Sensors, Microcontrollers and Actuators

Building Electronics

Basic building tips:

Try to build ‘modular’. Do not build all parts of the circuit at once and on the end connect the power, finding out it does not work. Test your circuit while building!

Connect or route the power supply first. Add functionality later.

Try to use wire color consequently, especially for power connections: Red for plus power supply, **black for ground**, and blue for negative power supply.

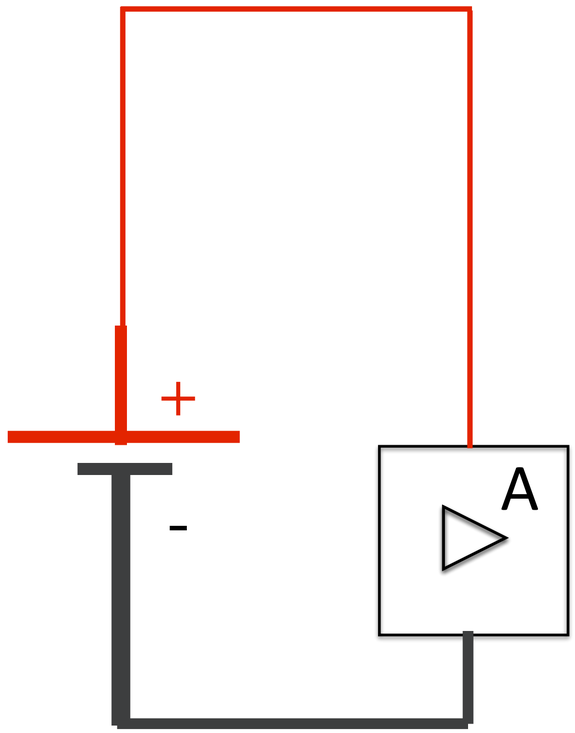
Use the **right cable** for the **right purpose**: Thick(er) cable when the current is expected to be high (think of big speakers). Shielded cable when the signal is very weak and/or high frequent.

Always build safe.

Officially, by rule, any voltage above 48Vdc is considered dangerous.
When using 230V~ AC, make sure no finger can touch /reach this point. Use good isolation.

When touching 230V~AC, it’s the frequency in combination with the high voltage that’s dangerous. Our heartbeat is about 60 times per minute; one time per second. The frequency of the net is 50Hz; 50 times per second ...

Power Supply tips:



When you connect power to a circuit, use **thicker wire for the ground.** The ground should always be very **LOW IMPEDANT.** This means, the resistance should be low. **Thicker wire does the job ...**

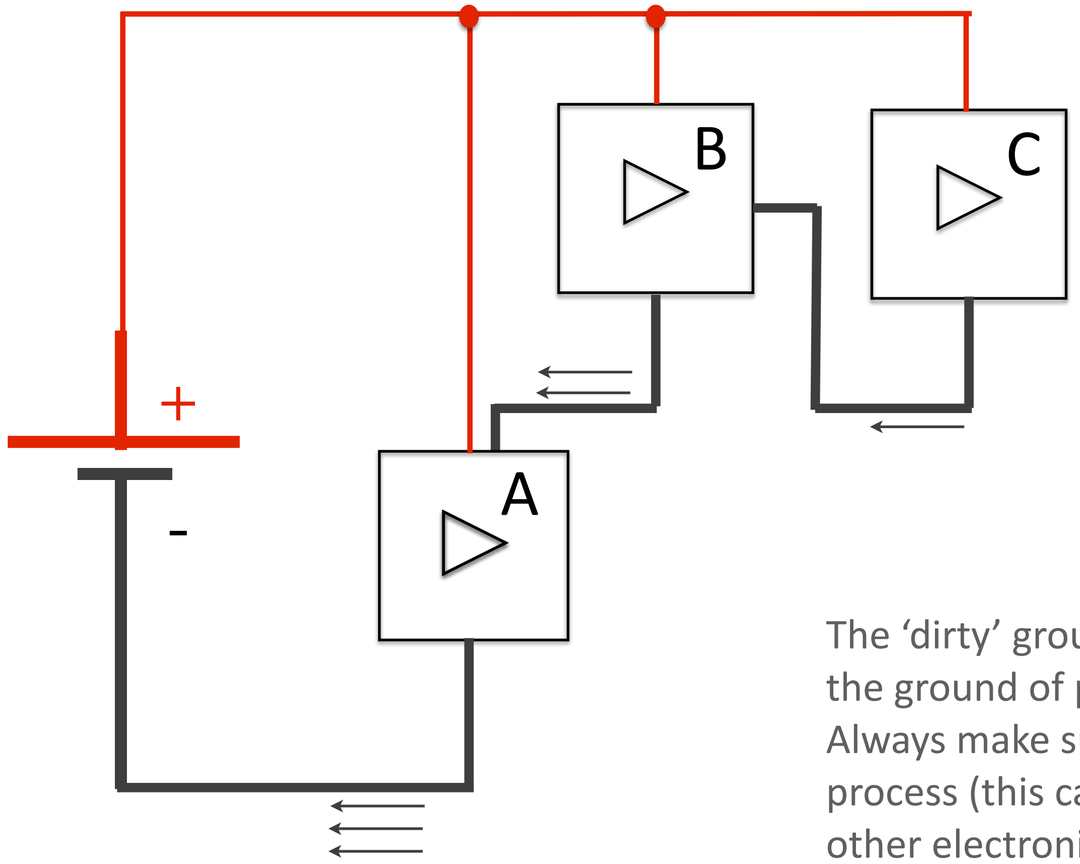
Think of the water supply in your house: the water is coming in the house in a tube of 14mm, but going out in a big tube ...!

Using **thicker wire for the ground, avoids disturbances and unpredictable behavior**

Also check HOW you connect the ground...

Power Supply tips:

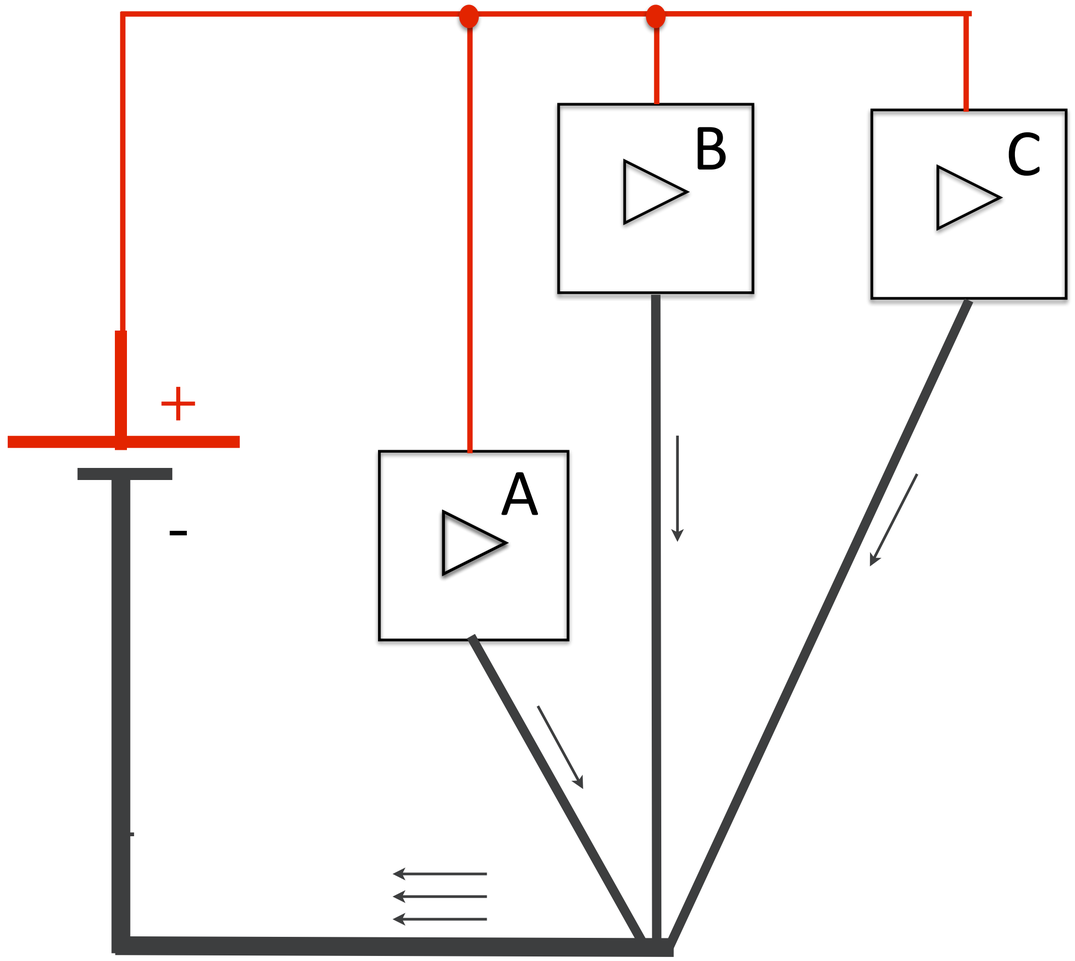
Connecting it like the example below, can cause **problems**:



The ‘dirty’ ground from process C is polluting the ground of process A and B.
Always make sure that the ground of a certain process (this can be an opamp, a motor or other electronics) has a separate ground connection ...

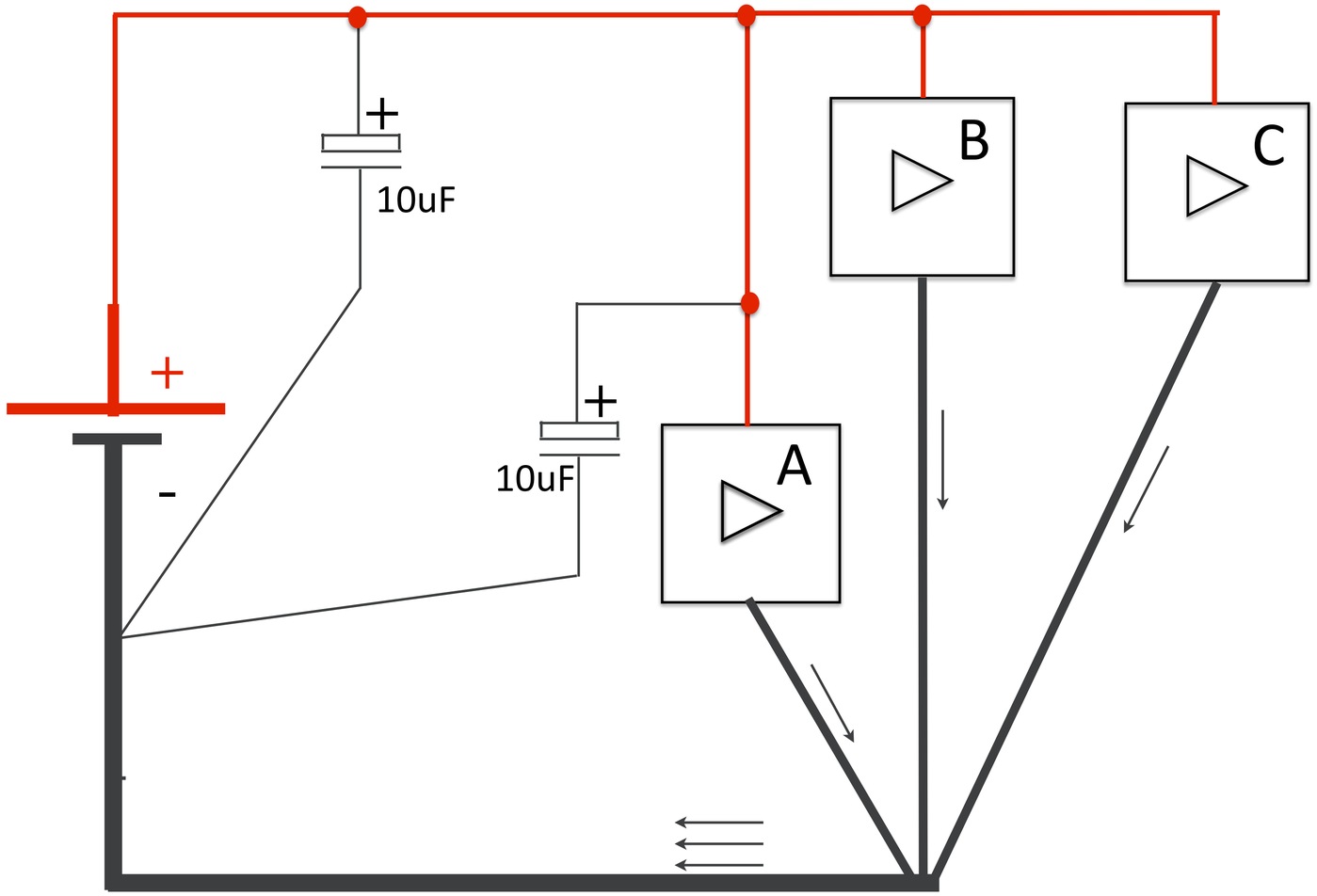
Power Supply tips:

Always try to **connect the ground into a star**

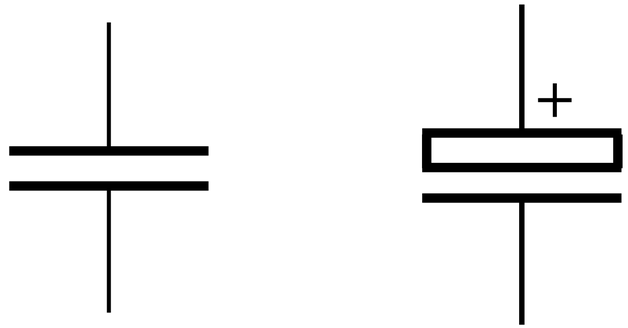


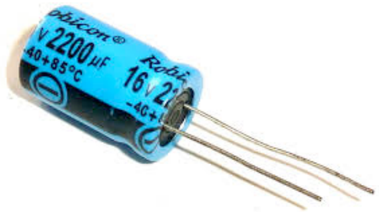
Power Supply tips:

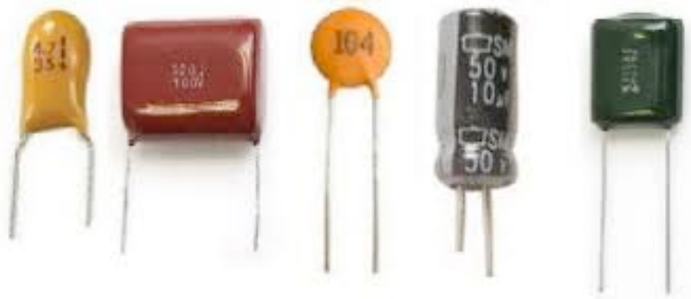
If connecting the power to a circuit, it's a good idea to add a capacitor. This will function as a **LowPass filter**; it will take away disturbances.



Capacitors




2200µF
16V
-40+85°C

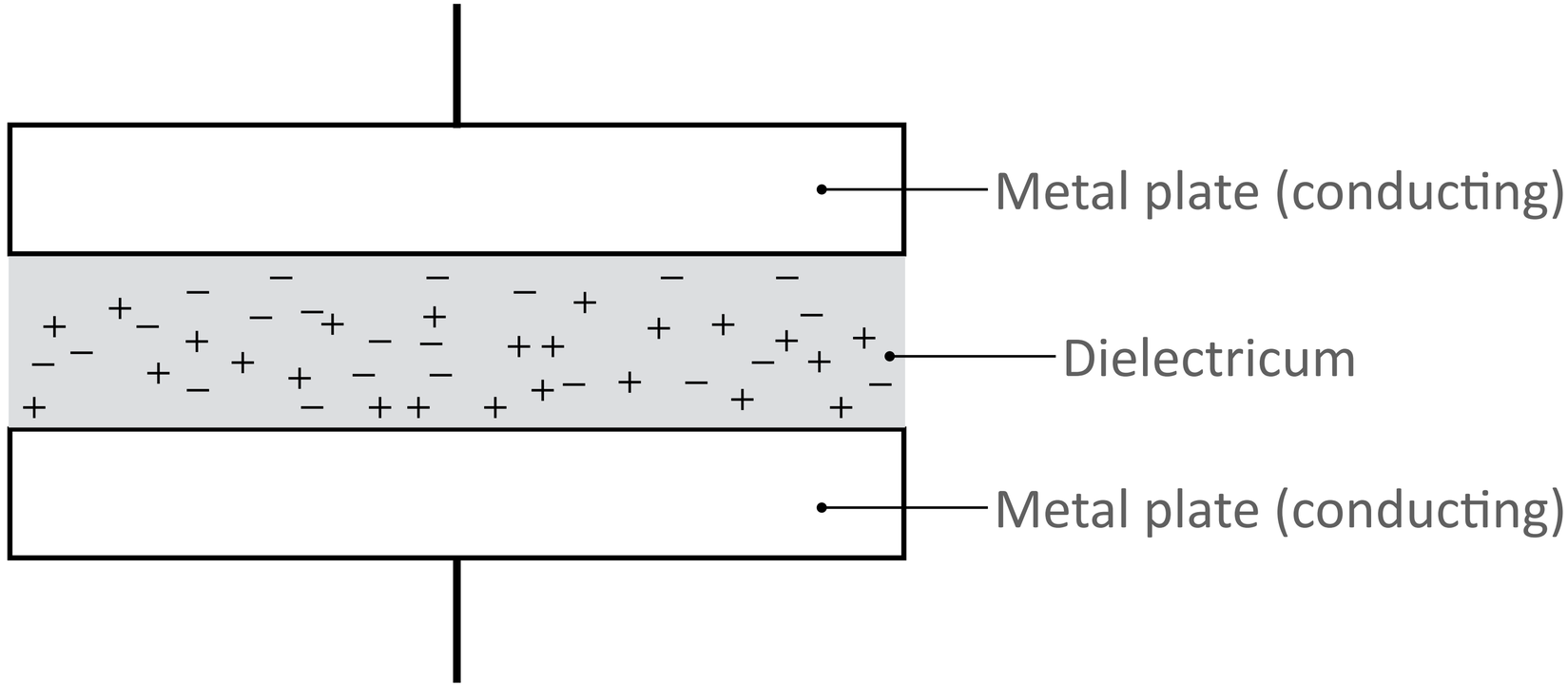

104


4700uF 25V 4700uF 25V


EPCOS
450VAC
No PCB's
B32332-I60
PROTECTED
MADE BY EPCOS

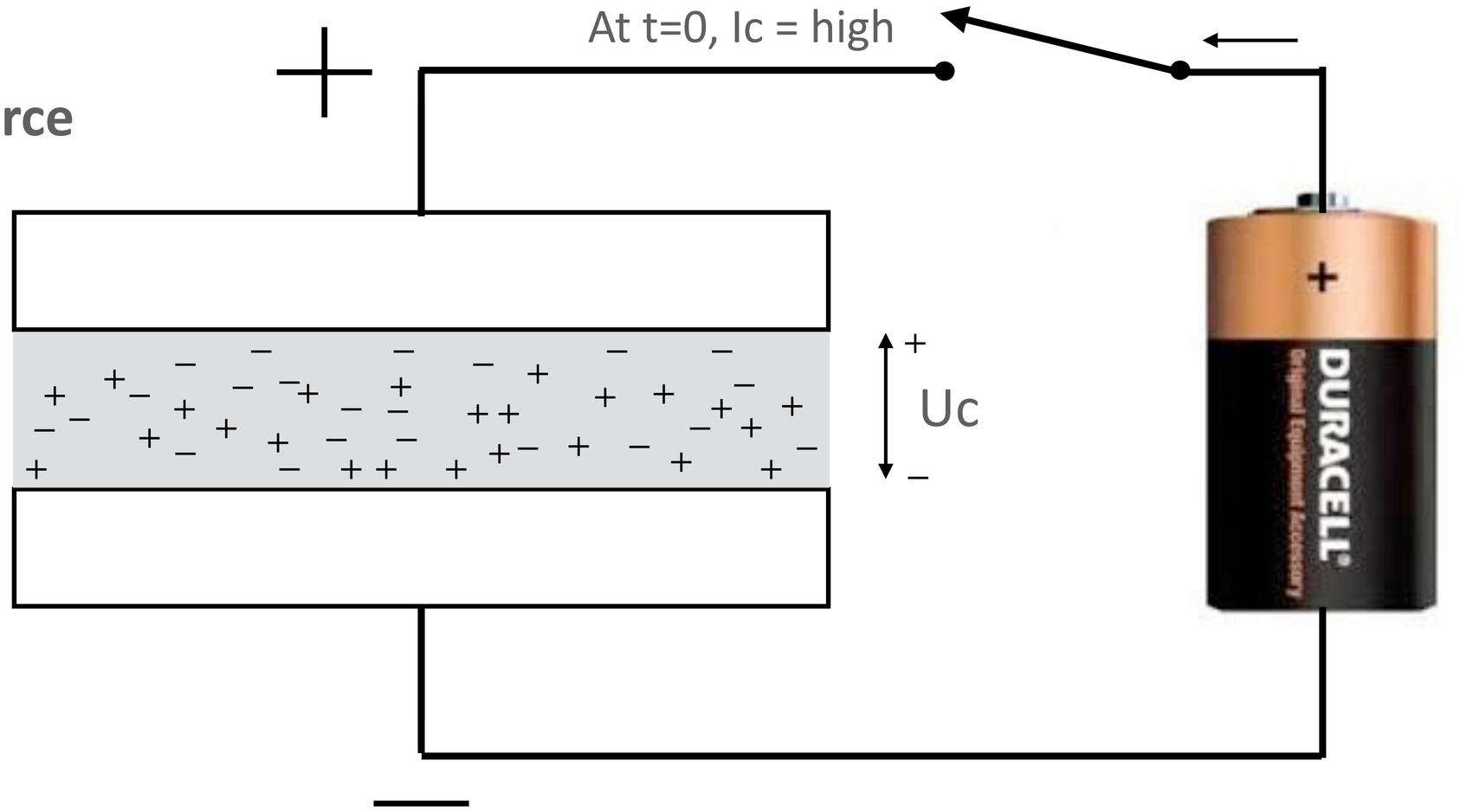
Capacitor

Not connected



Capacitor

Connected to a **DC-source**



The capacitor will charge until Uc = U battery

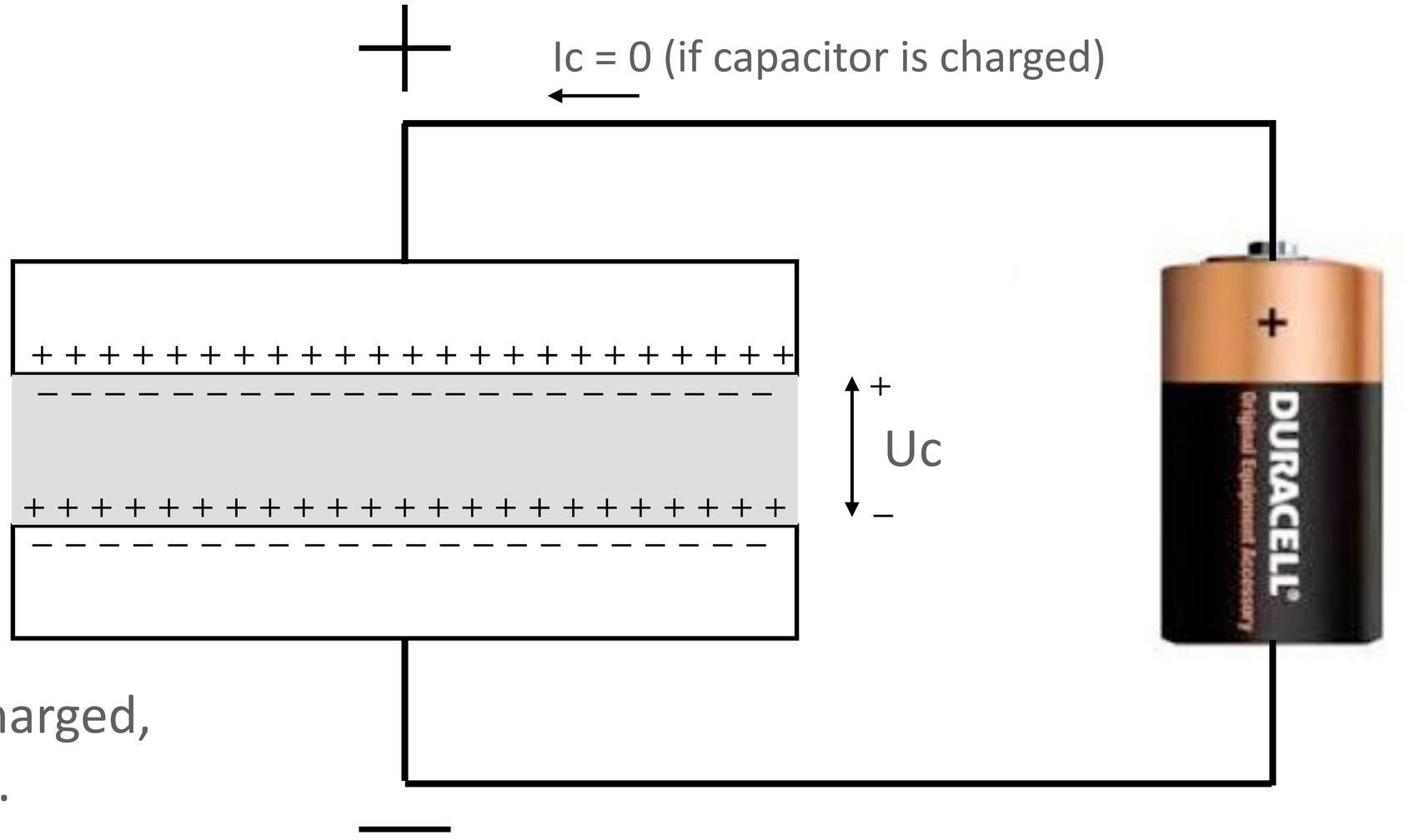
The charge current is very high (at time=0 sec)

For AC voltage, the capacitor is a conductor or a resistor

Capacitor

Connected to a battery

The capacitor will charge until Uc = U battery



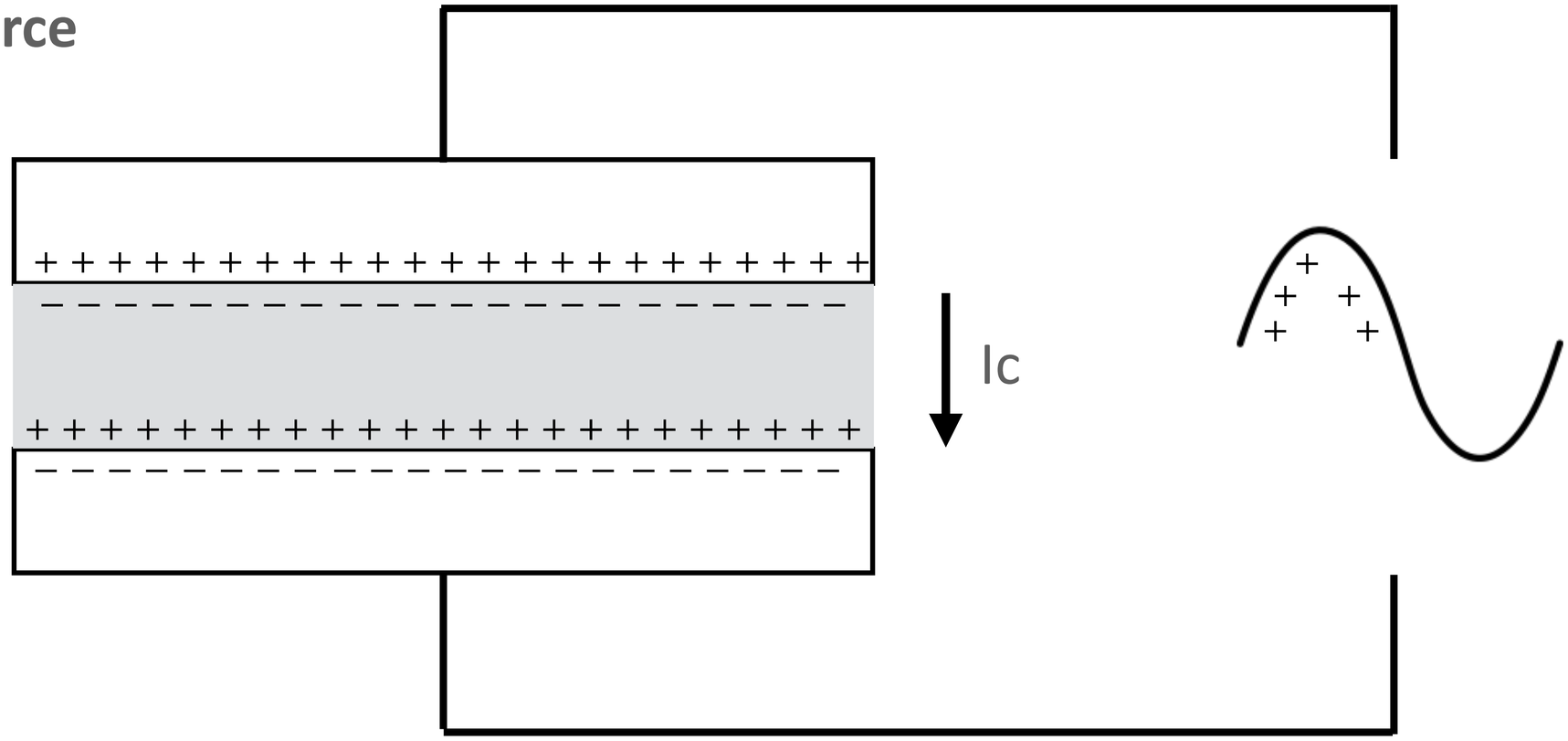
After the capacitor is charged, the current will be zero.

For DC voltage, the Capacitor is a blockade (very high resistor) - the current is zero

Capacitor

Connected to an **AC source**

The capacitor will charge and discharge

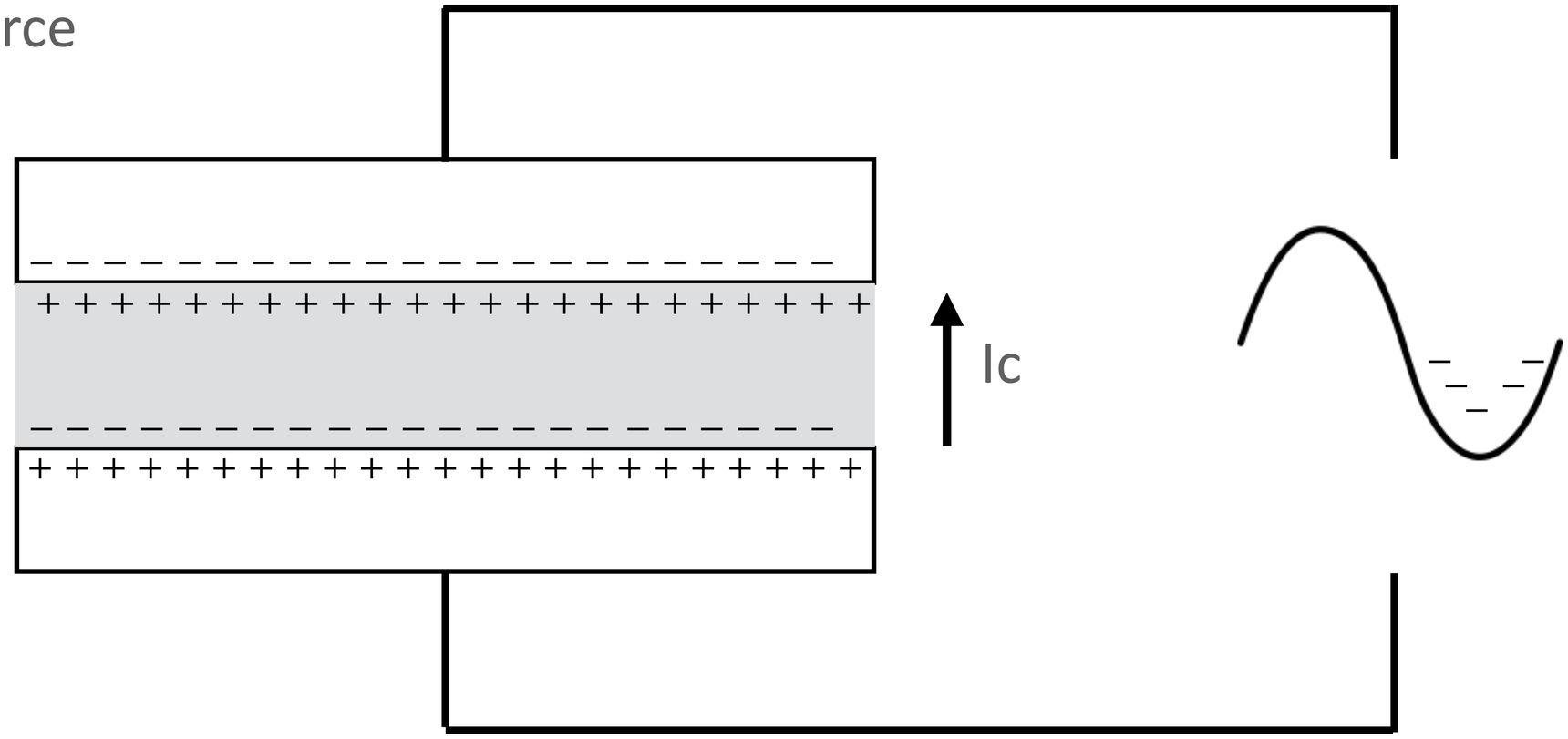


For AC voltage, the Capacitor is a conductor or a resistor

Capacitor

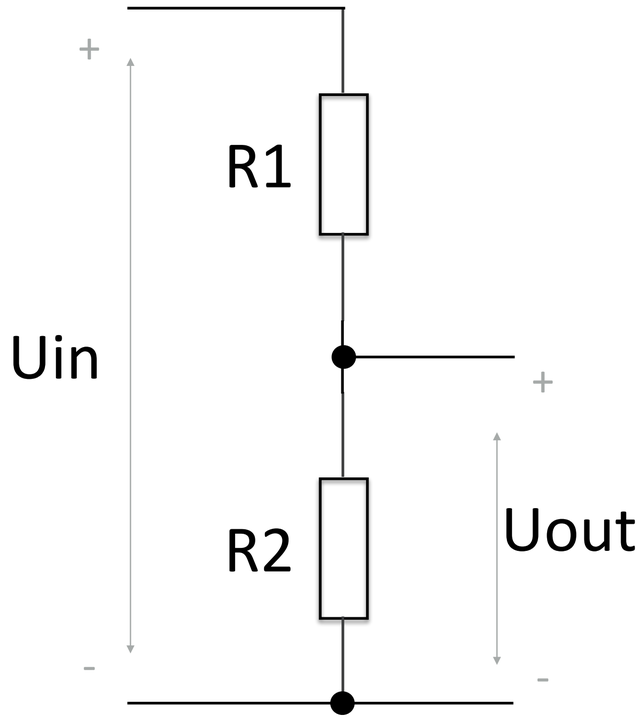
Connected to an AC source

The capacitor will charge and discharge



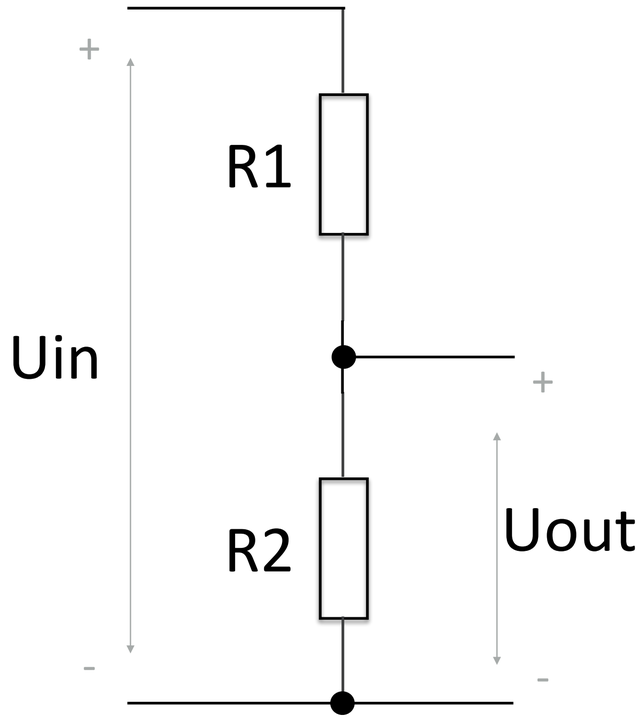
For AC voltage, the Capacitor is a conductor or a resistor

Filter



Uout = (R2 / (R1+ R2)) * Uin

Filter



Uout = (R2 / (R1+ R2)) * Uin

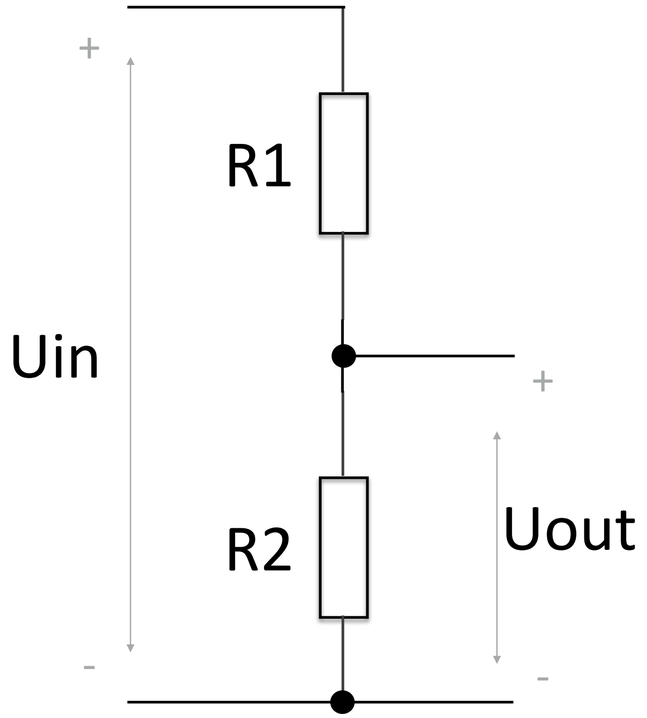
If R2 = high, Uout will be high as well
(Uout = I * R2)

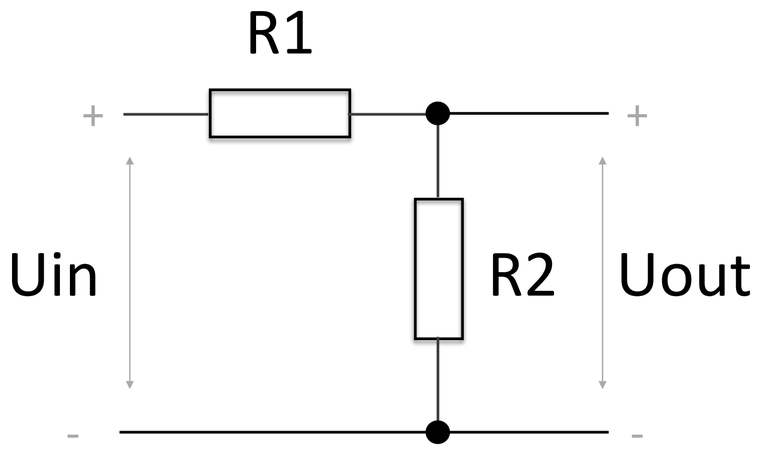
If R2 = low, Uout will be low as well
(Uout = I * R2)

Filter

If R2 = high, Uout will be high as well
(Uout = I * R2)

If R2 = low, Uout will be low as well
(Uout = I * R2)





Uout = (R2 / (R1+ R2)) * Uin

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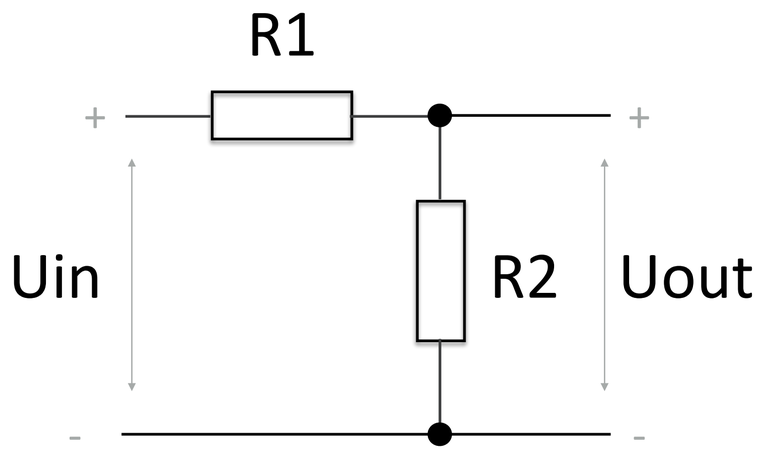

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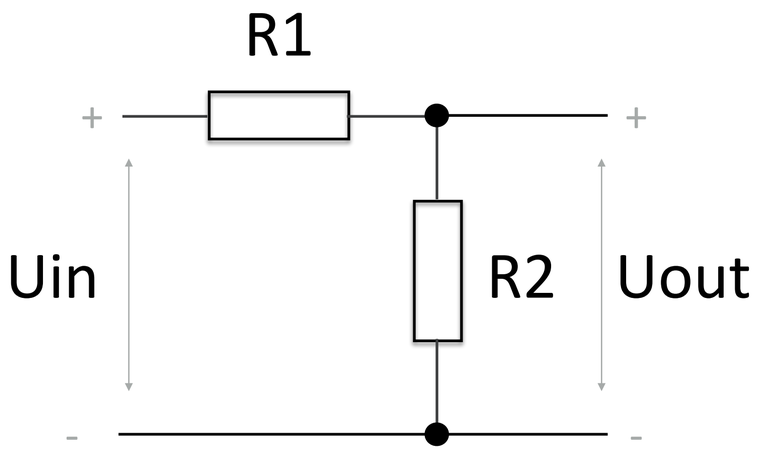

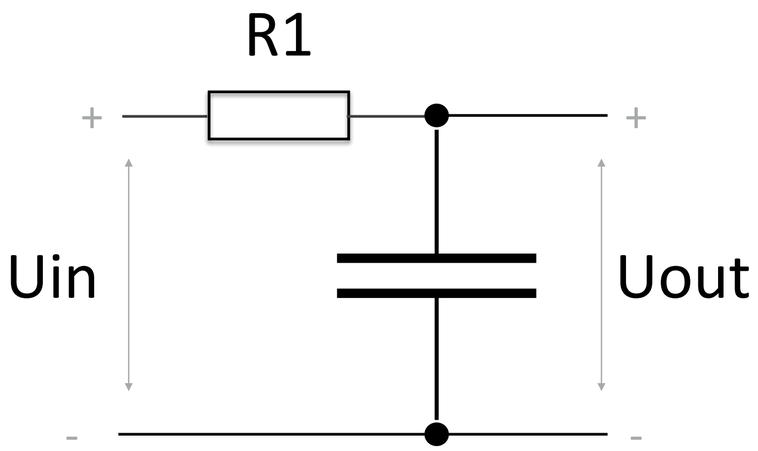

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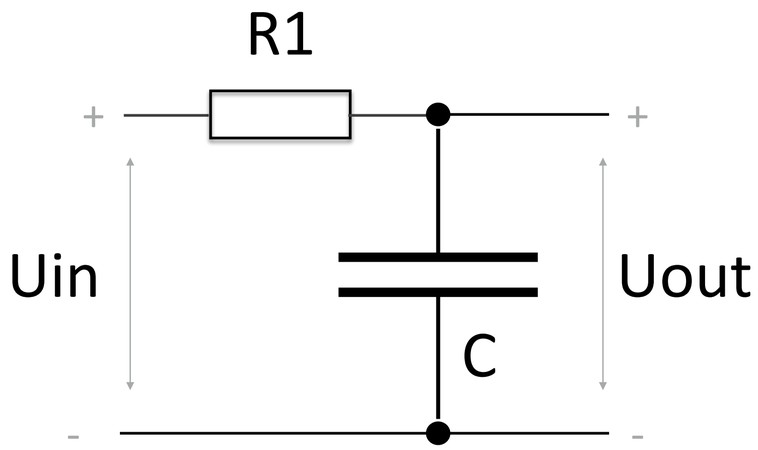
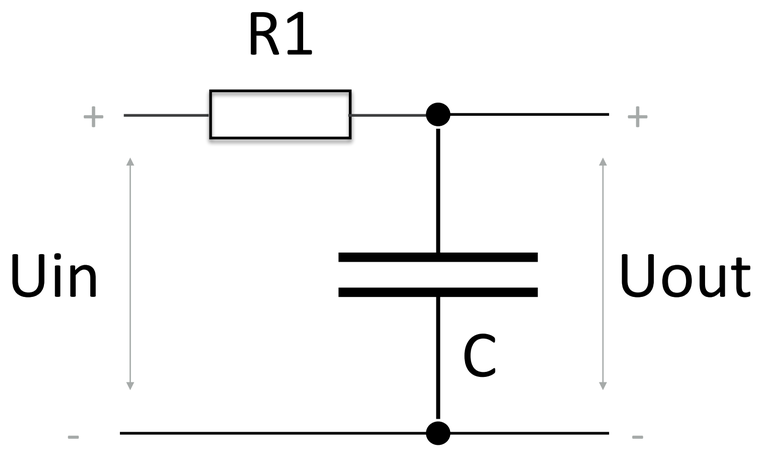
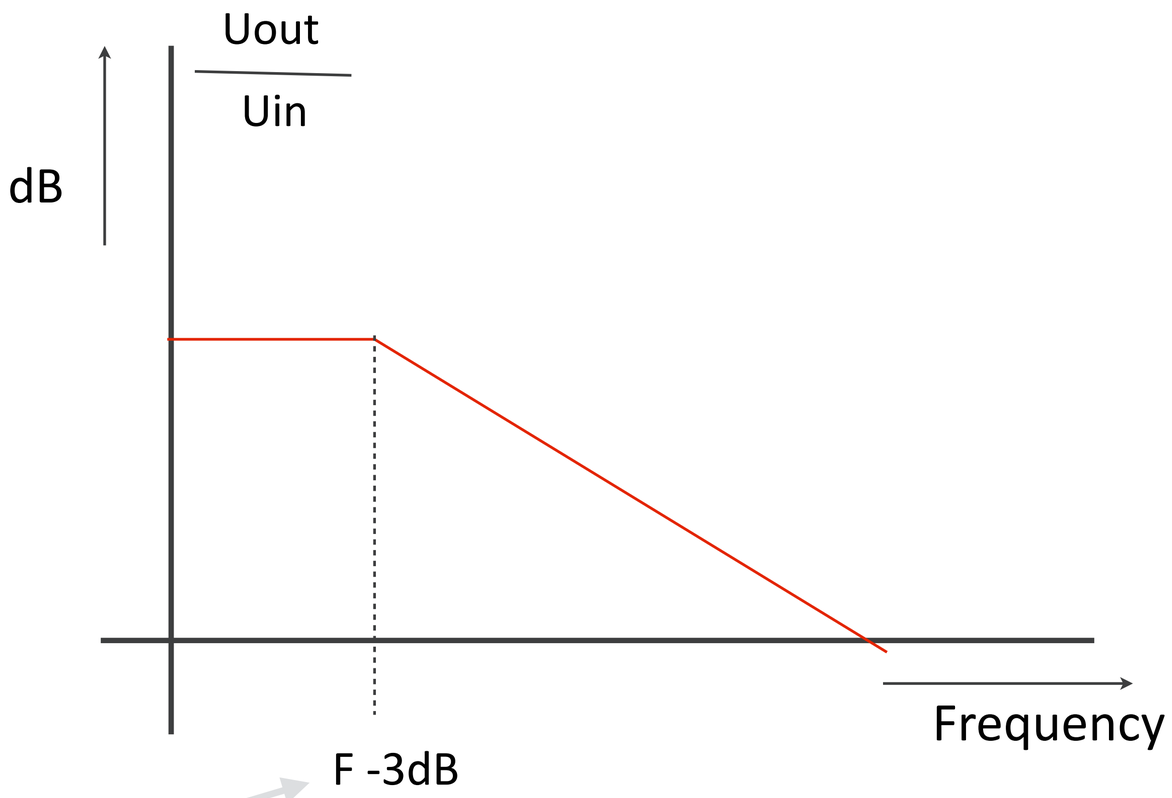


Filter

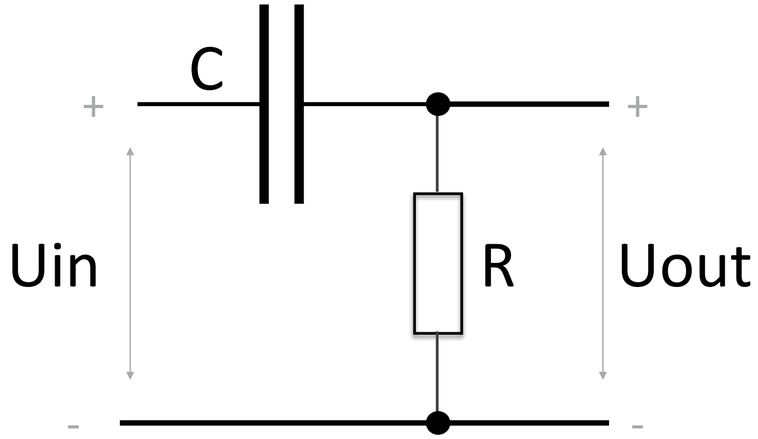
Low Pass Filter

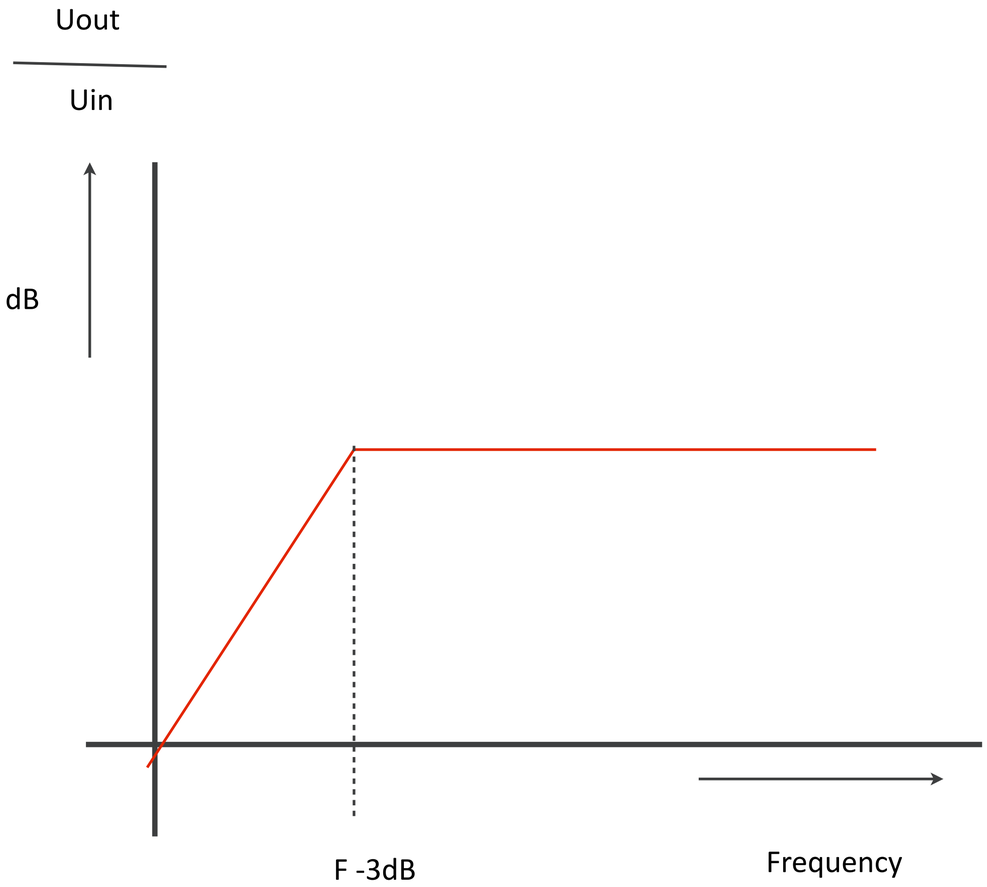




$$F(-3dB) = \frac{1}{2 \times pi \times R \times C}$$

High Pass Filter





Building protoypes:

Start with the breadboard and check the functionality; measure the characteristics of the circuit and adjust the values.

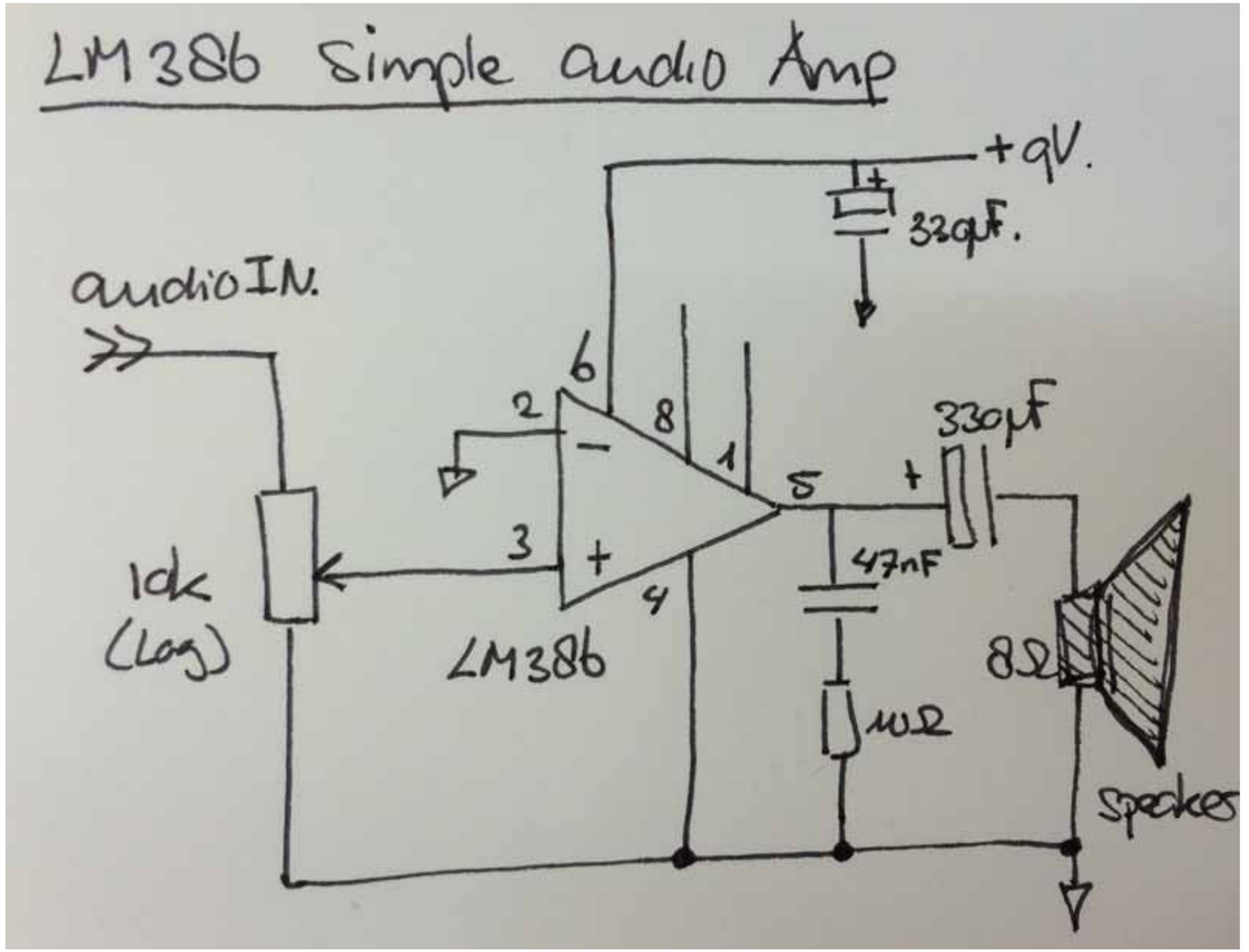
1. Build the circuit in a more stable form; use a printed circuit board to solder the components. When you only make one or two boards, this is the best and stable solution to build electronics

2. When you want to make a little production of the same circuit board, you can think of designing a **Printed Circuit Board.** This can easily be done with the program Eagle.

Always document your circuit. It can really come in handy when you have to solve problems later! In other words: be kind to your future self!

Building protoypes:

Example:



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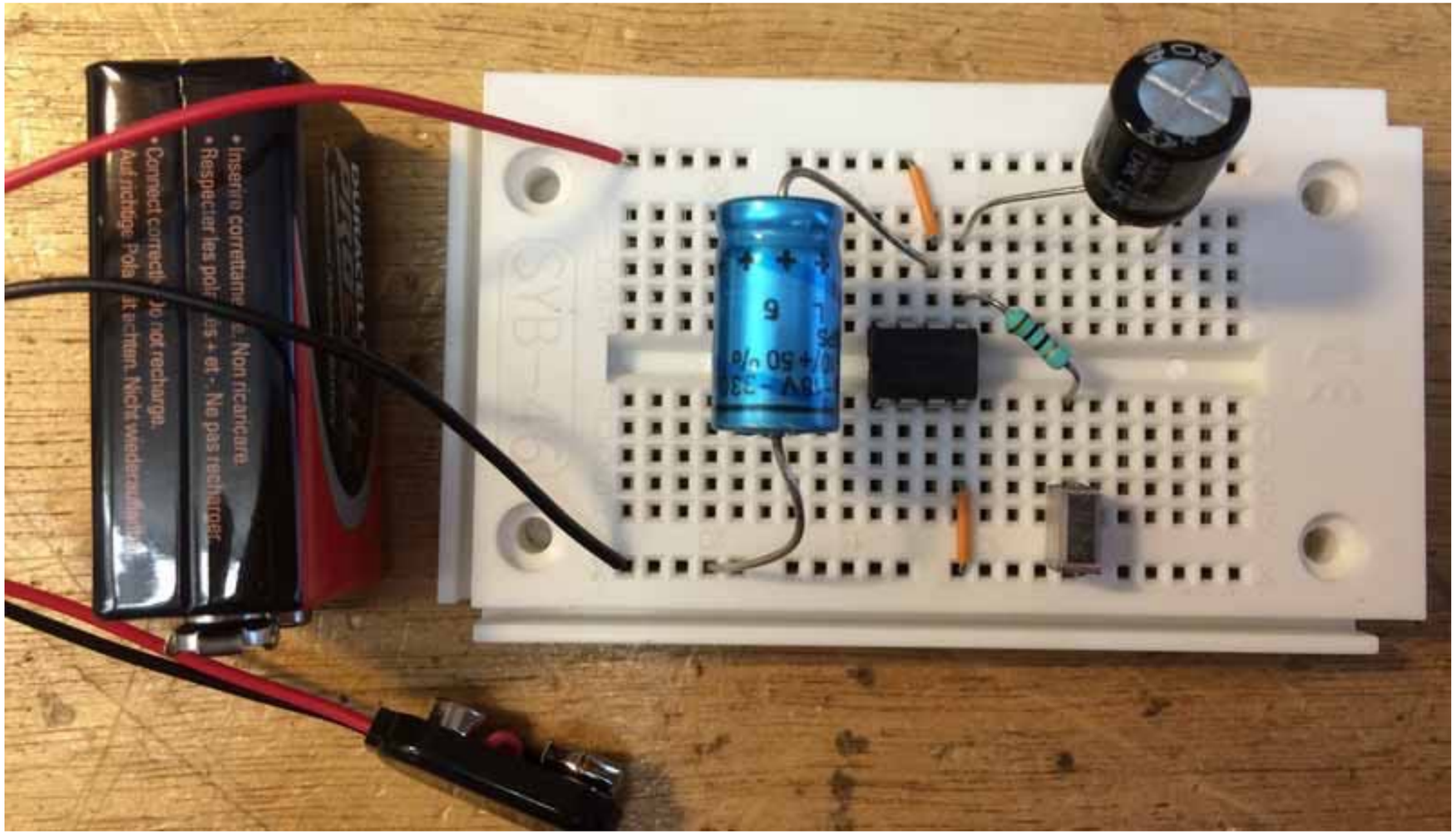

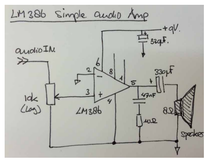

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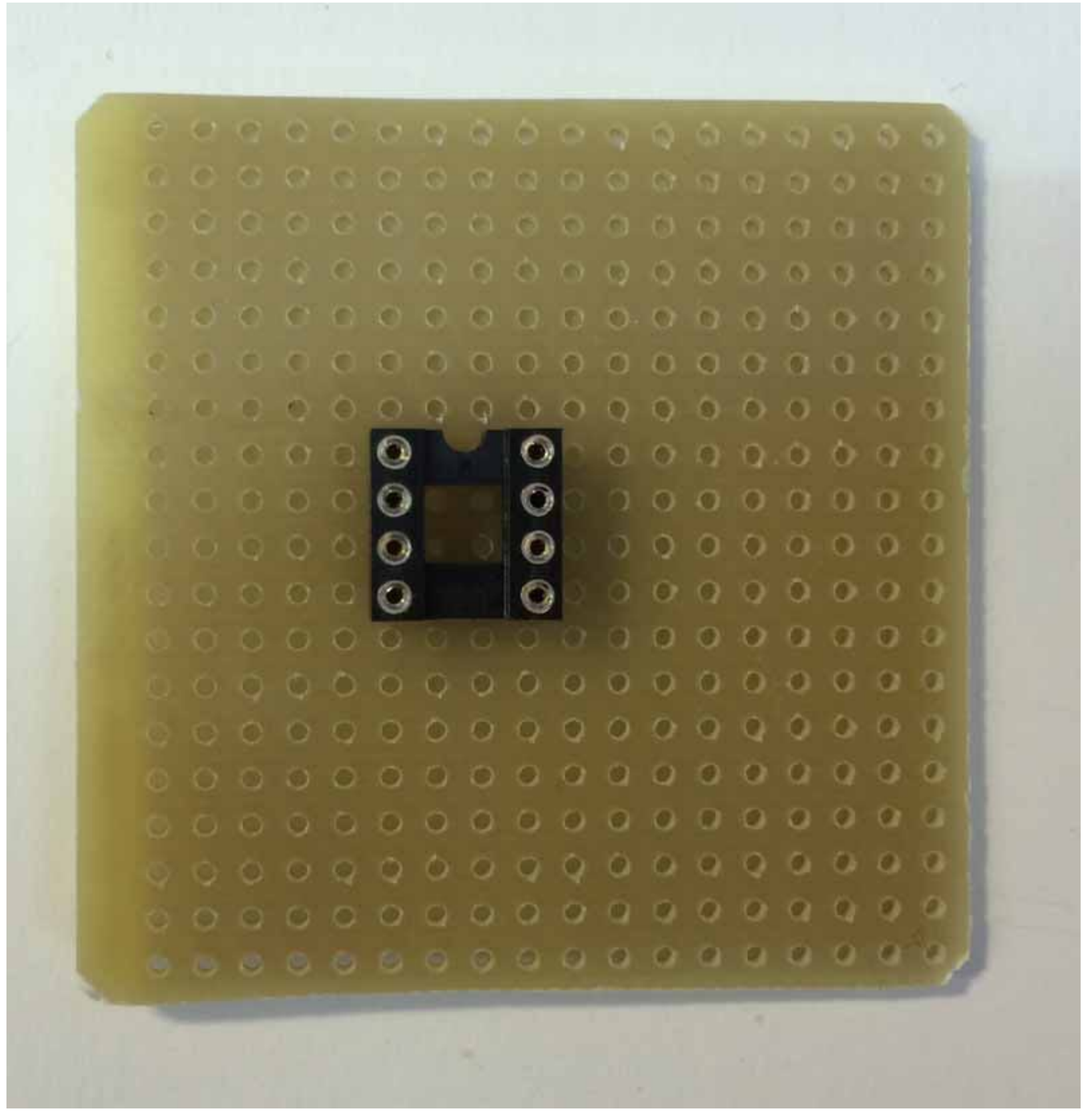

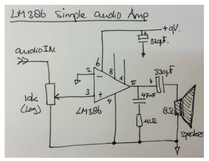

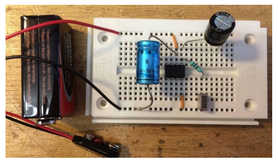

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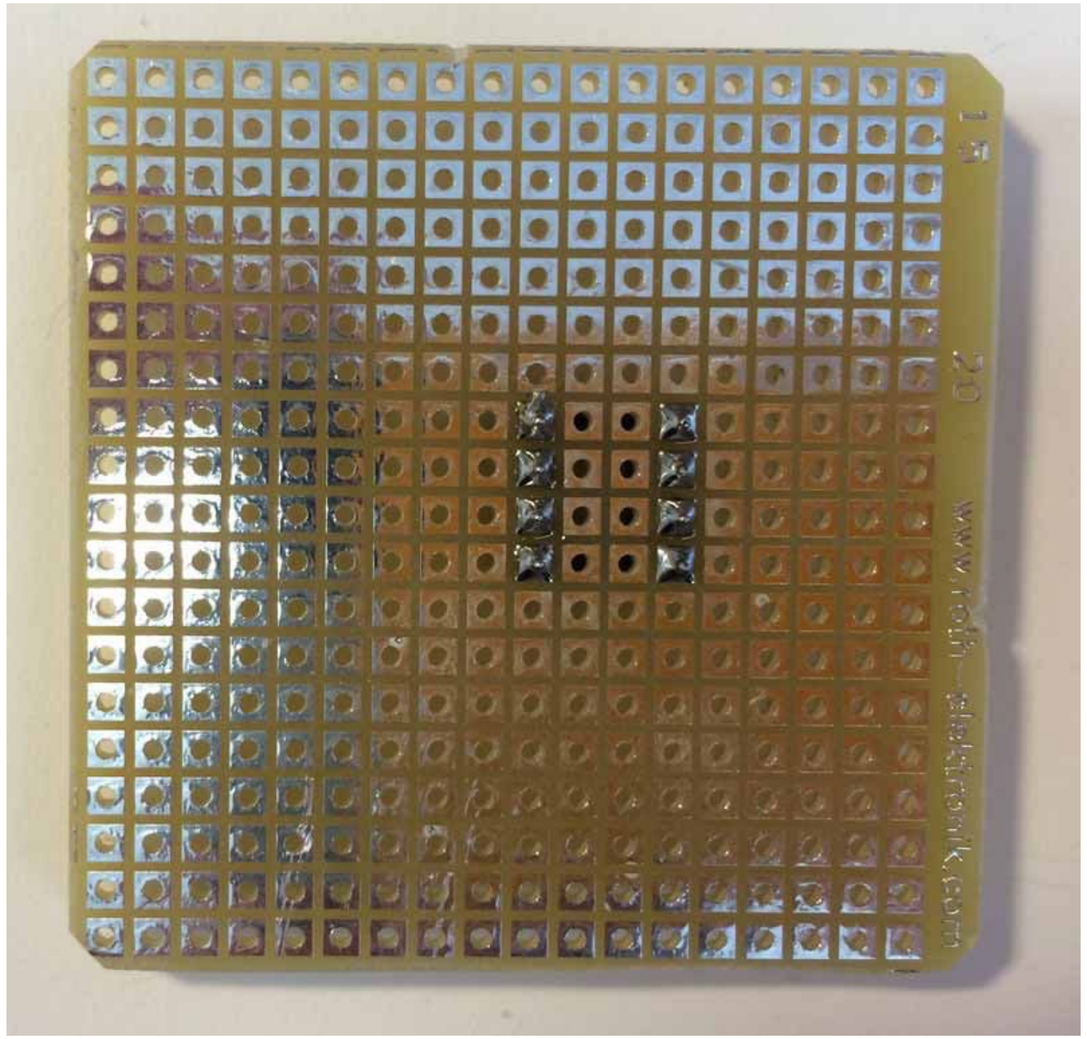

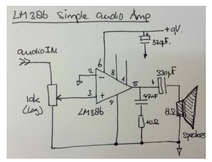

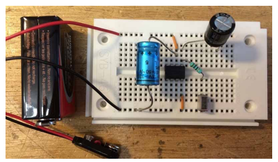

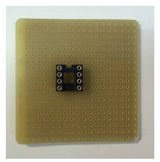

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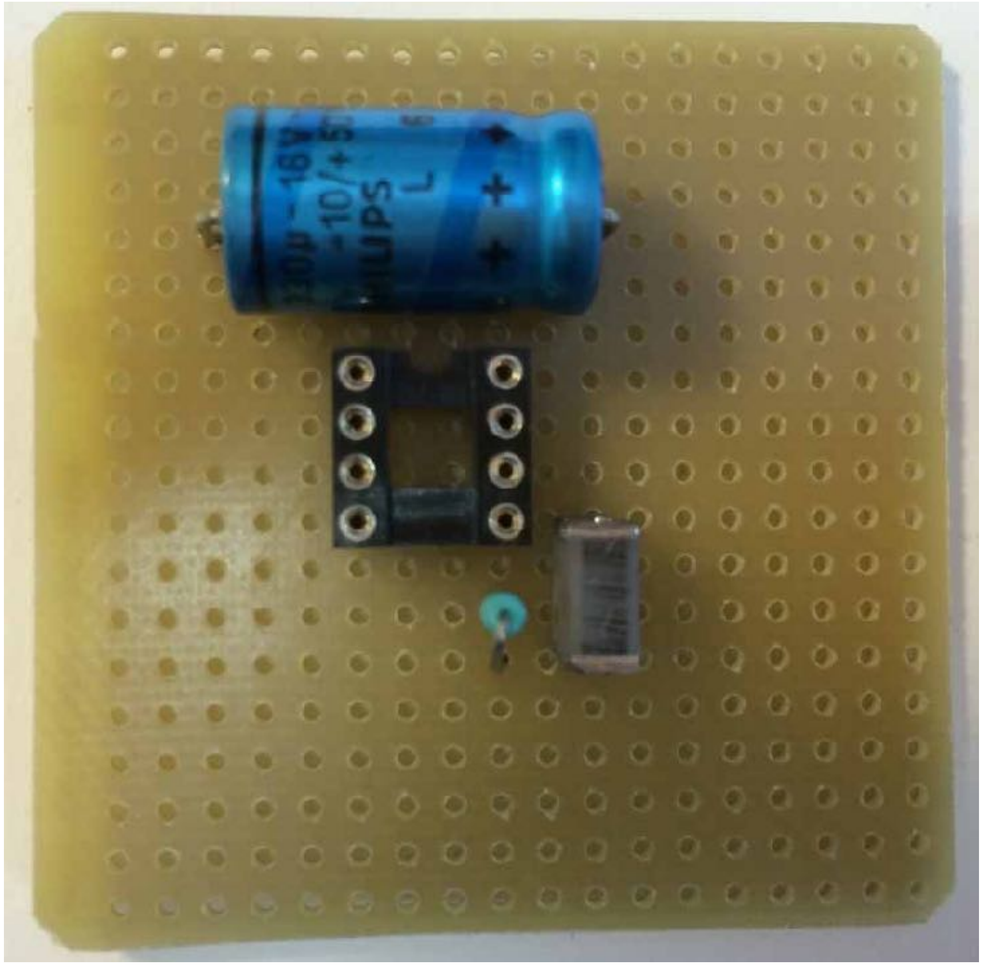

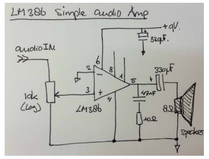

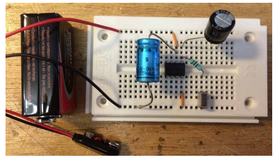

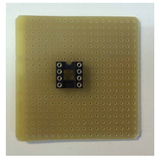

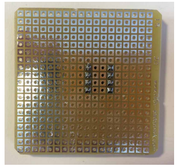

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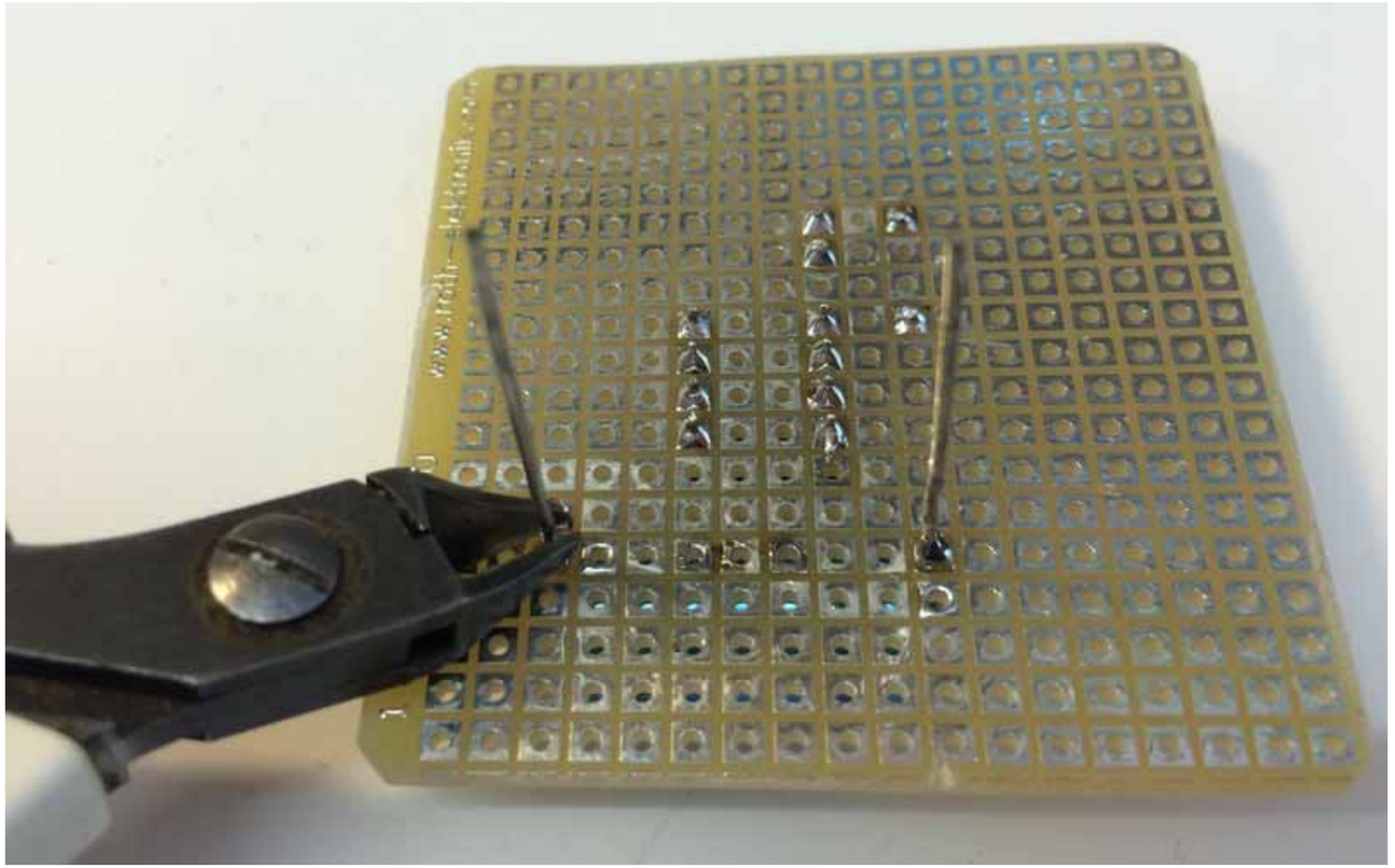
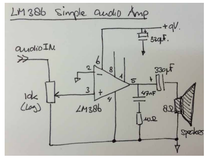
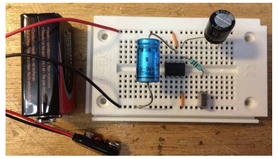
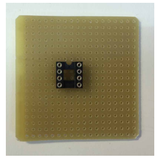
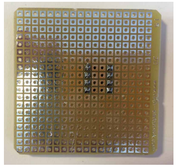
Example:

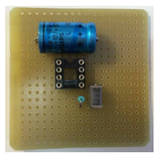












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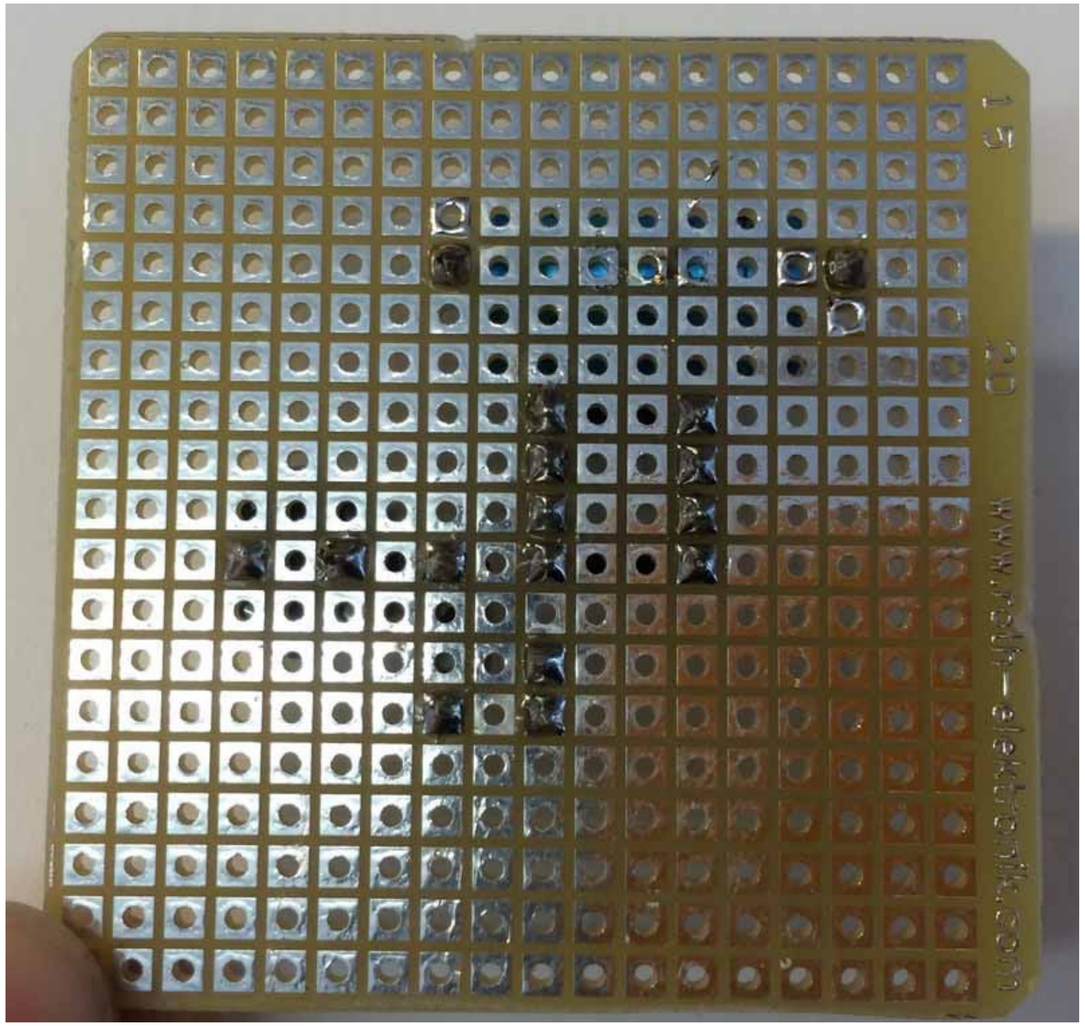

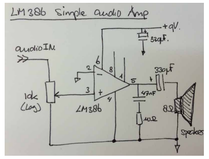

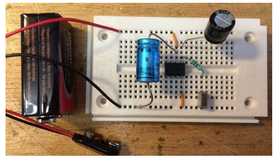

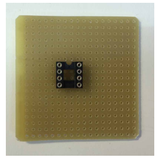

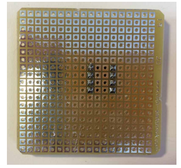

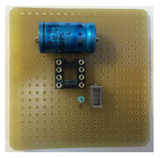

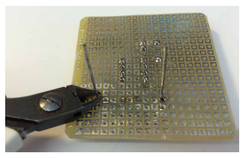

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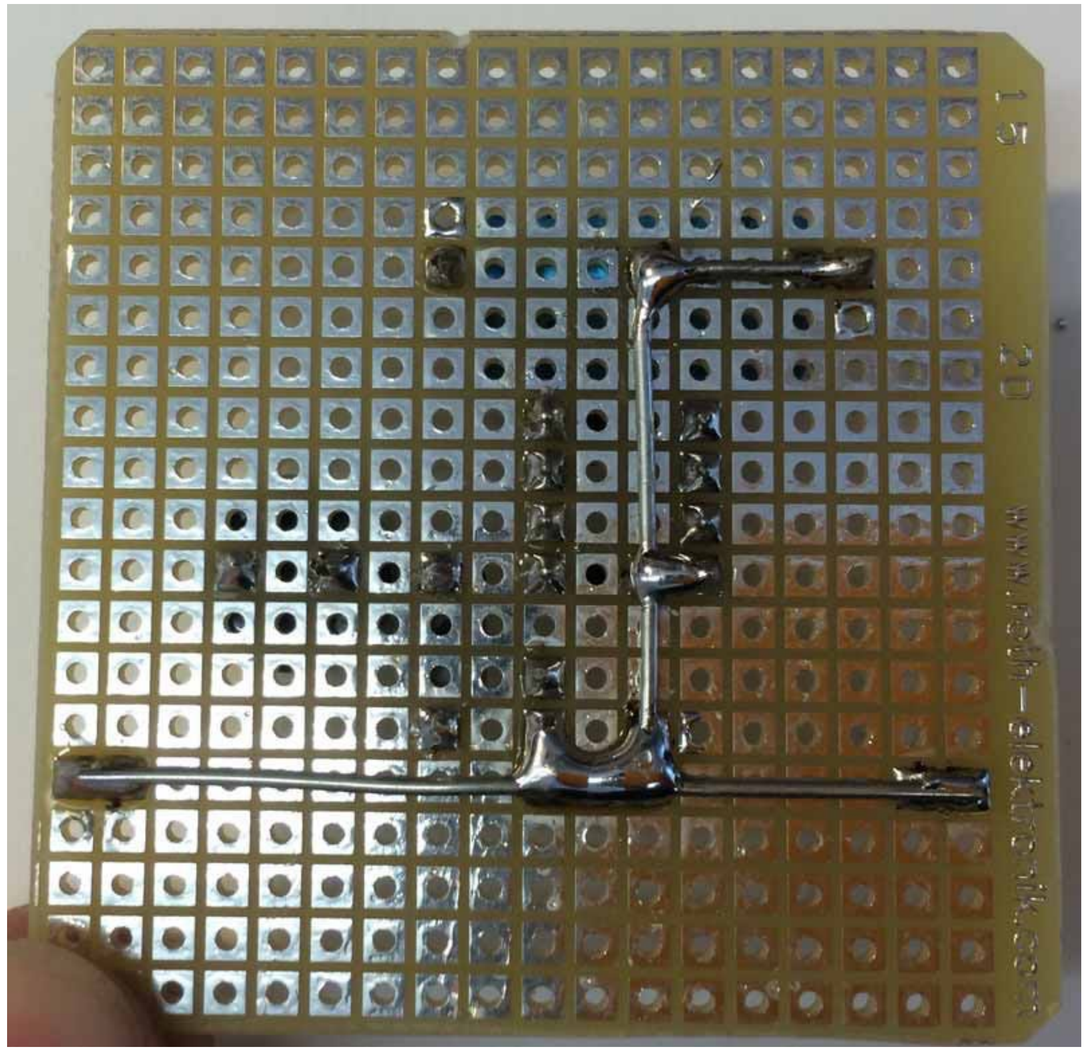

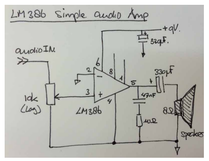

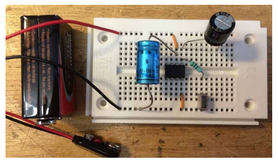

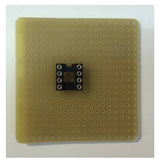

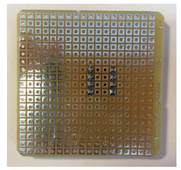

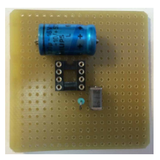

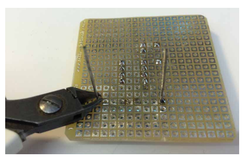

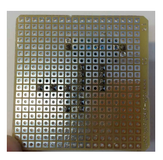

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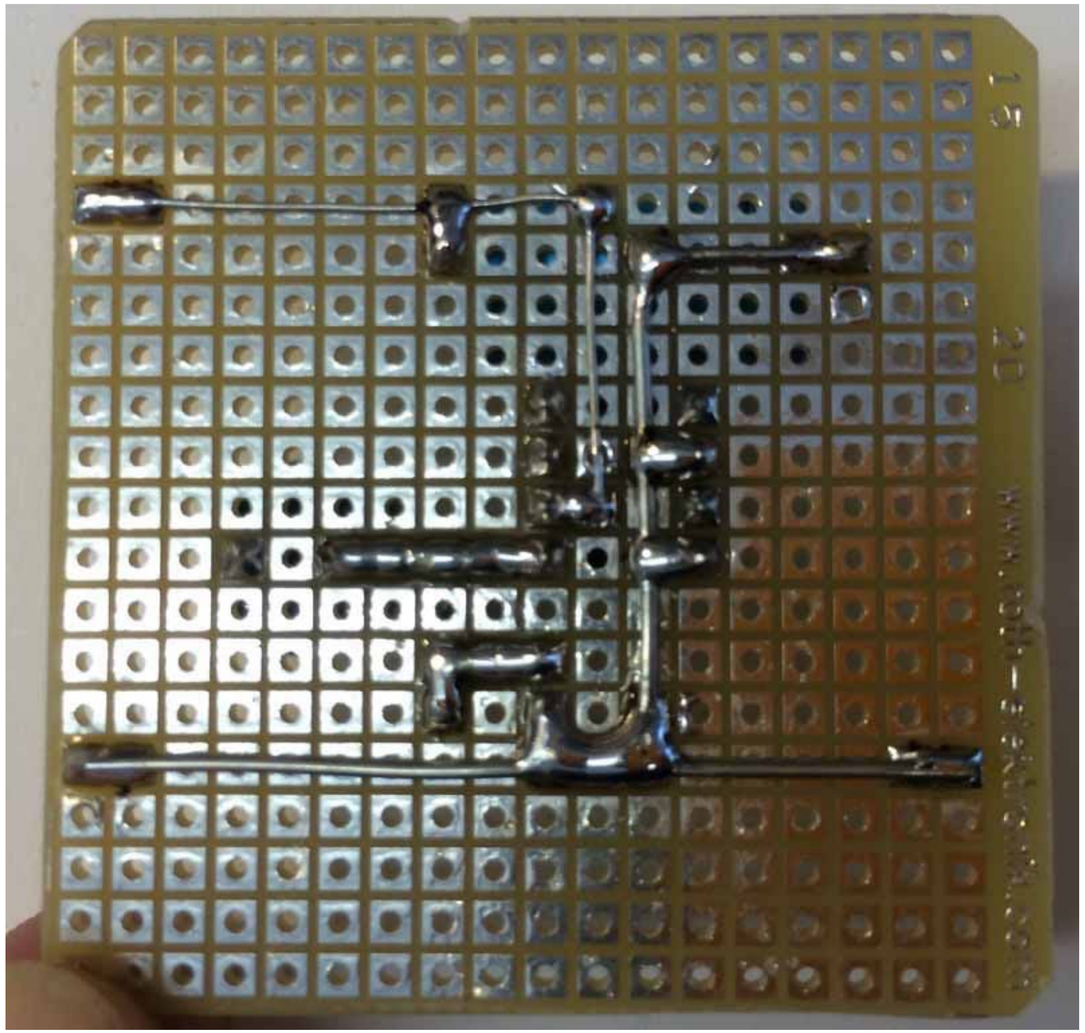

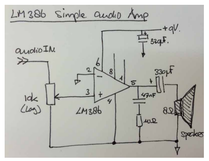

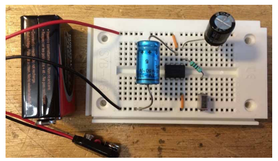

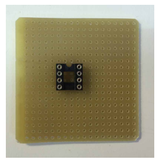

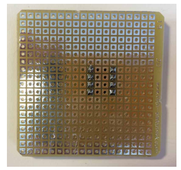

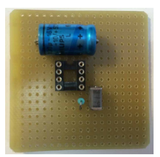

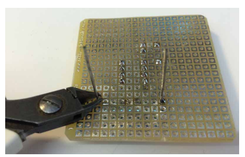

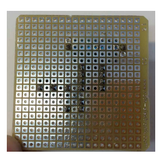

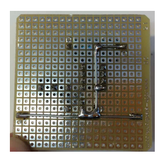

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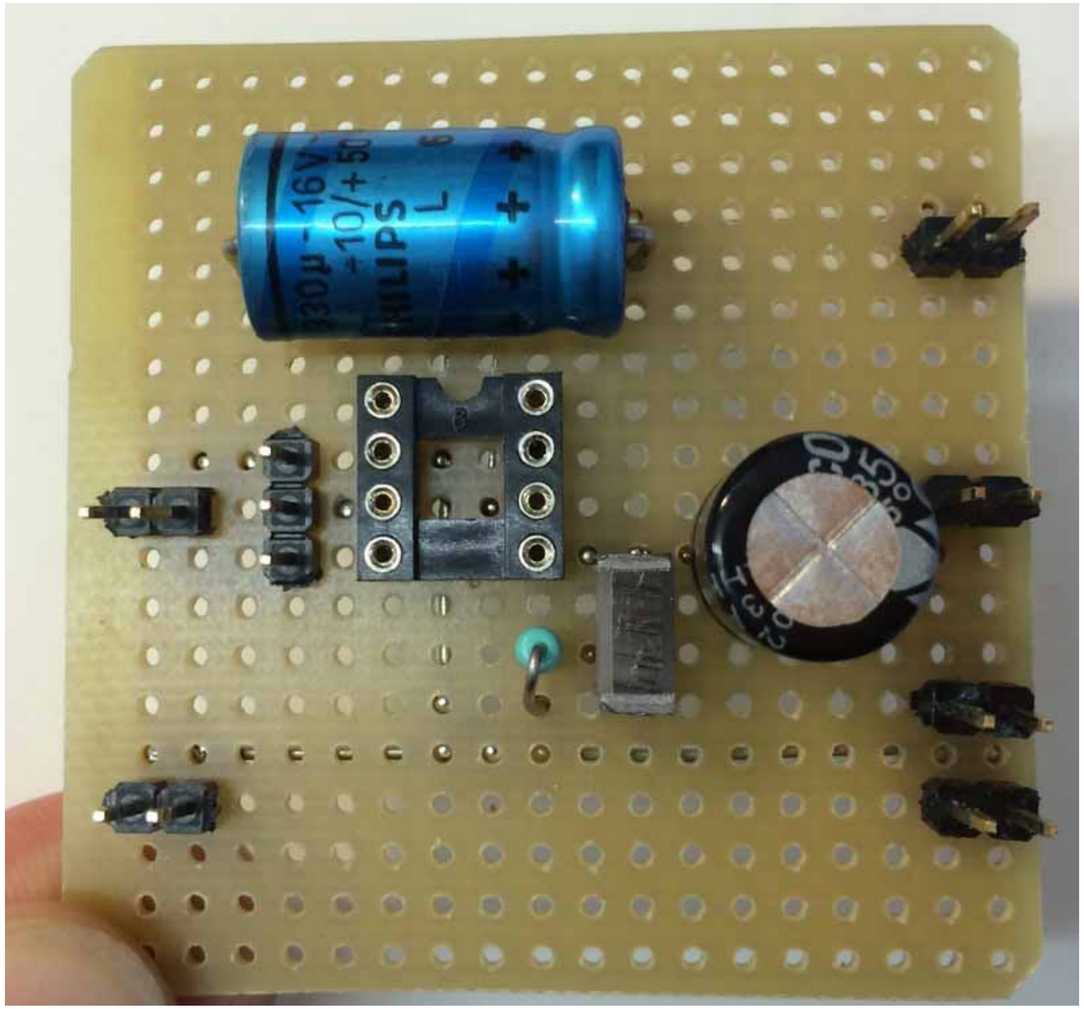

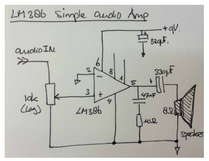

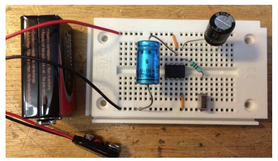

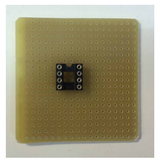

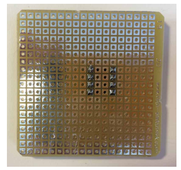

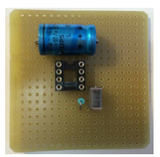

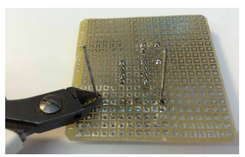

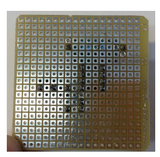

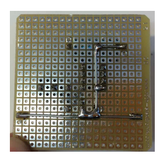

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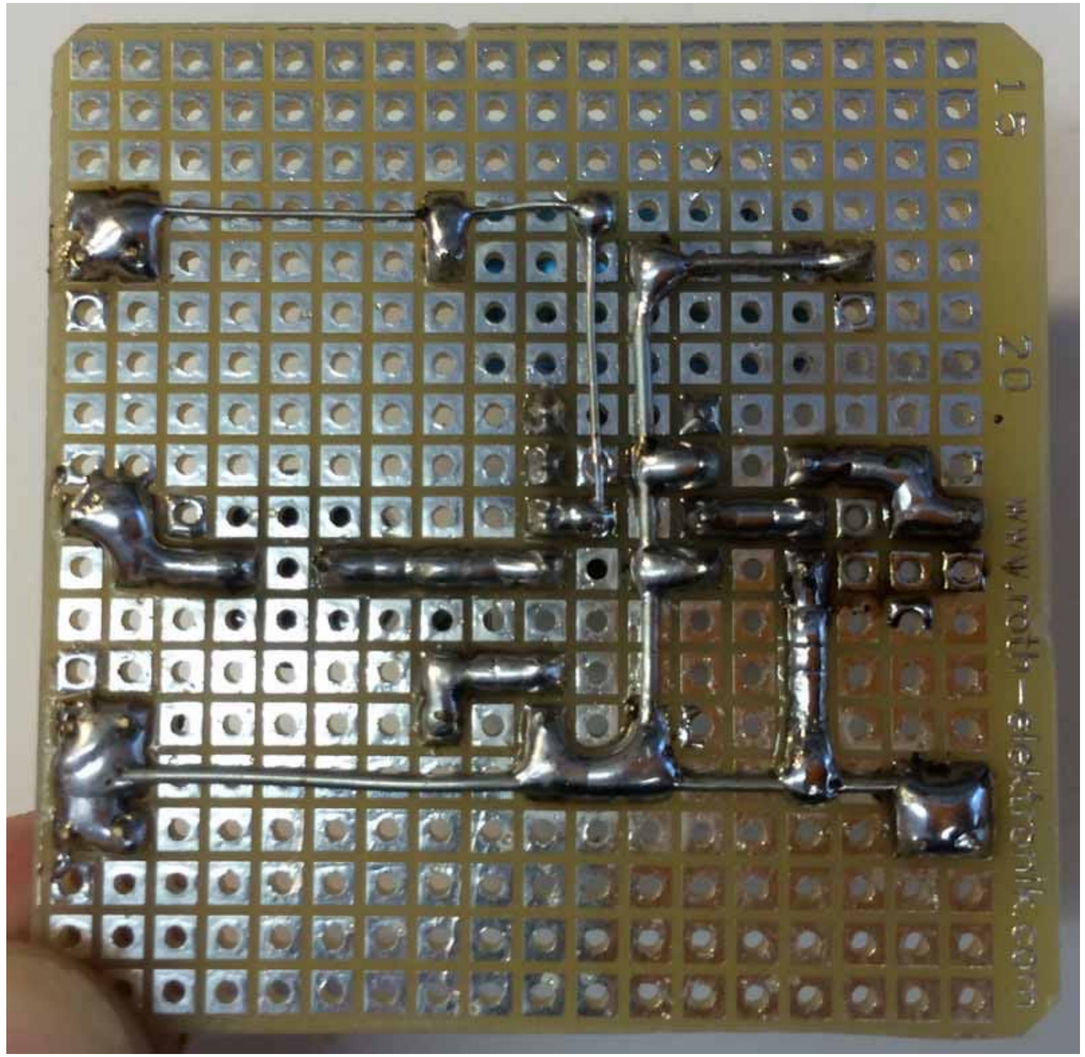

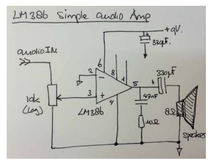

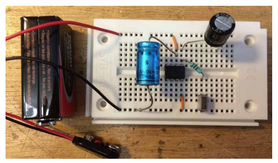

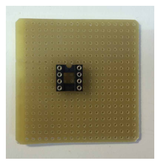

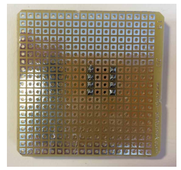

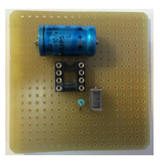

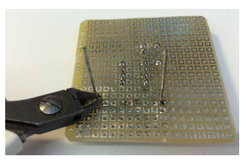

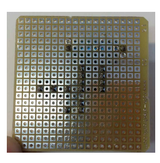

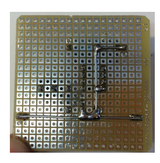

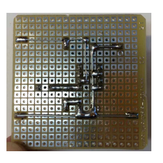

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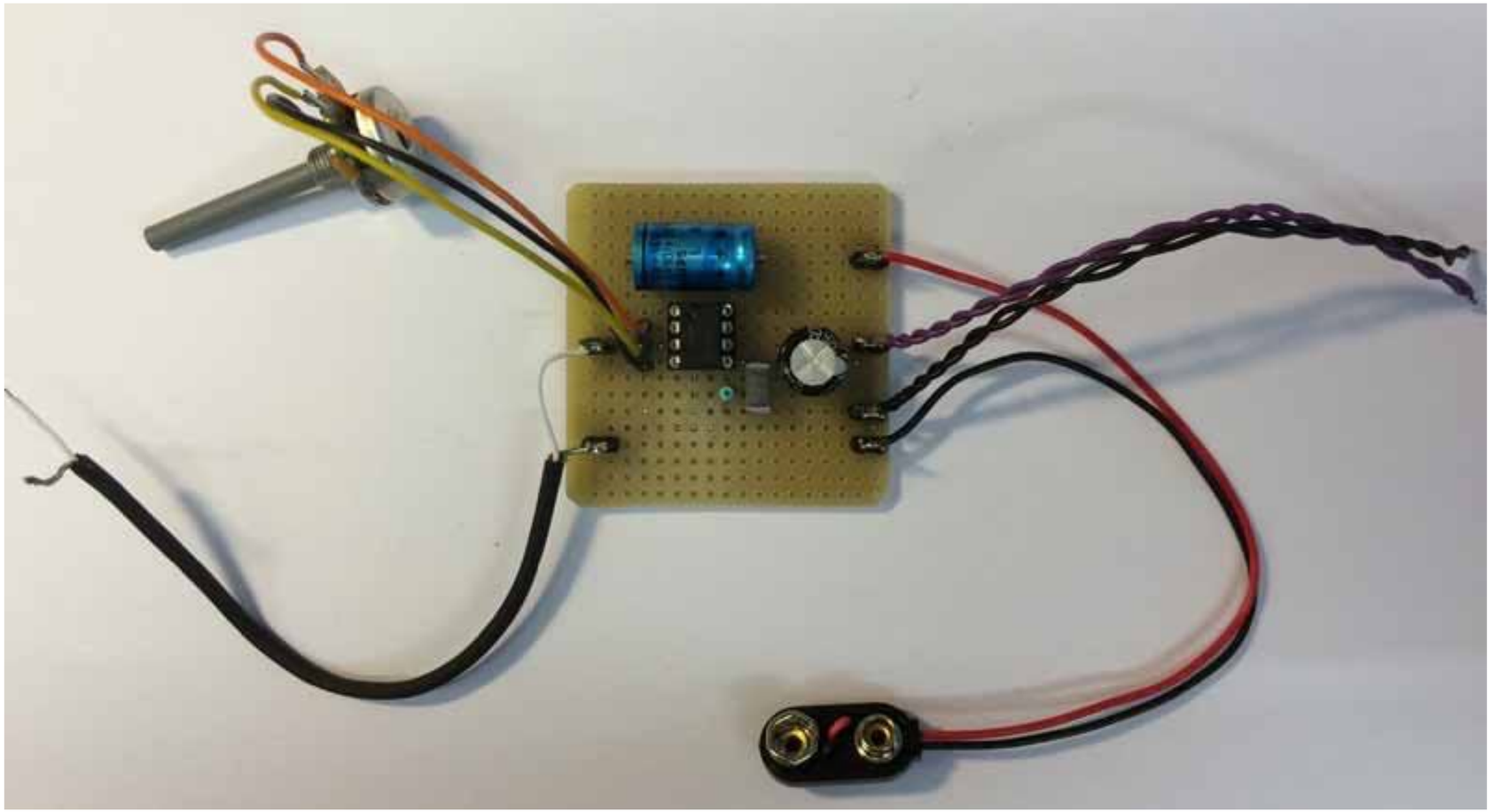

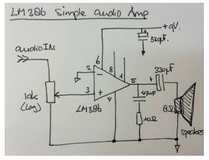

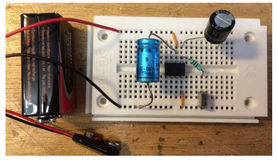

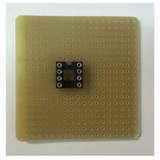

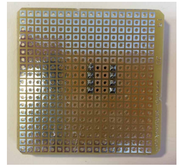

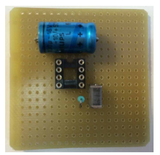

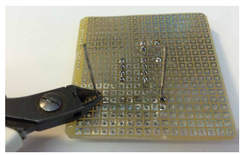

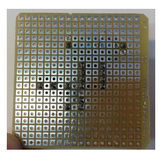

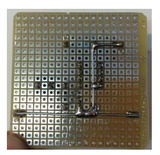

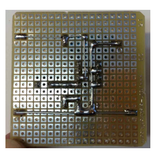

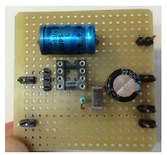

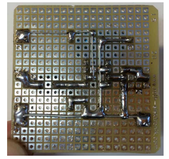

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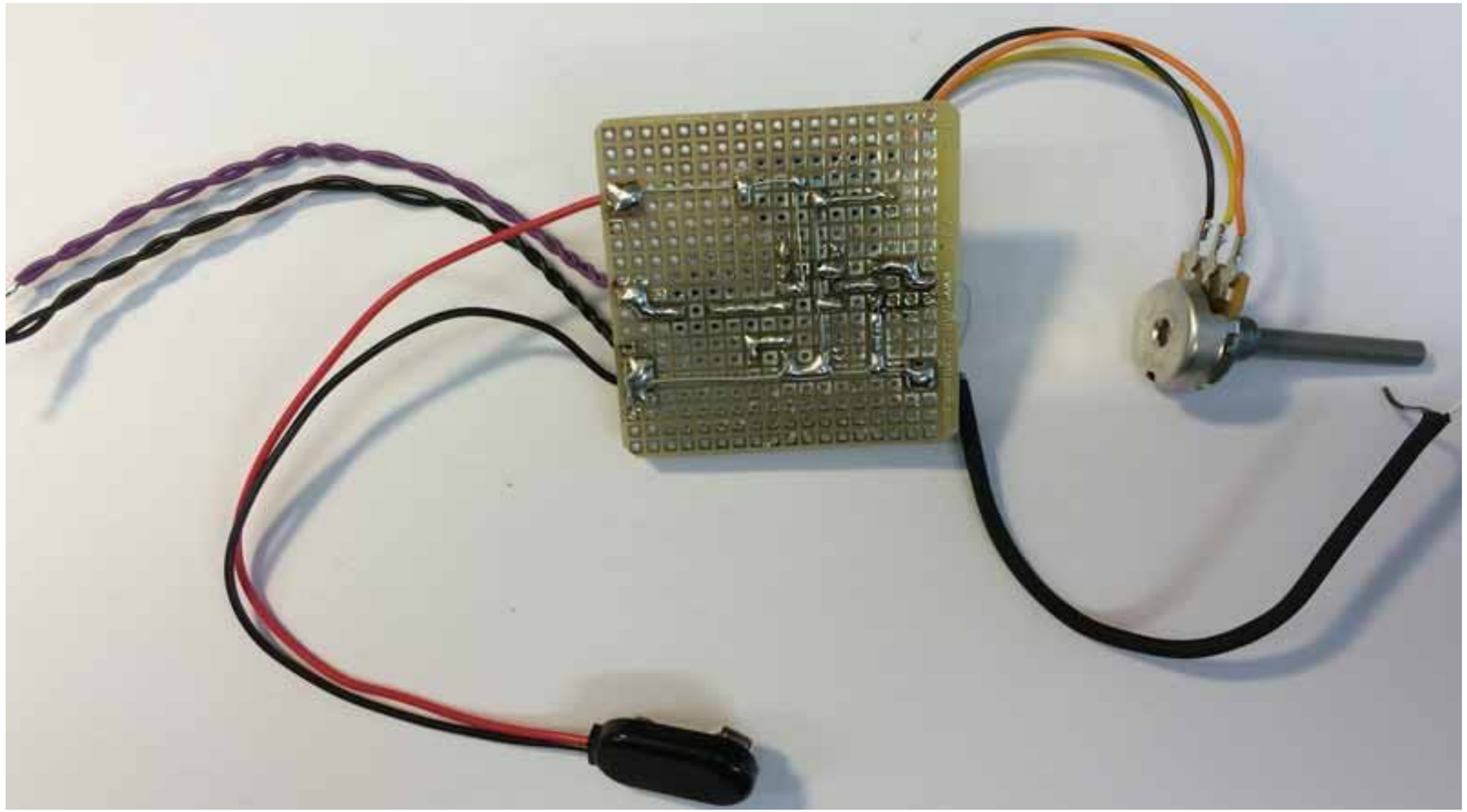

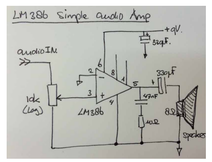

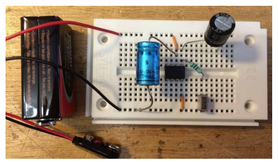

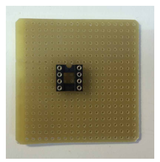

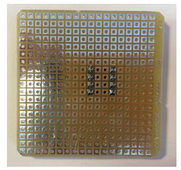

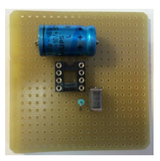

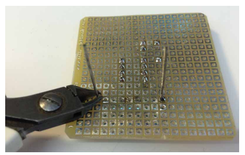

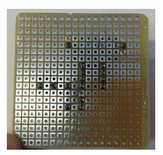

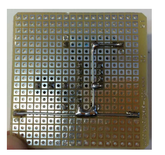

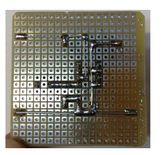

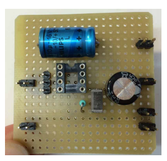

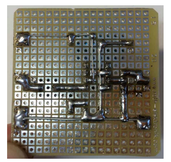

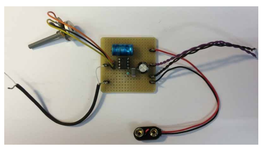

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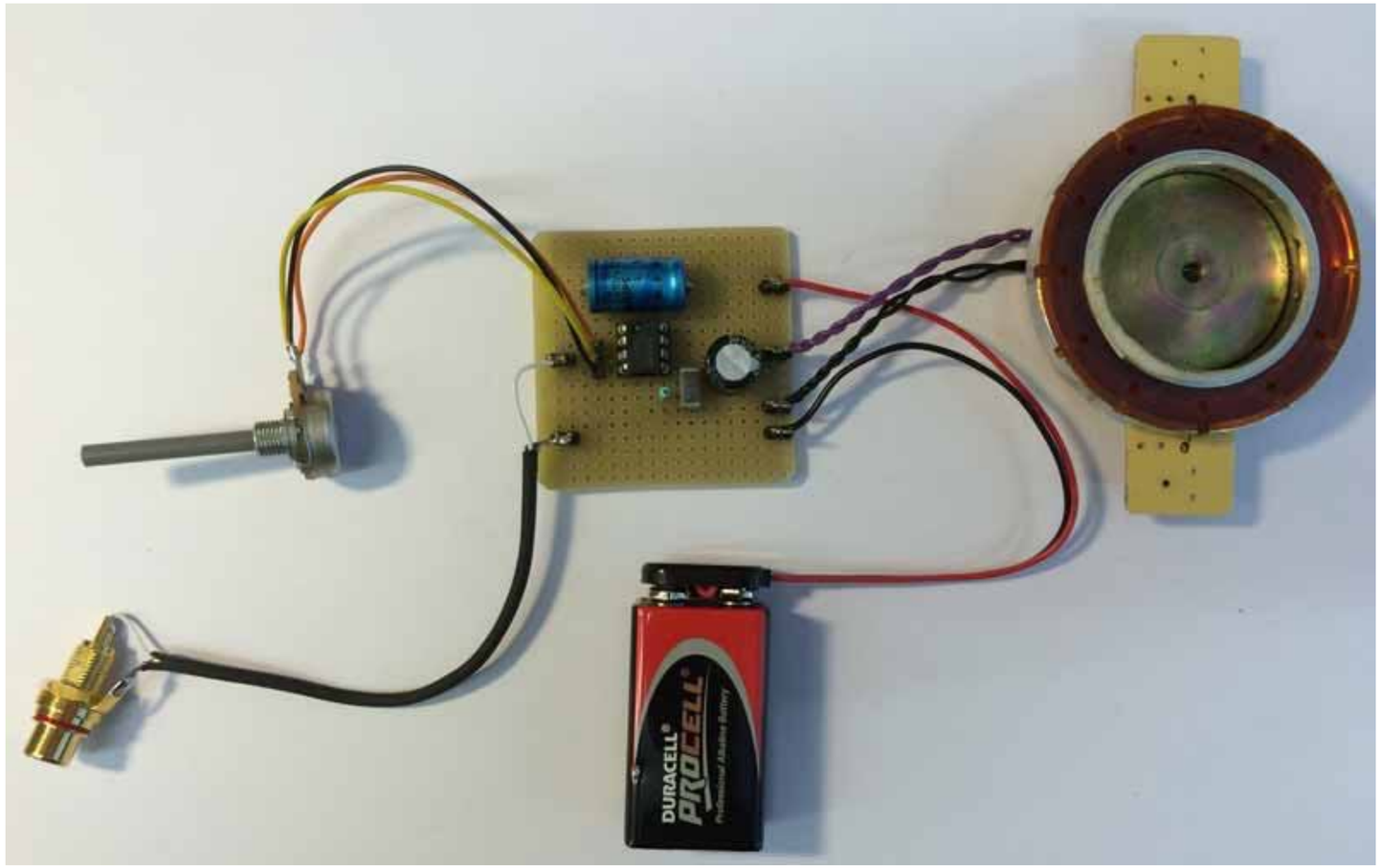

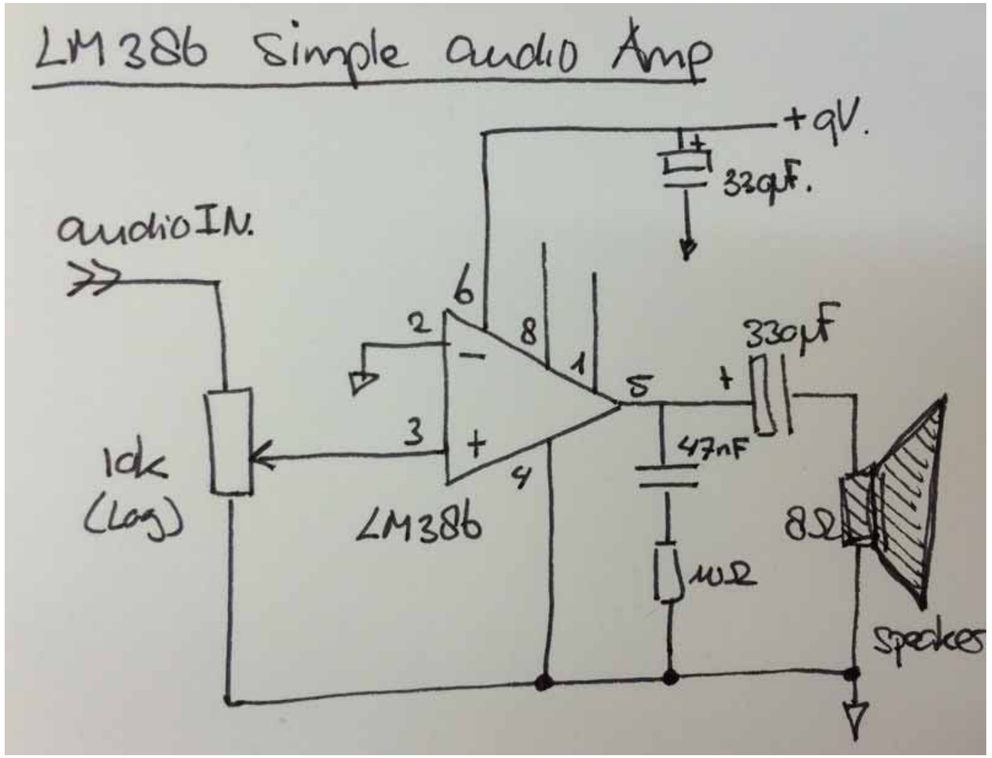

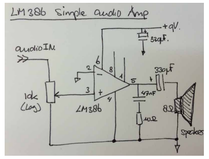
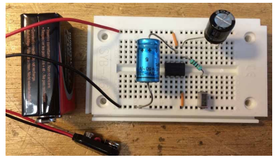
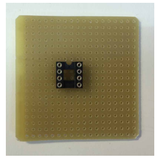
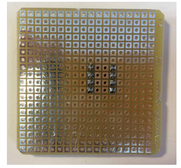
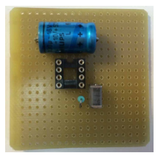
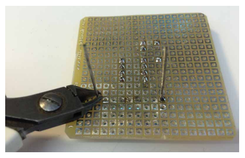
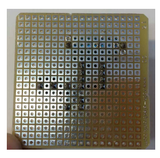
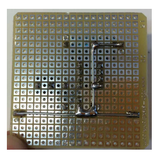
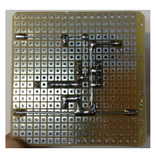
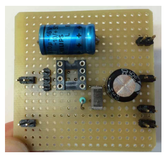
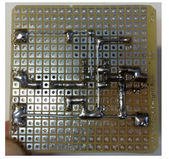
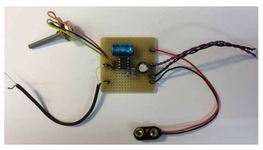

Sensors, Microcontrollers and Actuators

Building electronics
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