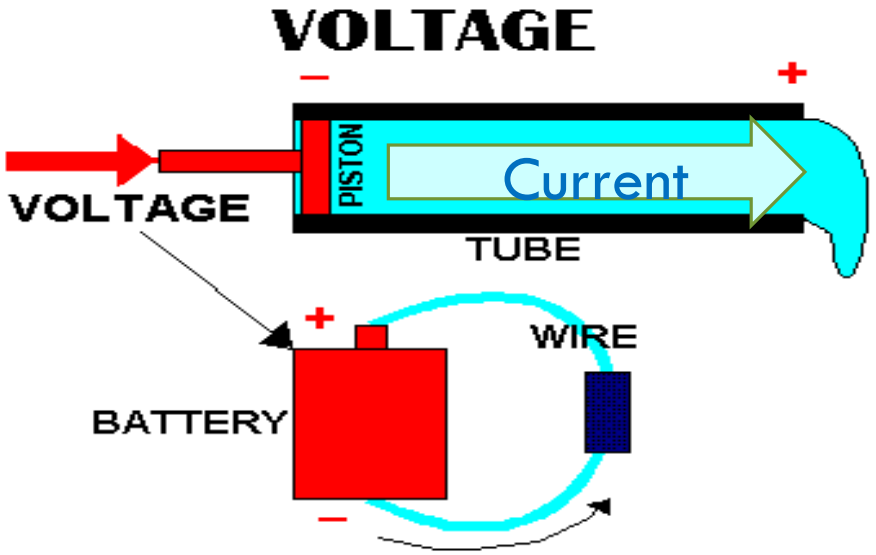




Voltage

- Voltage makes the electrons move
  - Don't confuse it with current
- It is measured in Volts (V)
- It pushes the current though a conductor



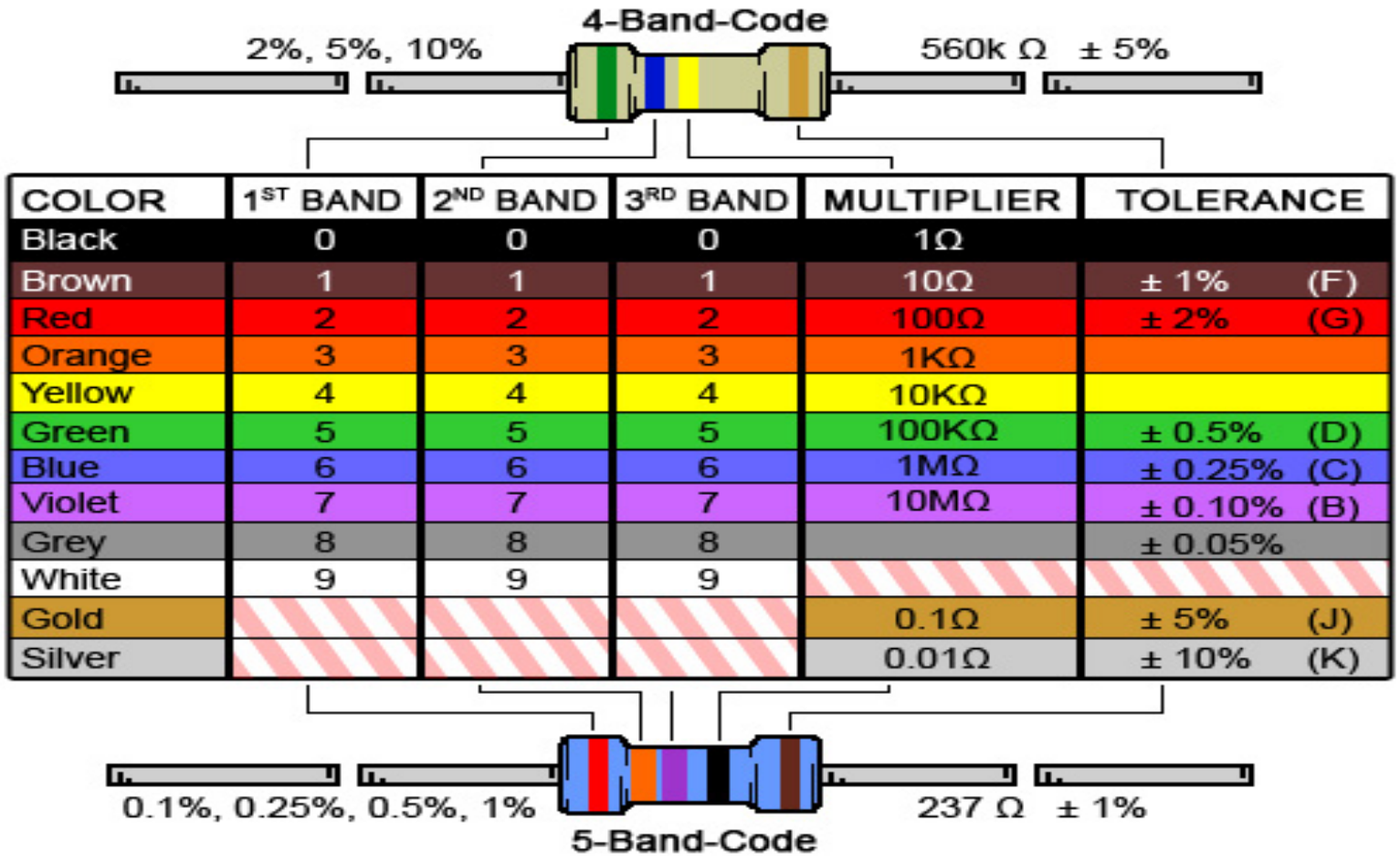


Resistors

- Resistors are components that work to reduce current flow within circuits as well as to lower voltage levels through a process known as resistance
- Resistor values are measured in Ohms Ω

Resistor Color Code

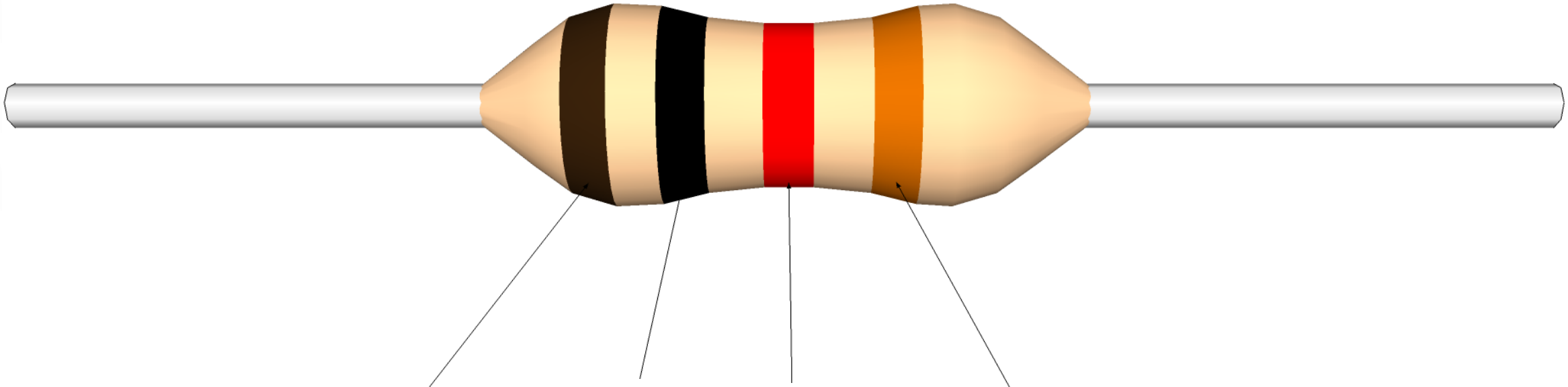
To tell the value of each resistor you can use the resistor color coding system.



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8		± 0.05%
White	9	9	9		
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

Color Coding Example

Resistor color codes: an example (a 1-kilohm 5% tolerance resistor)



1st band	2nd band	3rd band	4th band
Brown = 1	Black = 0	Red = 3	gold = 5%

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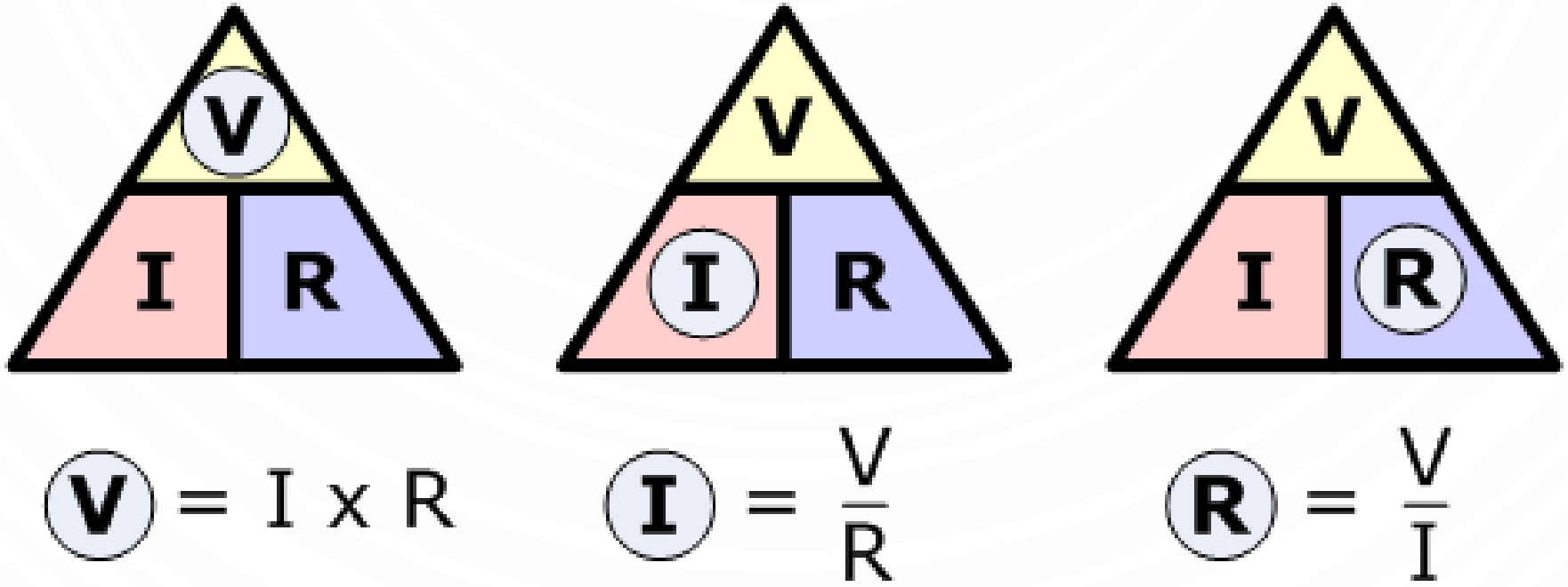
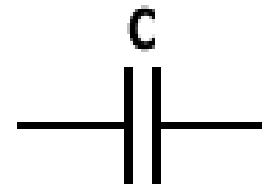
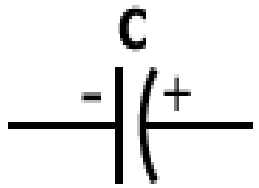
Ohm's Law

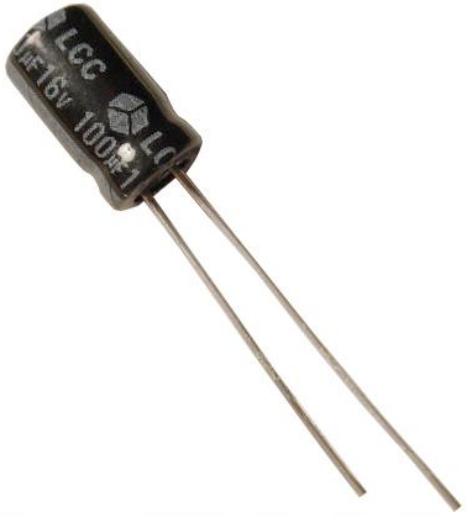
- When learning about circuits, it is important to understand the relationship between voltage, current, and resistance.



Capacitors

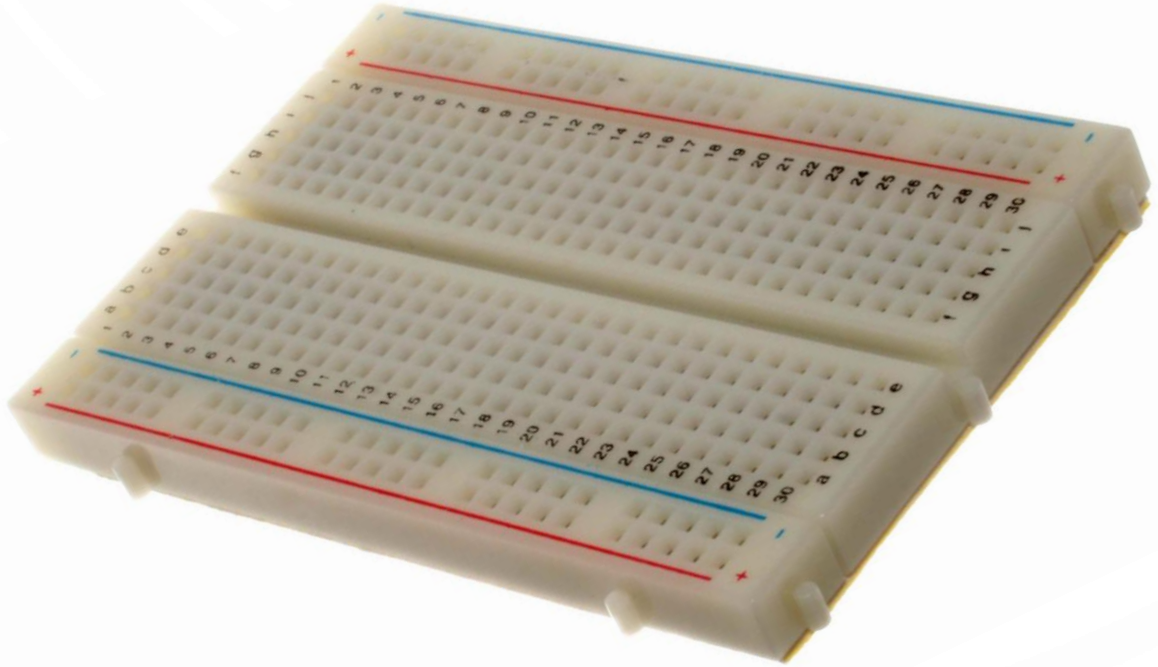
- A capacitor is a two terminal electric component that stores energy electrostatically in an electric field.

Capacitor schematic symbols:	
	
Non-Polarized Capacitors	Polarized Capacitors



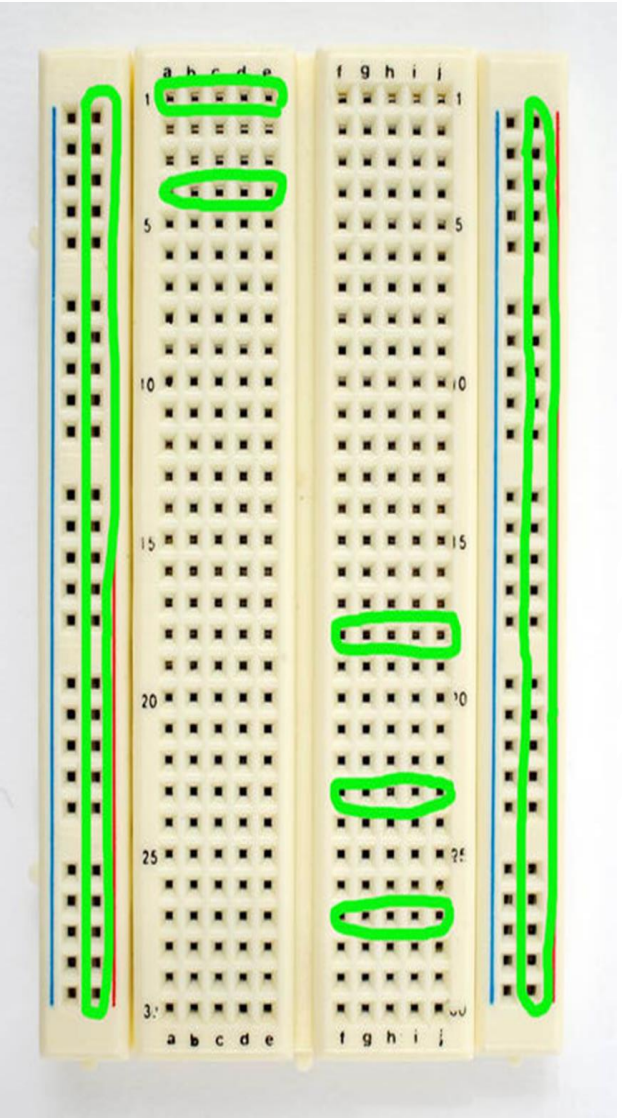
Breadboards

- A breadboard is the construction base for prototyping electronics.
- It allows you to make electronic connections and build circuits.
- We will be using breadboards as the base for all of our tasks today.

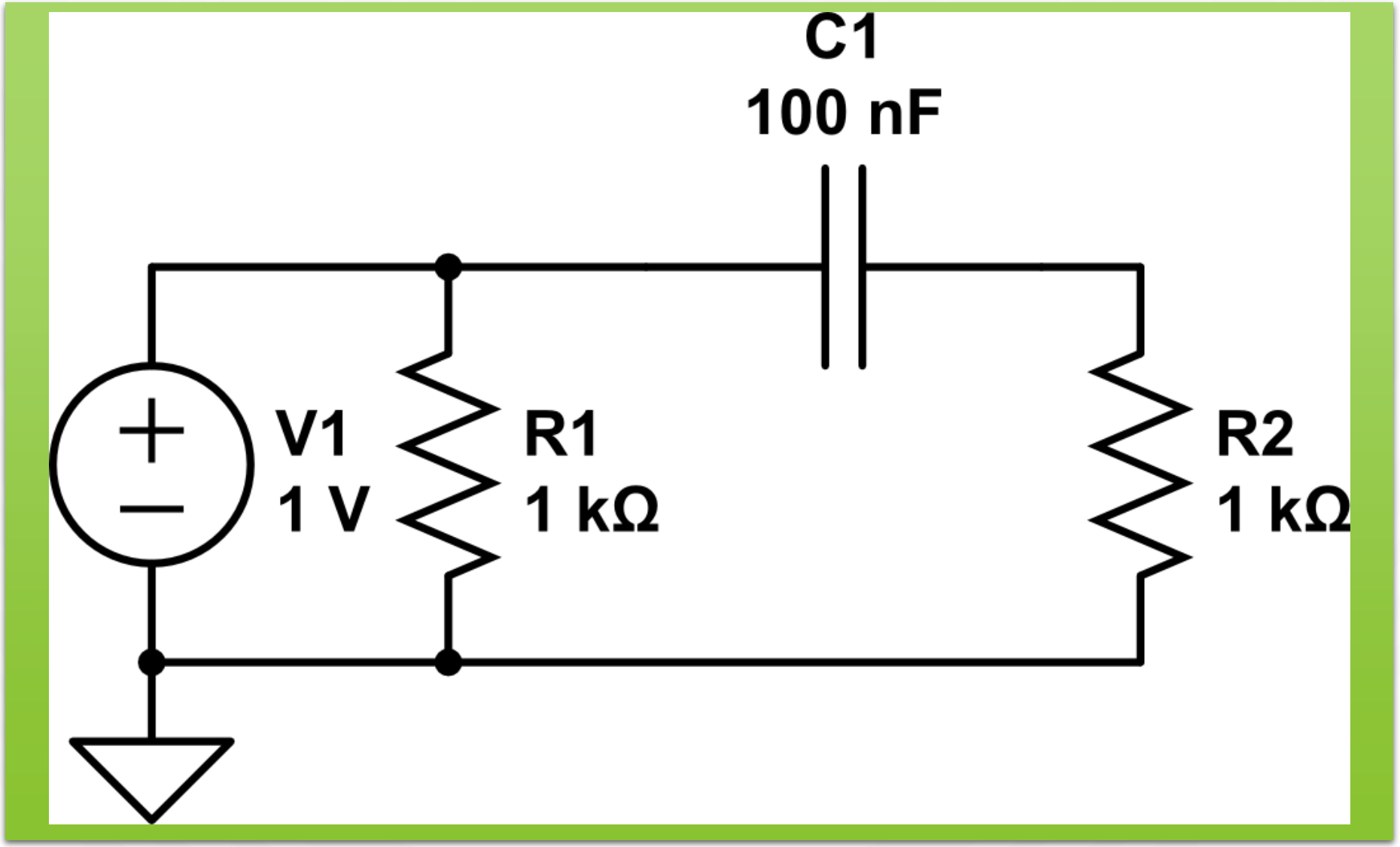


Breadboards

- The columns in the center of the breadboard are connected horizontally
- The gap in the center separates the columns from connecting
- The negative column (blue) represents ground
- The positive column (red) represents voltage



Let's try few examples…



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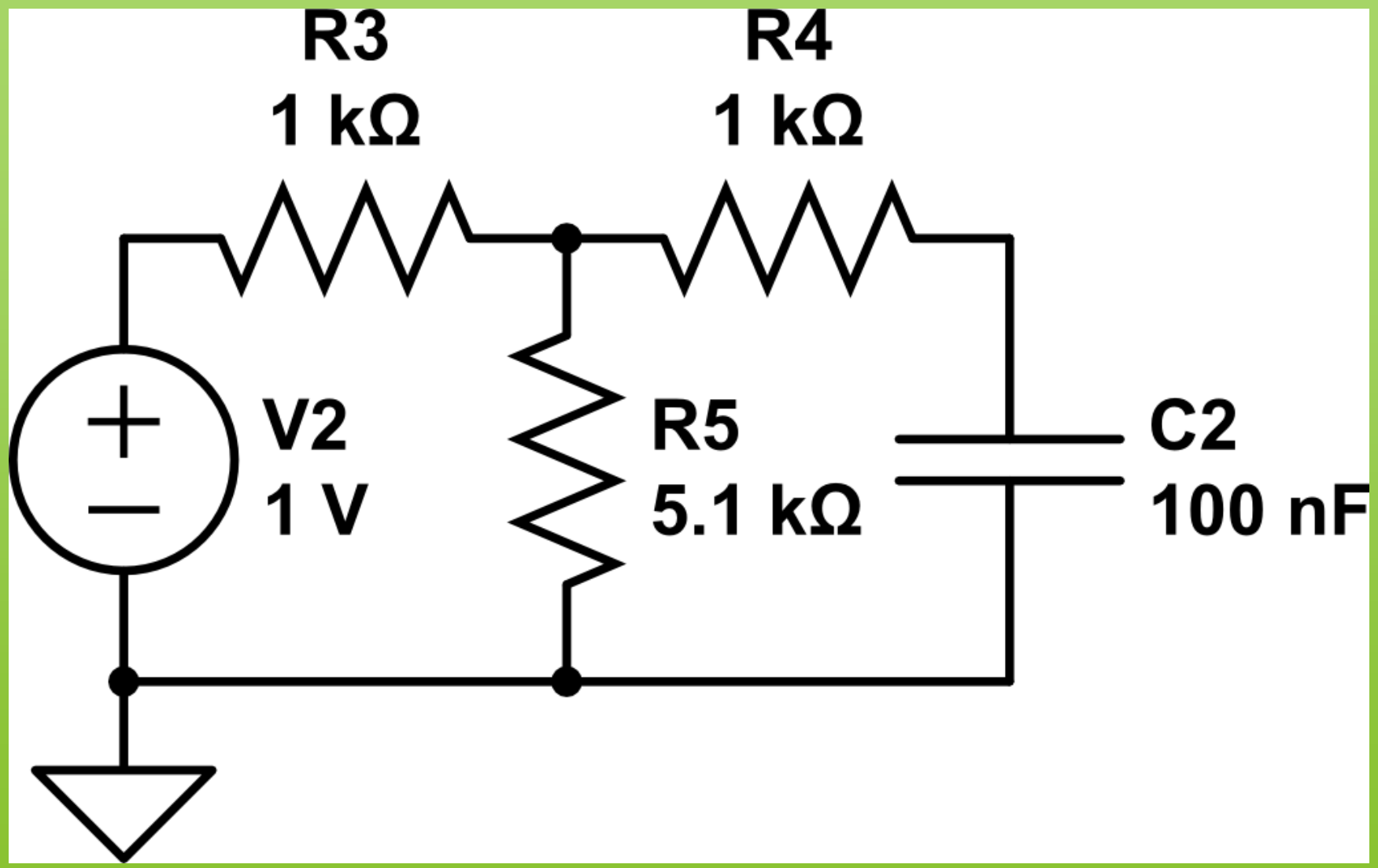

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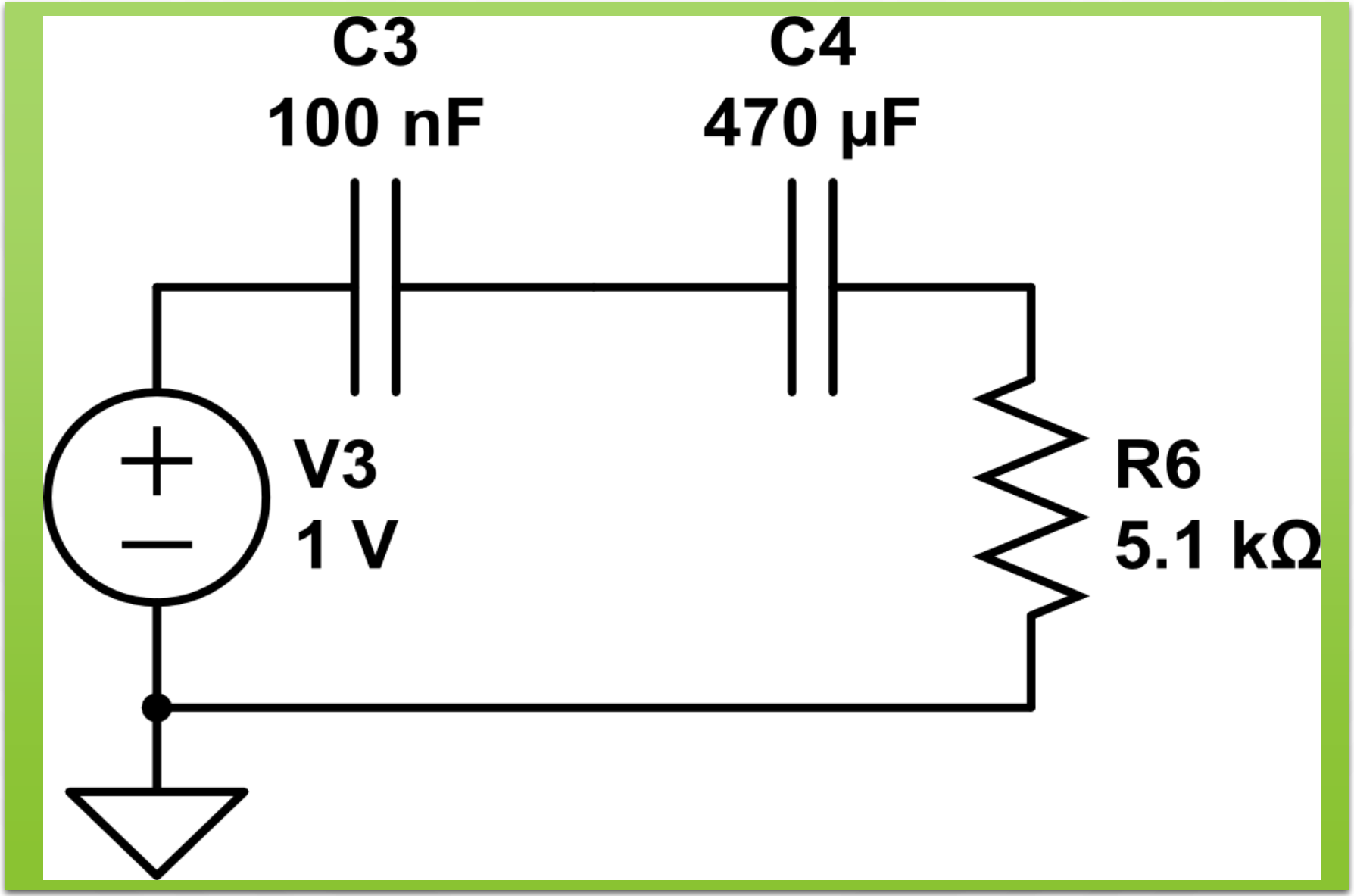
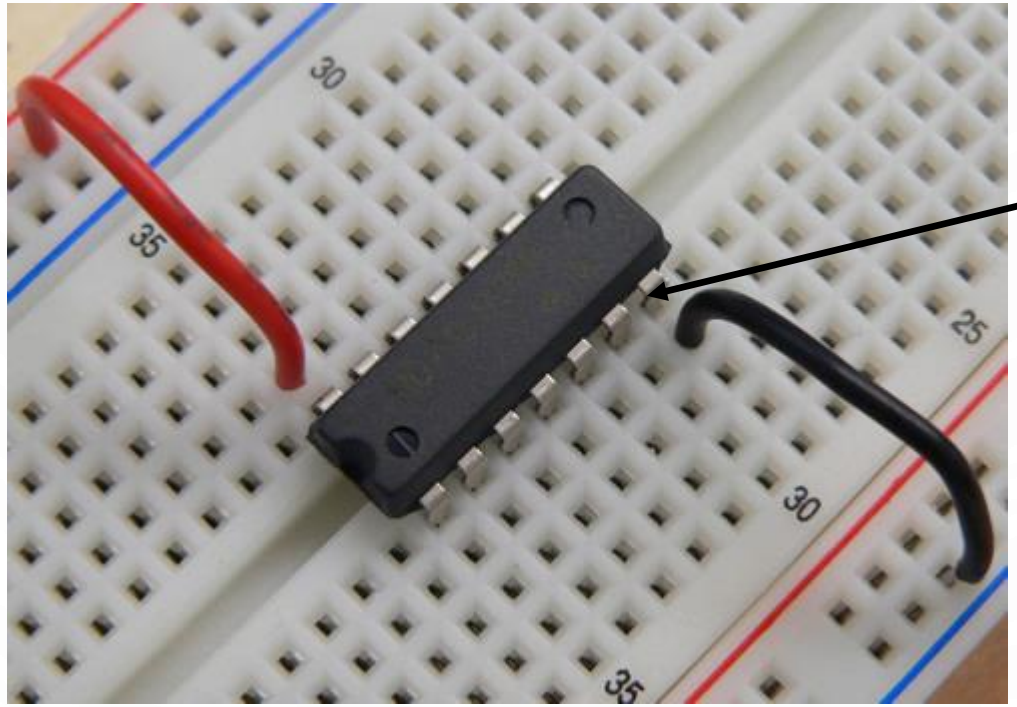
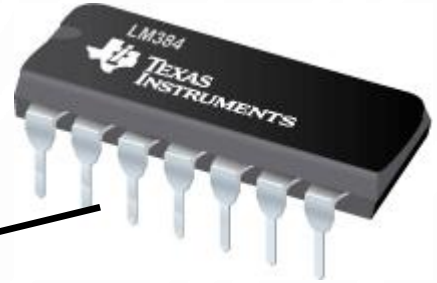


Task A: Building a Power Amplifier

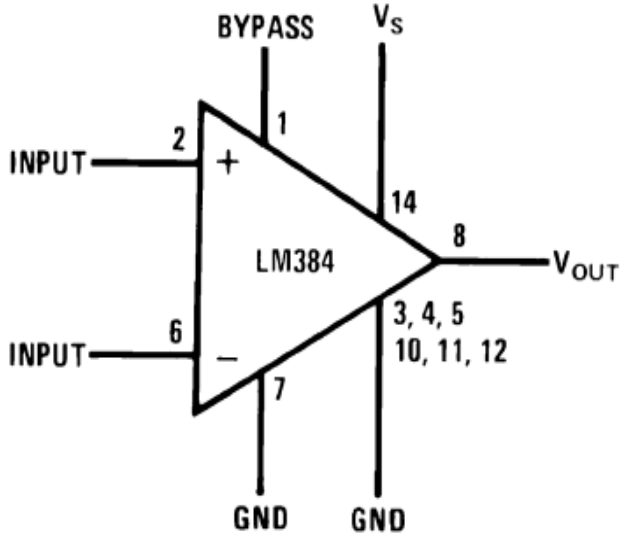
- An **integrated circuit** (IC) has many components built into it.
- ICs can be placed on breadboards.

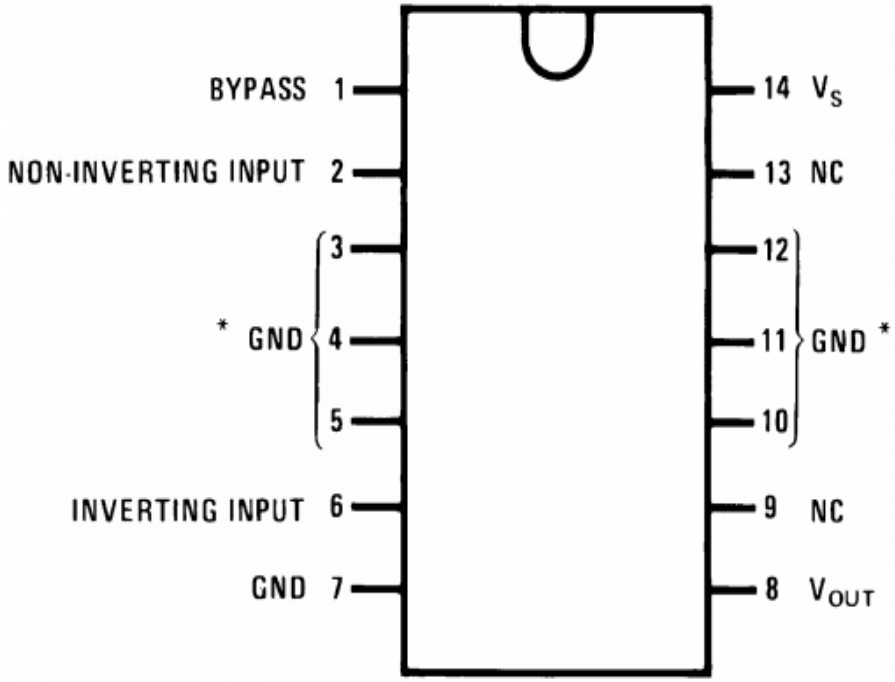




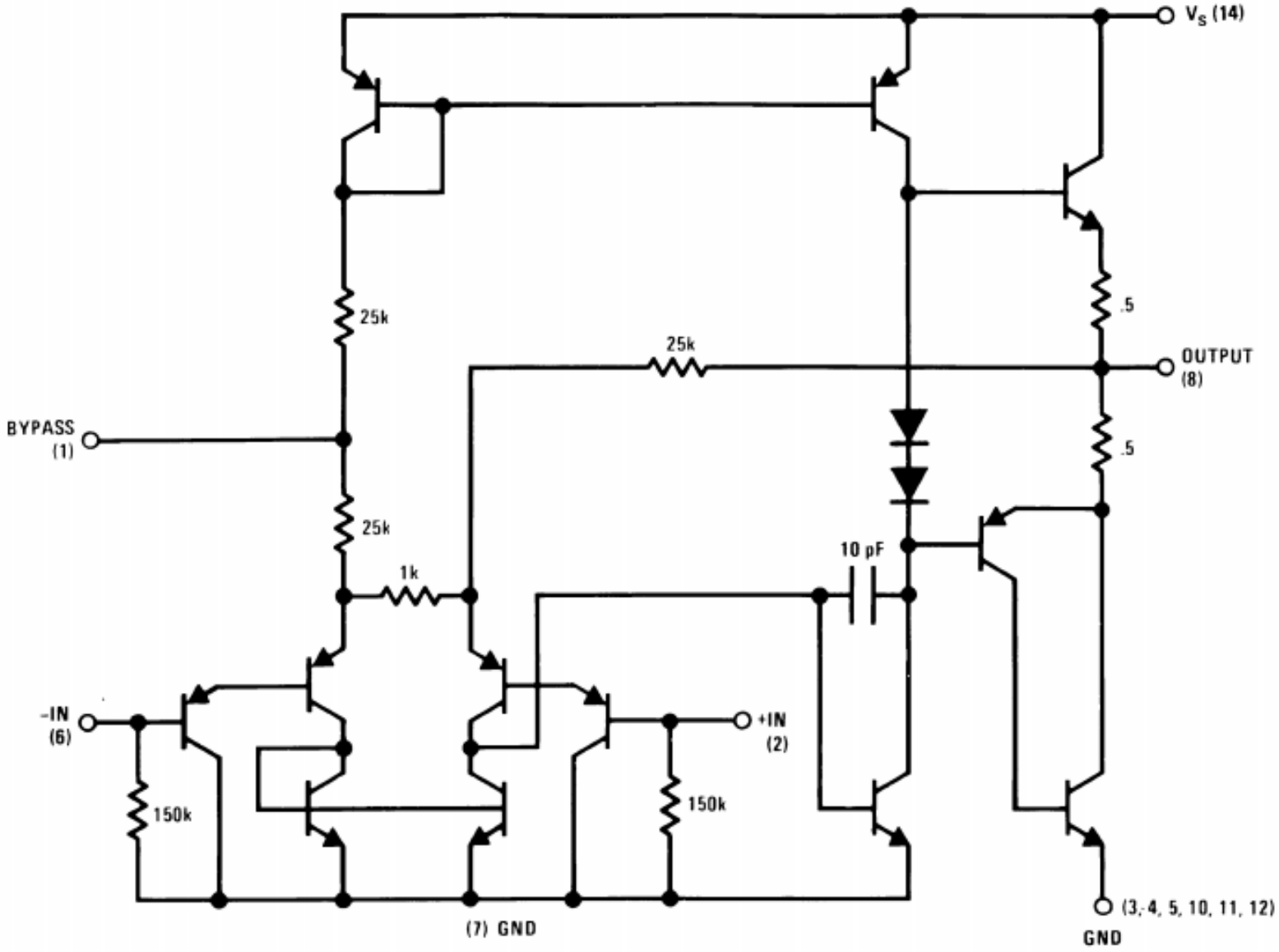
Task A: Building a Power Amplifier

- ICs have special circuit diagram symbols and pin diagrams





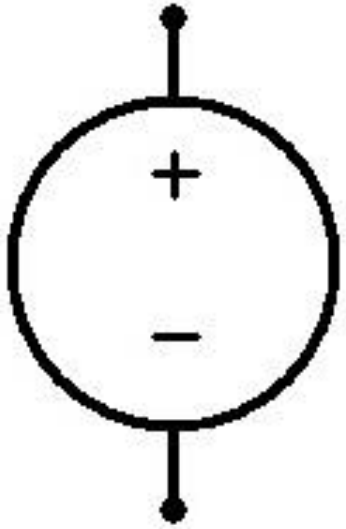
What's Really Inside the LM384



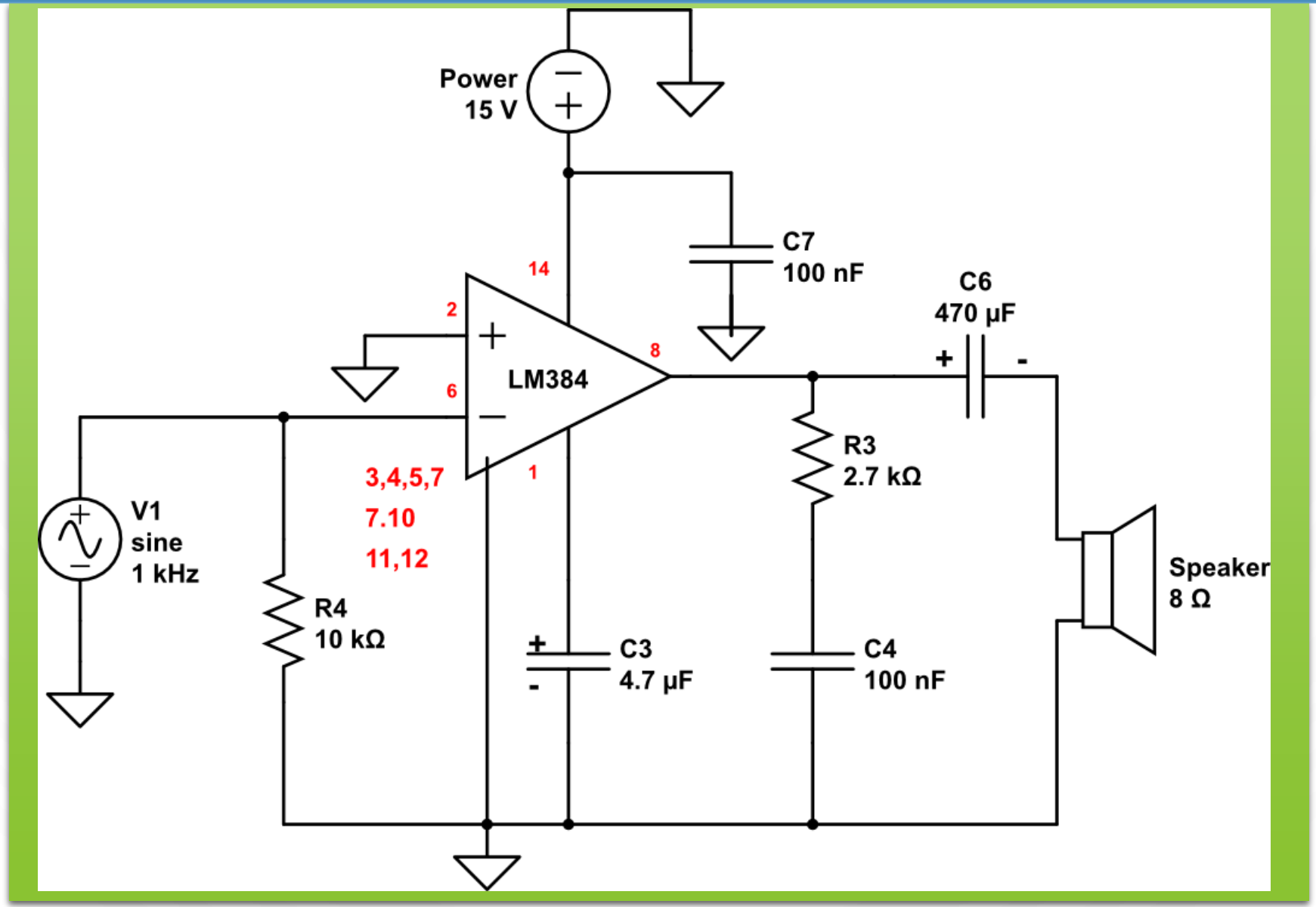
Task A: Building a Power Amplifier

- The LM384 requires an additional voltage source to operate. This is called the **supply voltage**.
- Extra voltage is supplied by a power supply.

Symbol for a voltage source



Power Amplification Circuit Diagram



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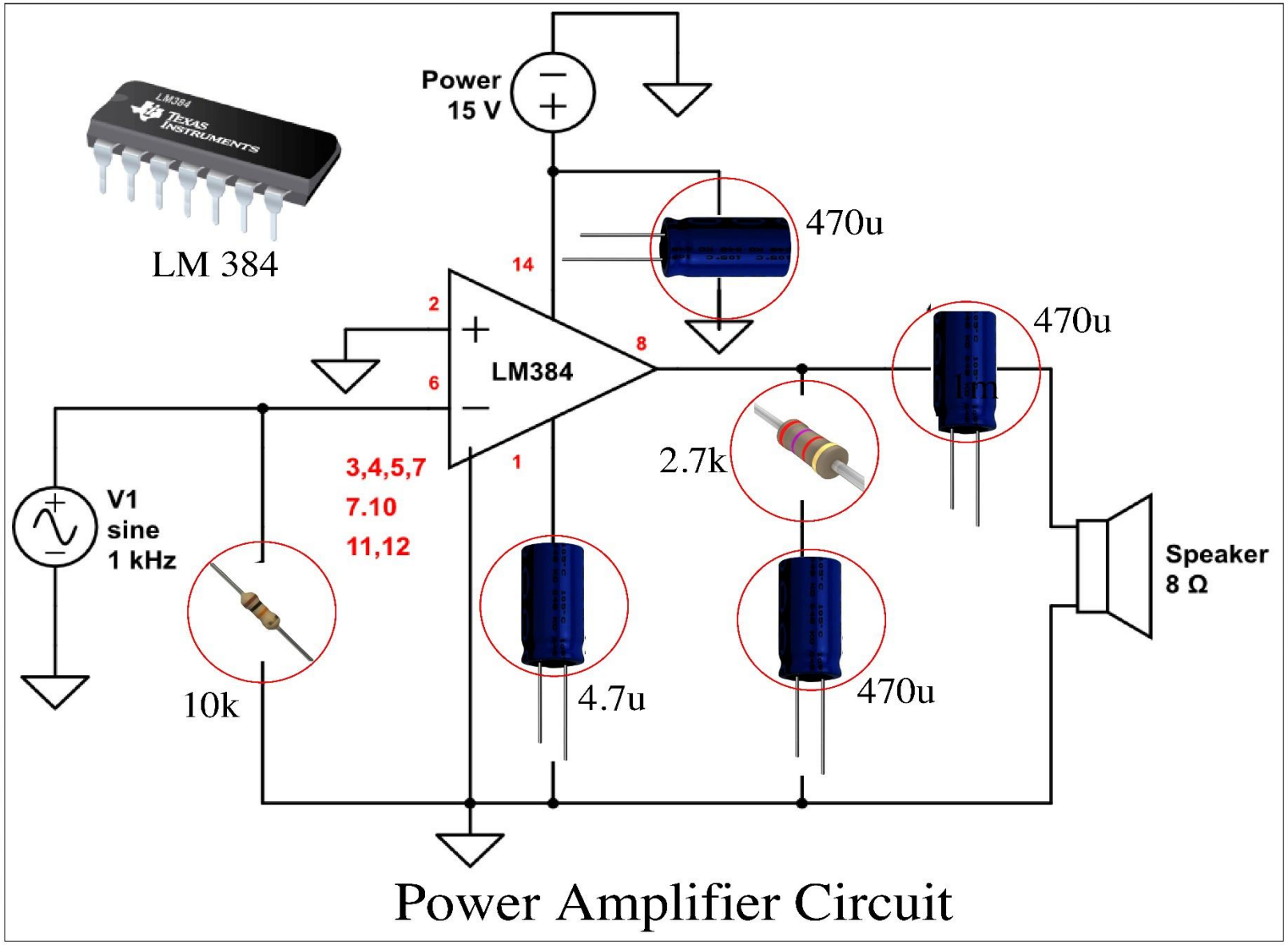
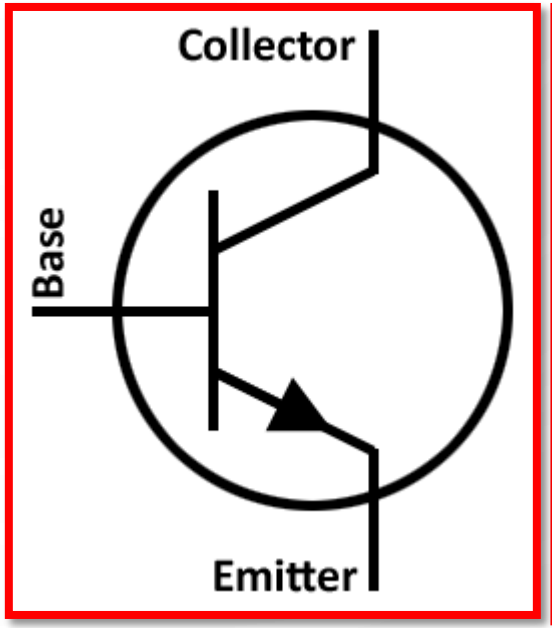


Transistor Amplifier

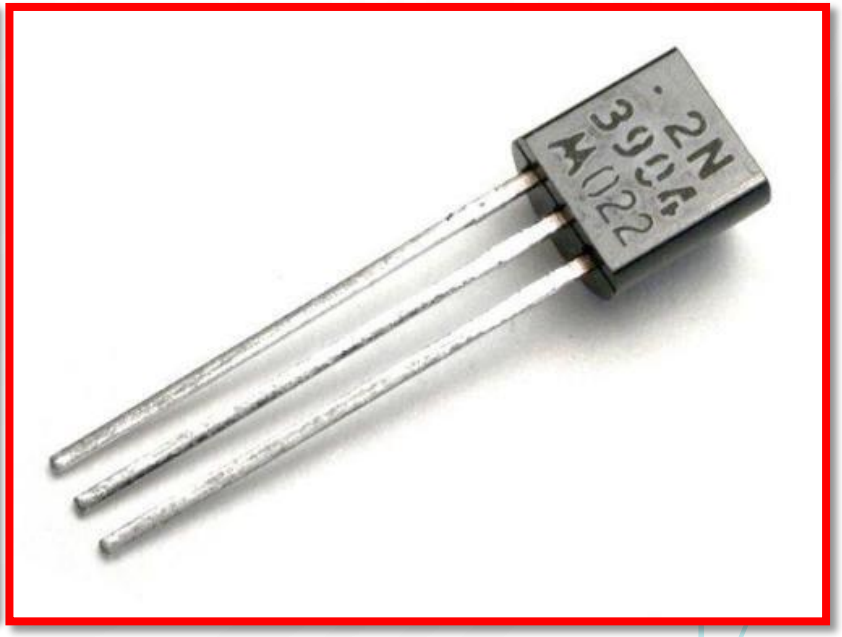
- Transistor is a fundamental electronic component which is mainly used in electronic circuits to
  - Amplify and
  - Switch

  signals and electric current.

- Consists with three terminals,
  - Base
  - Emitter
  - Collector



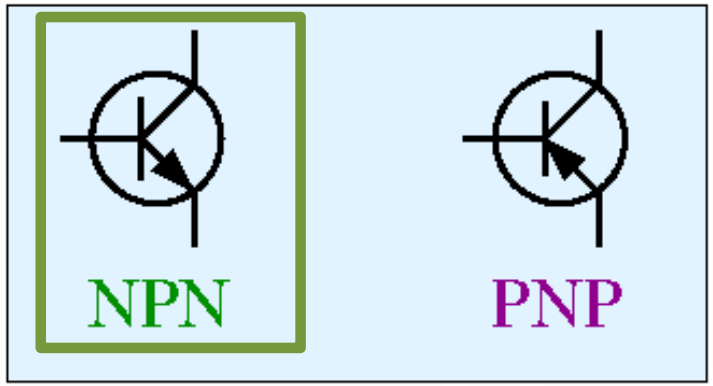
Transistor circuit symbol



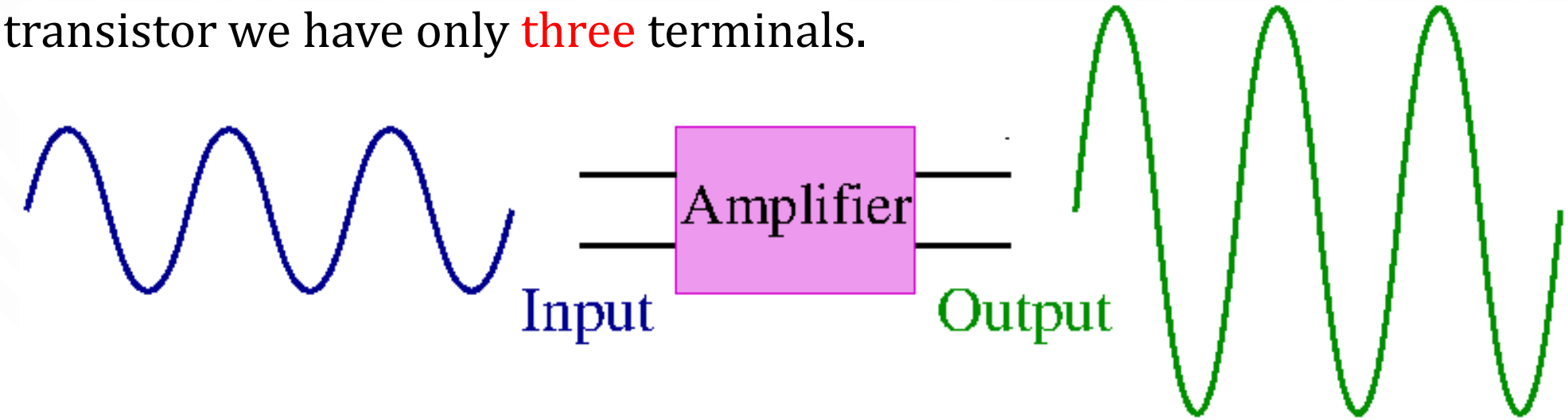
Transistor actual

Transistors

- Two types of Transistors,
  - ❖ NPN and PNP.
  - ❖ NPN transistors are used in our design.

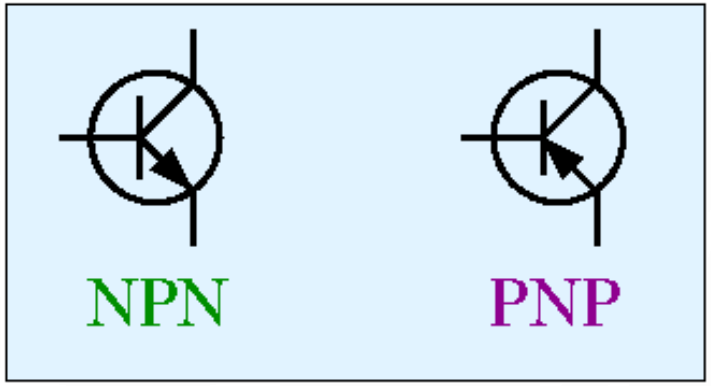


- Amplifier needs two pins for the input and two pins for the output. But in transistor we have only three terminals.

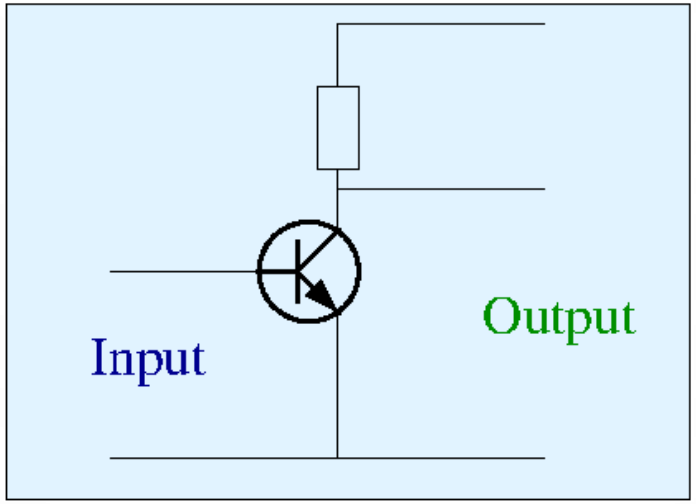


Transistors

- Two types of Transistors,
  - ❖ NPN transistors are used in our design.

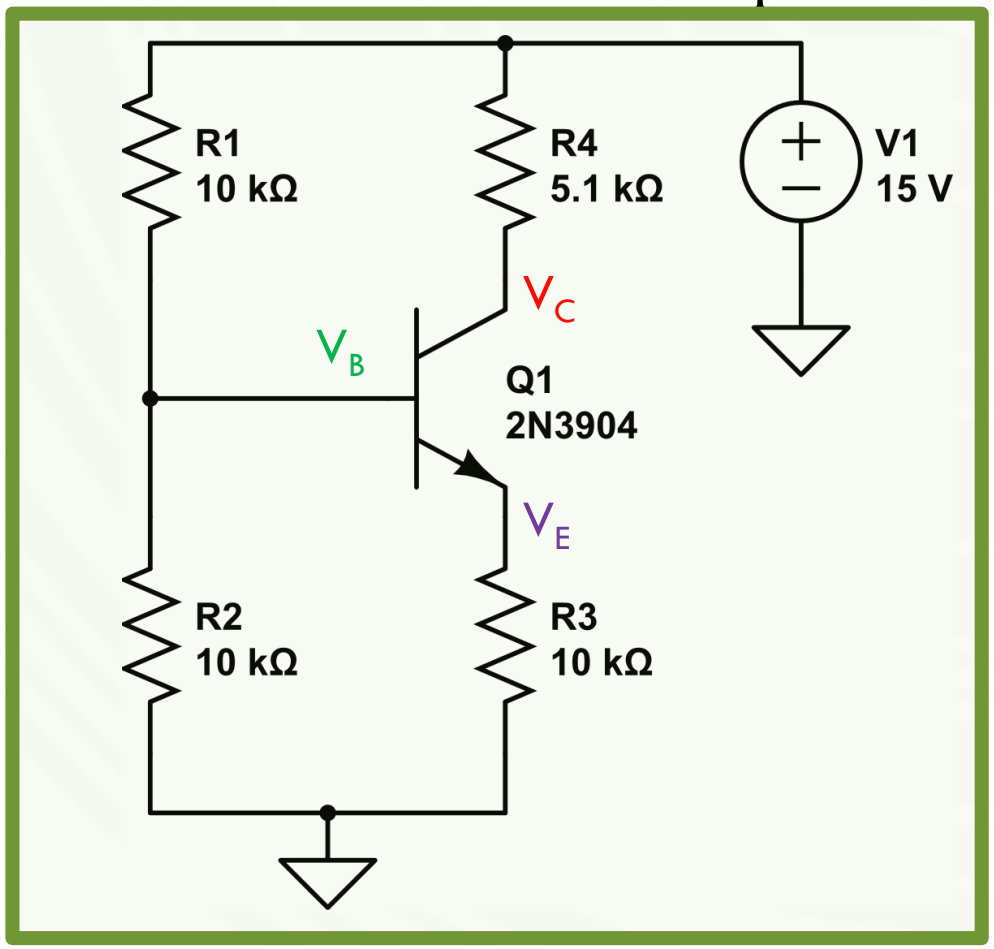


- Amplifier needs two pins for the input and two pins for the output. But, transistor has only three terminals.
- We make one terminal common. In our design we make emitter common.



Transistor Biasing

- The process of setting the transistor terminals on a correct DC voltage level so that it will work as an amplifier.



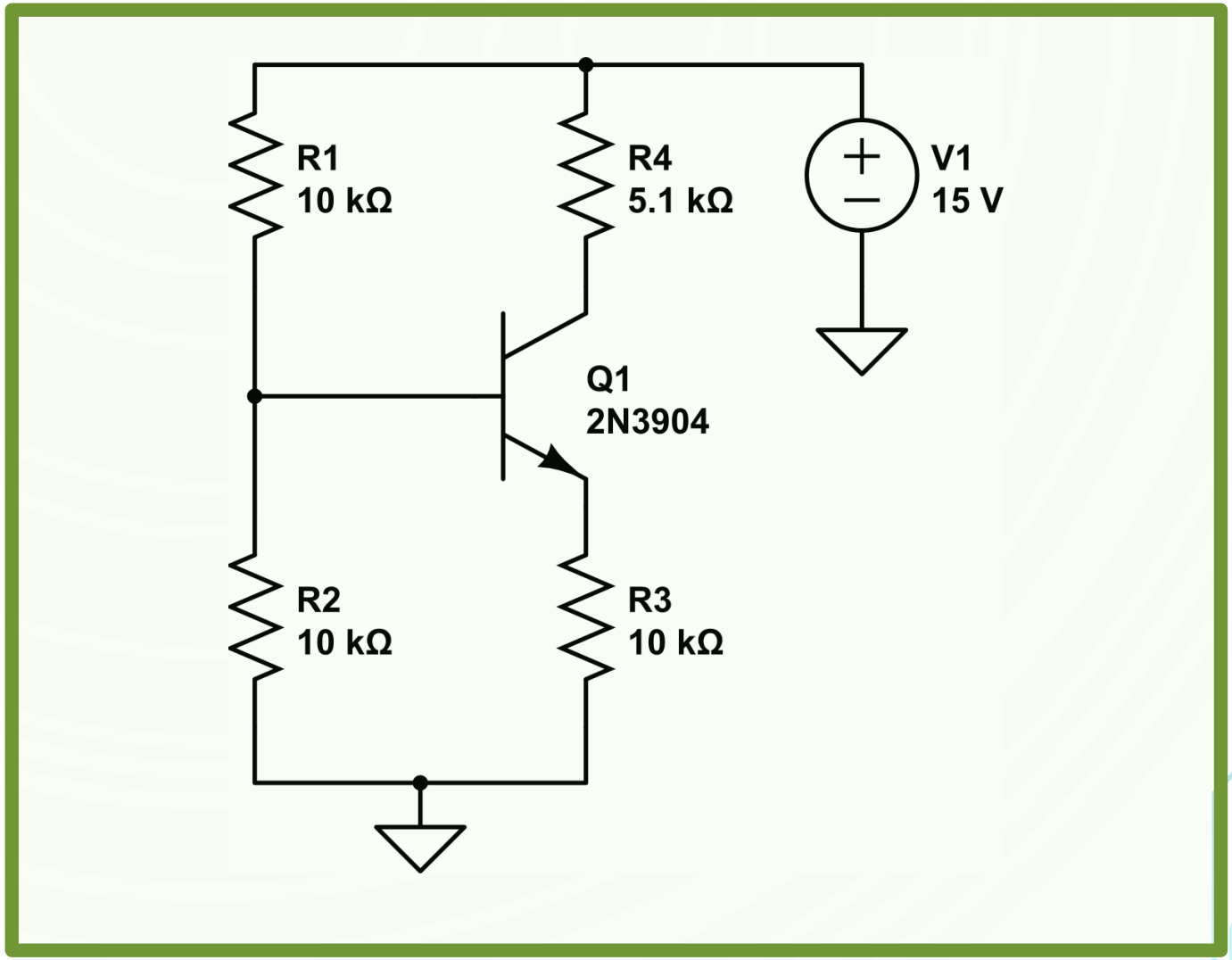
$V_B = 7.5\ v$

$V_E = 6.8\ v$

$V_C = 11.5\ v$

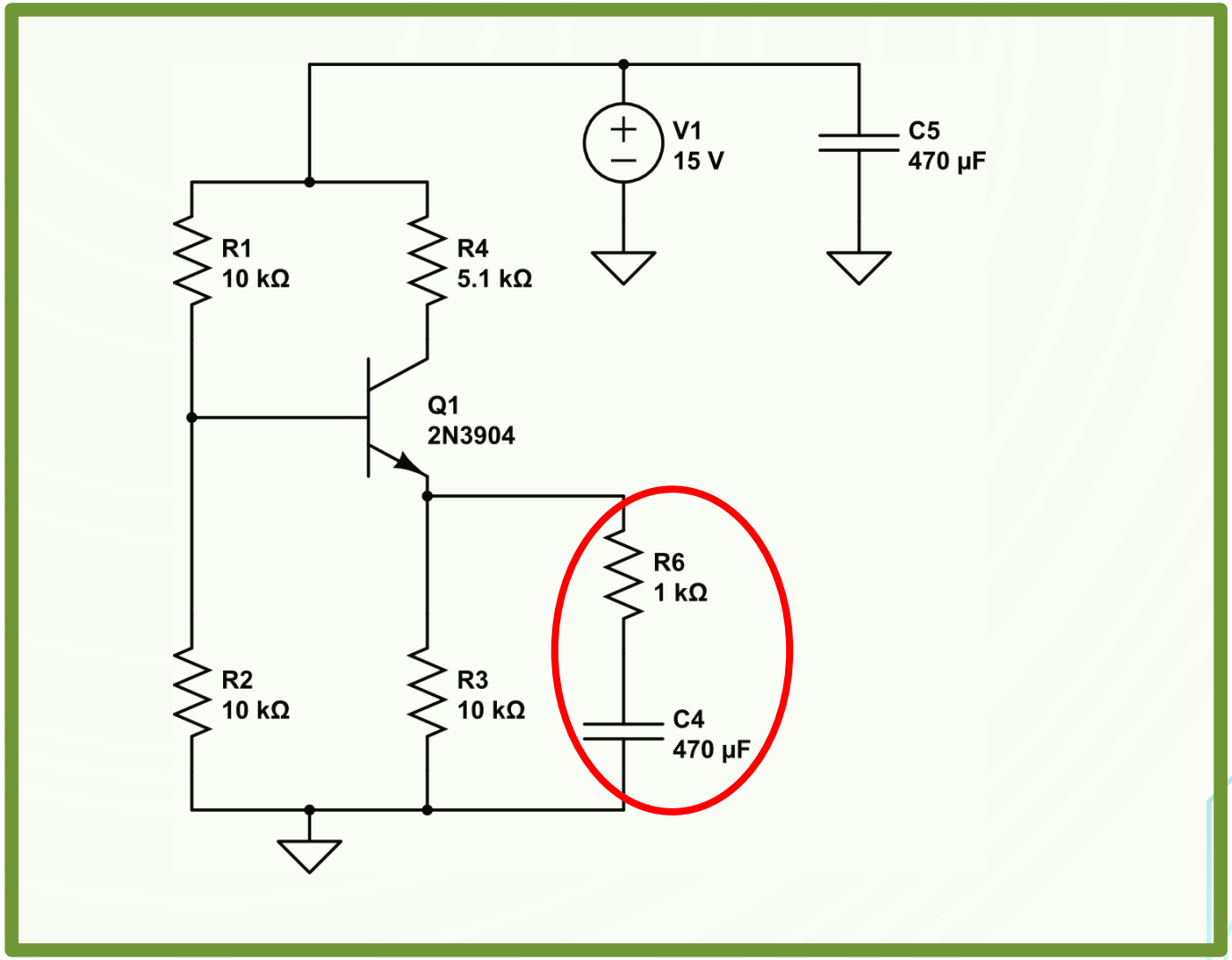
Amplifier Circuit – Step 1

- Step 1 : Bias the transistor to have the correct voltages.



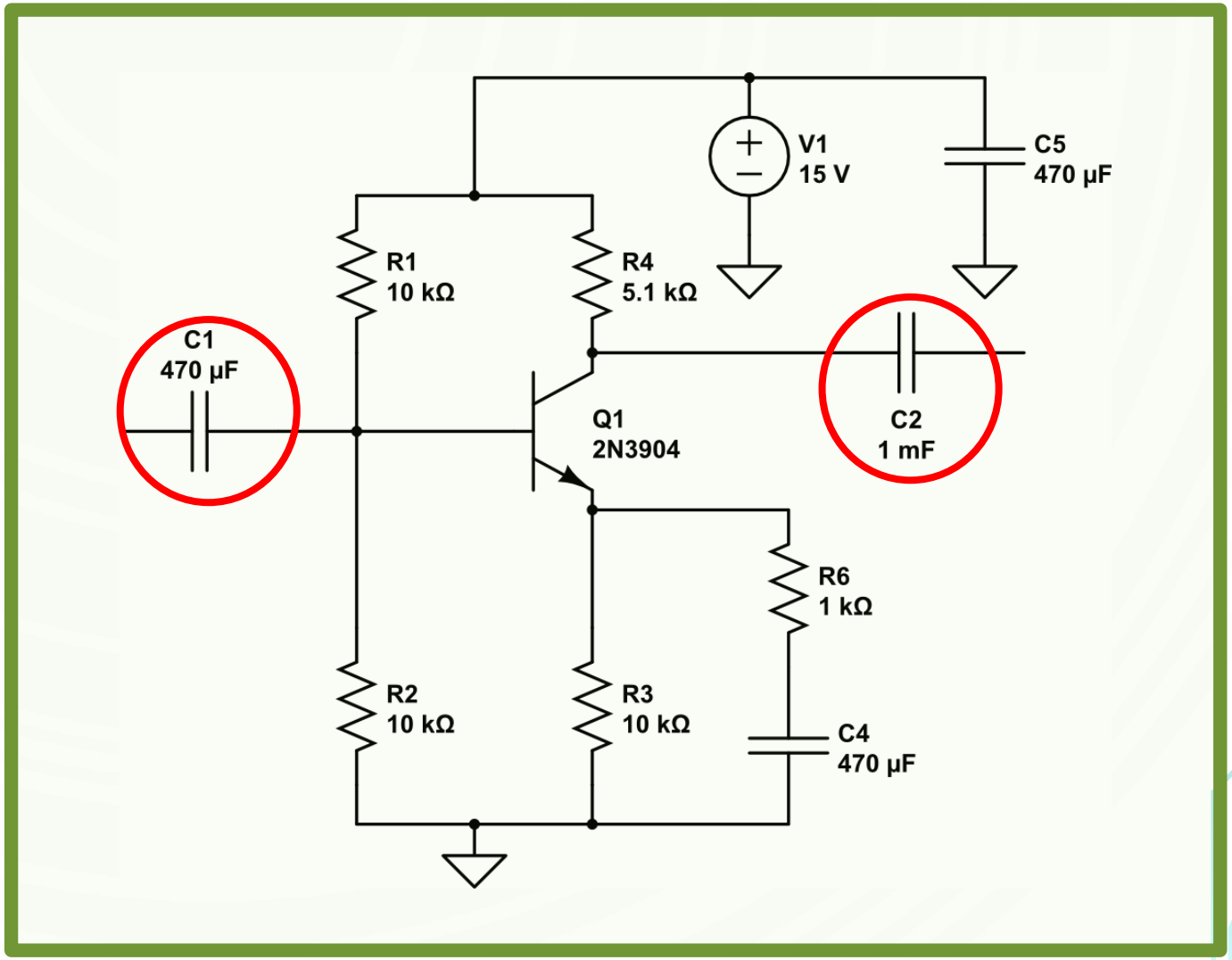
Amplifier Circuit – Step 2

- Step 1 : Bias the transistor to have the correct voltages.
- Step 2 : Add a resistor and a capacitor parallel to R3.



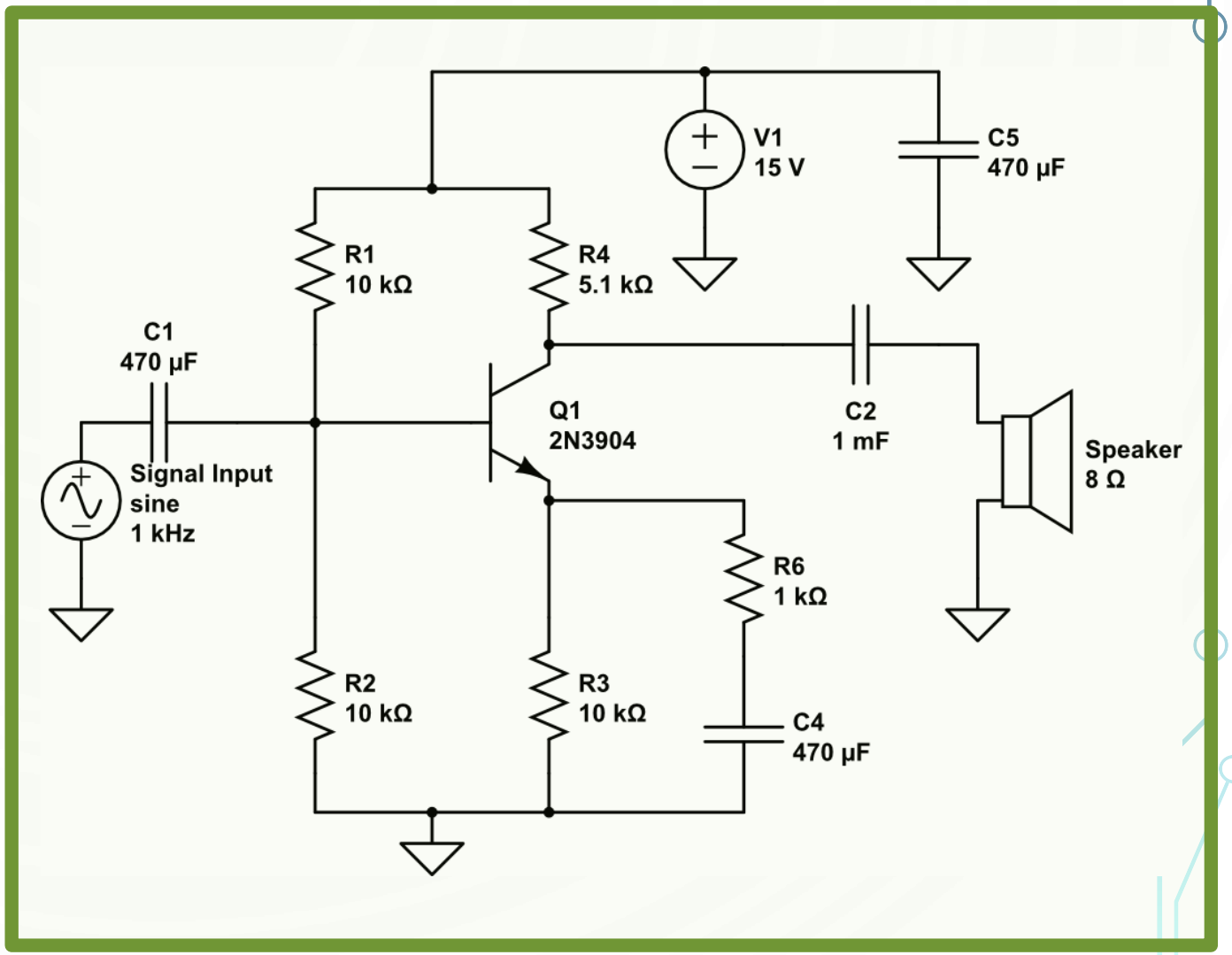
Amplifier Circuit – Step 3

- Step 1 : Bias the transistor to have the correct voltages.
- Step 2 : Add a resistor and a capacitor parallel to R3.
- Step 3 : Add DC blocking capacitors to the input and output.

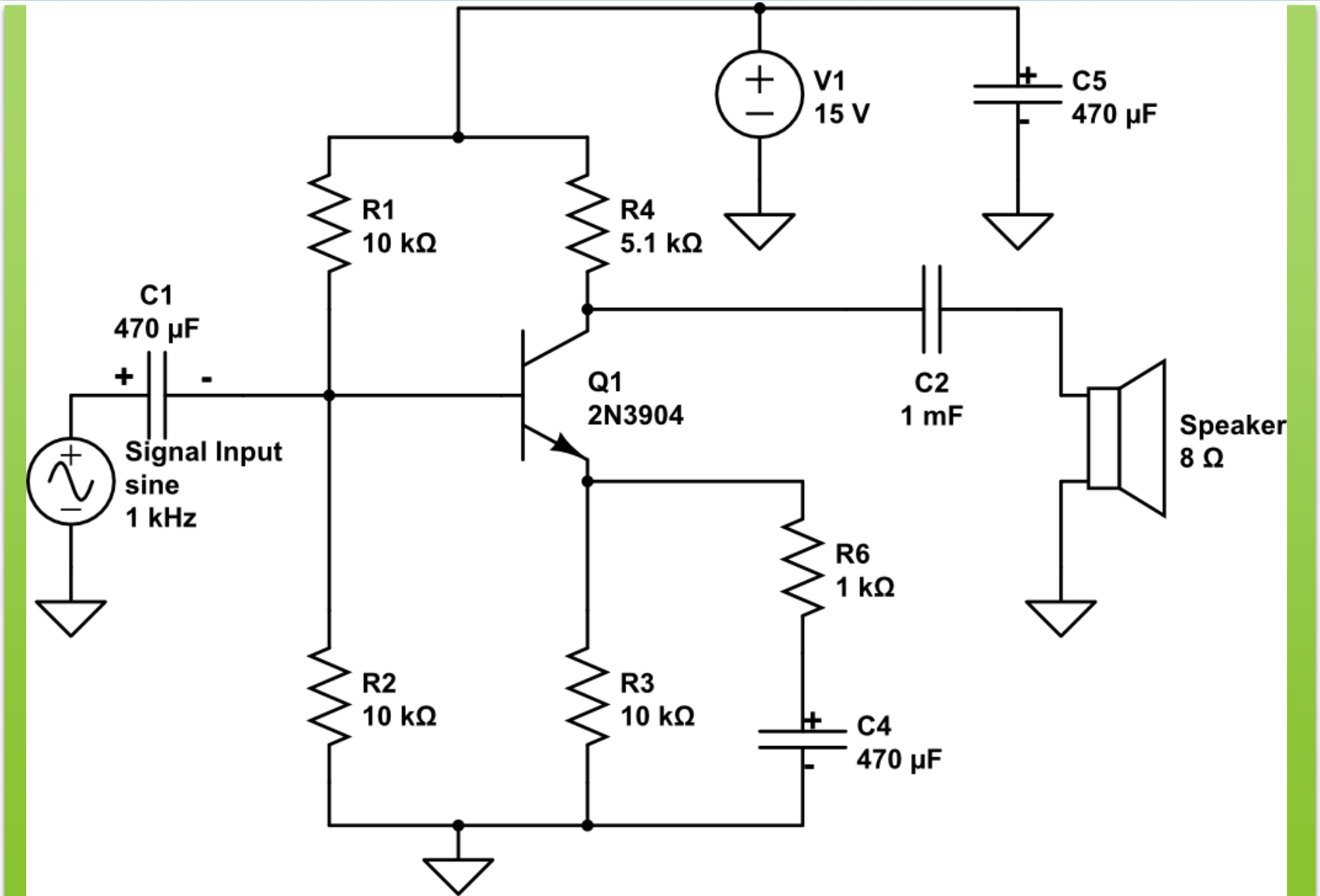


Amplifier Circuit – Step 4

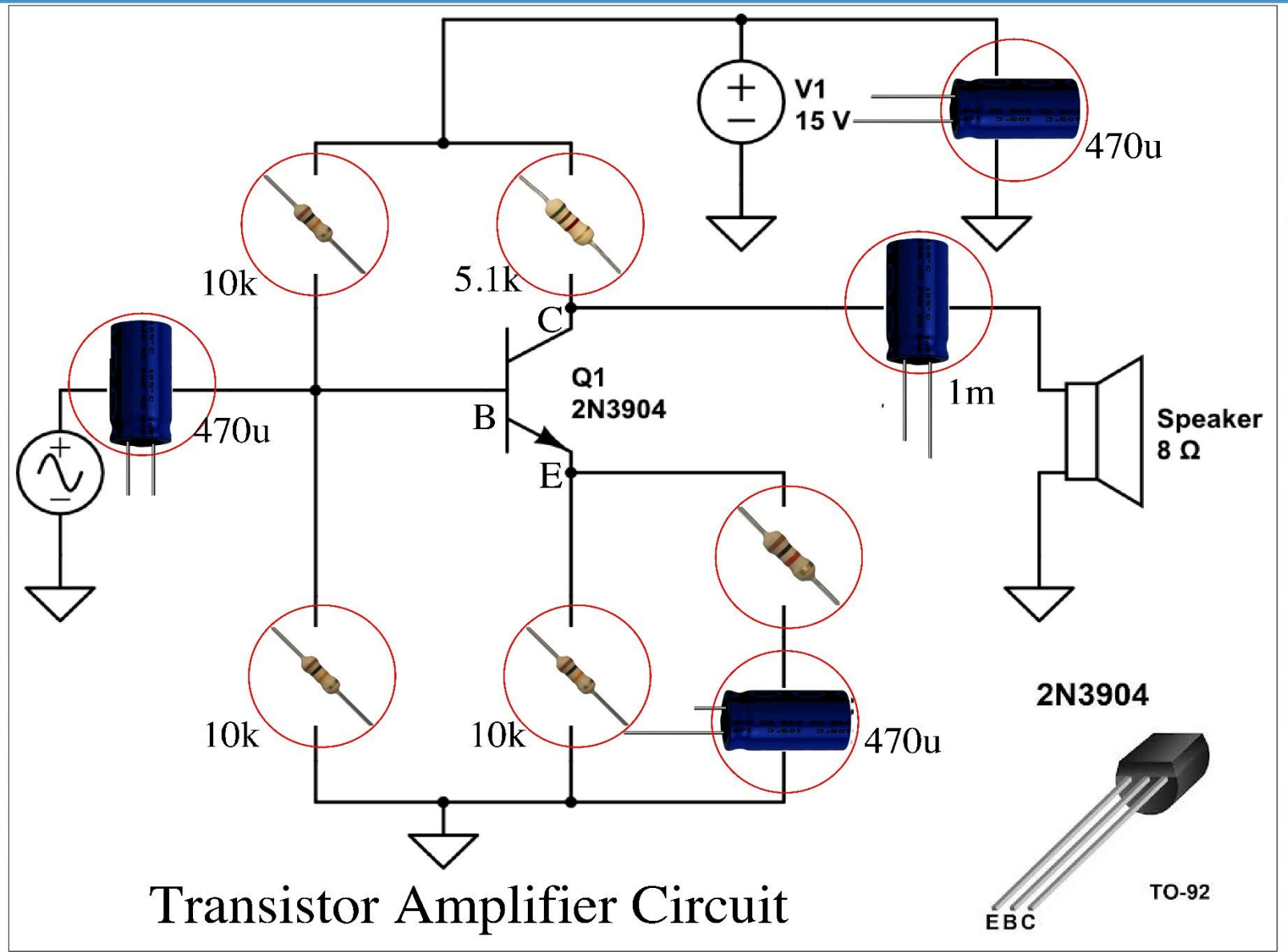
- Step 1 : Bias the transistor to have the correct voltages.
- Step 2 : Add a resistor and a capacitor parallel to R3.
- Step 3 : Add DC blocking capacitors to the input and output.
- Step 4 : Connect your phone to the input. Connect speaker to the output.



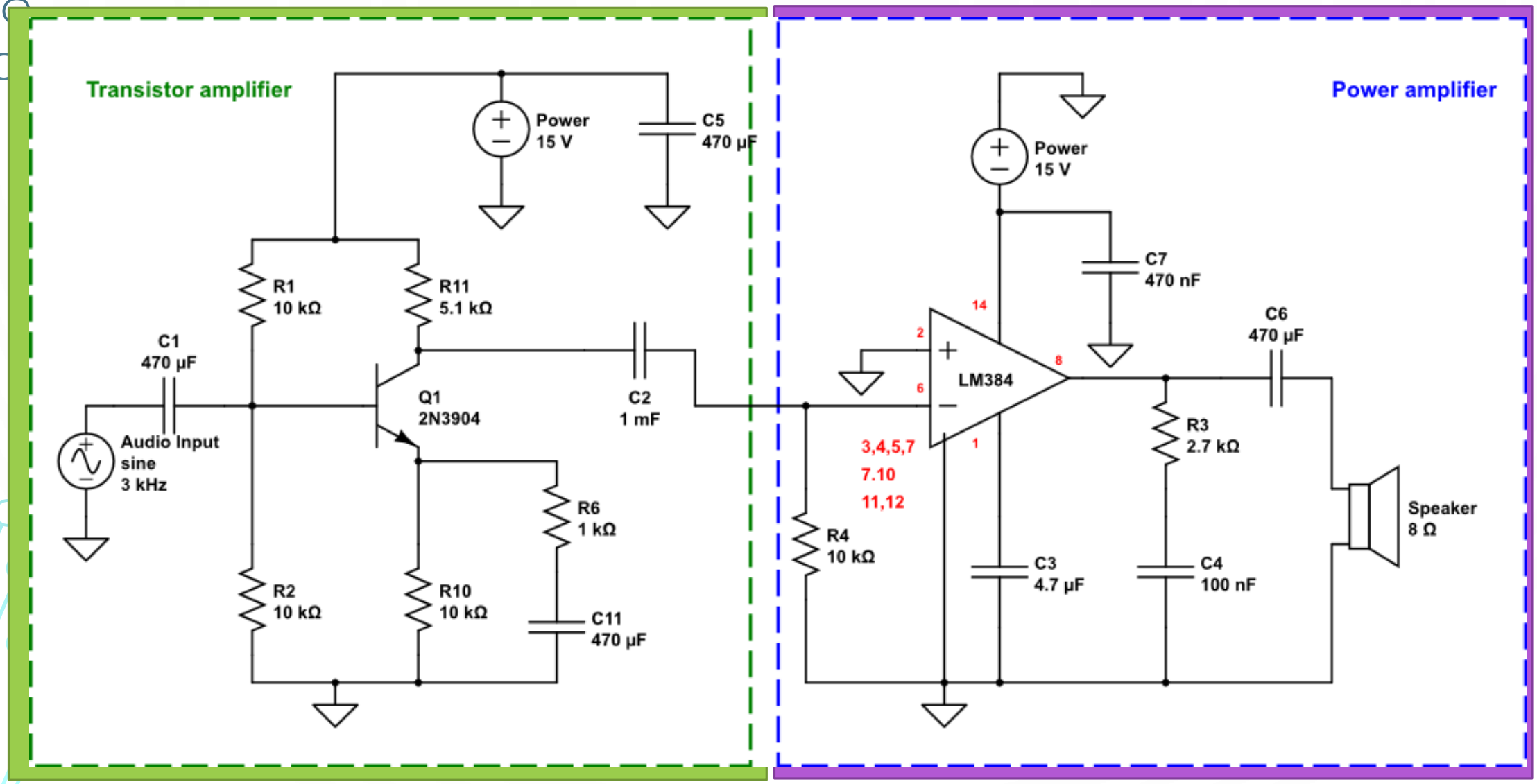
Transistor Amplifier Circuit Diagram



Transistor Amplifier Circuit Diagram



Cascaded Amplifier



Additional Features : Filtering Effect

- Filter is used when,

certain ranges of audio frequencies are needed to be

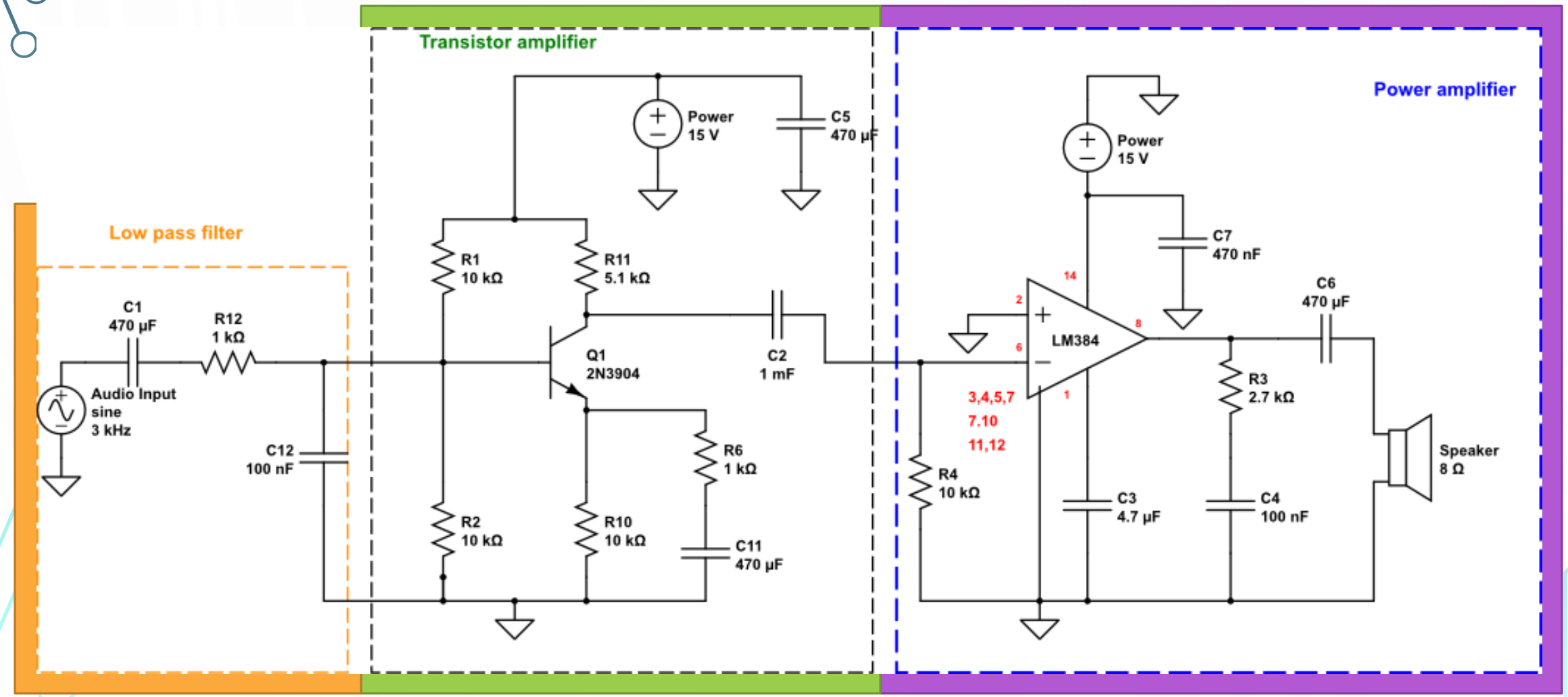
amplified or suppressed

Low-Pass Filter

Passes the low-frequency signals and reduces the amplitude of signals with frequencies higher than the cutoff frequency

Low pass filter

Amplifier with the Low-Pass Filter

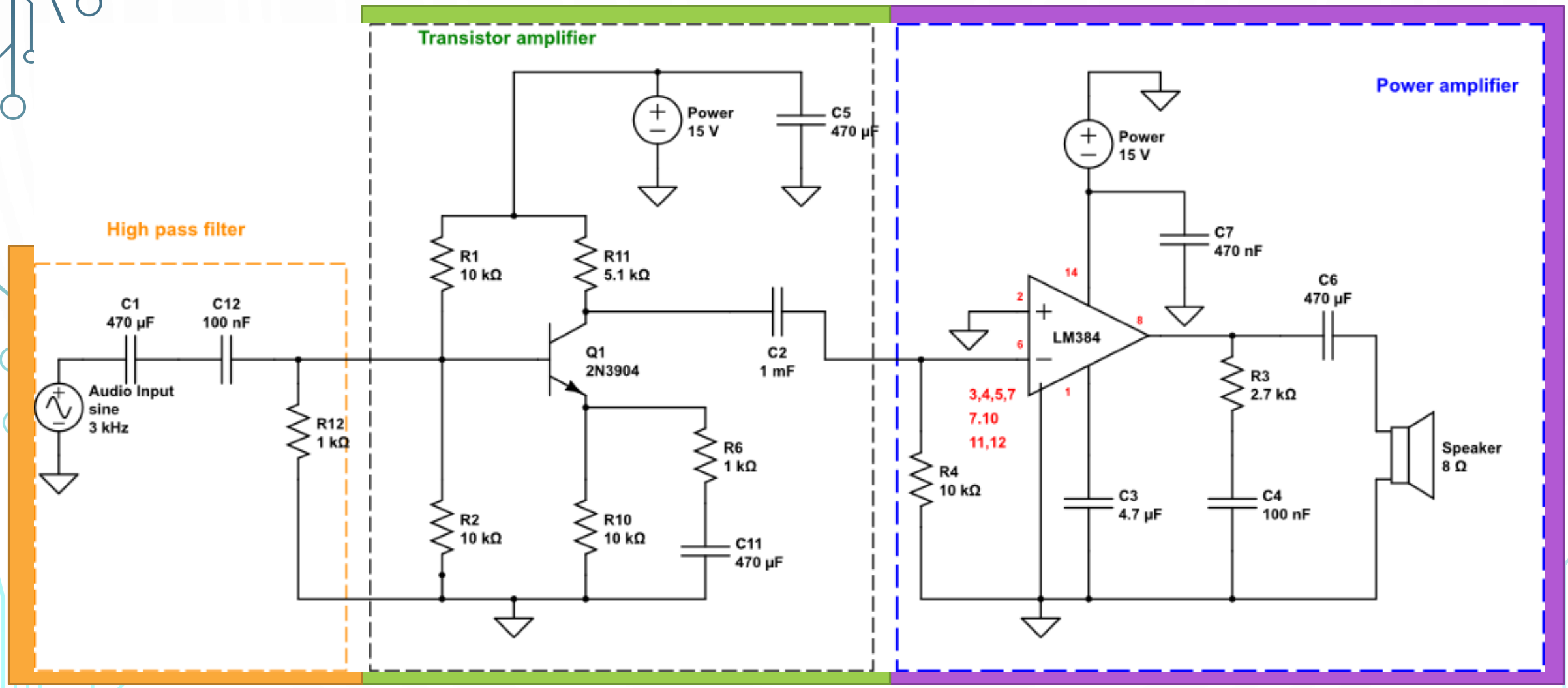


High-Pass Filter

Passes high-frequency signals but reduces the amplitude of signals with frequencies lower than the cutoff frequency

High pass filter

Amplifier with the High-Pass Filter



Thank you

This workshop was made possible due to a grant from the National Science Foundation (NSF).
We thank NSF Program Managers Dr George Haddad and Dr Andrew Clegg (now at Google) for financial support, and Norfolk State University (NSU) for their collaborative assistance in making this workshop a success.