# Analogic sonometer


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# INTRODUCTION

When they got invented, sonometers were considered to be one of the finest inventions of the century.

A sonometer is an instrument usually used to measure the tension, frequency or density of vibration. They're mostly used in the medical domain to test both hearing and bone density.

During this mission we were told to build a sonometer that measures the sound level of its environment.

This will be displayed with lights. The higher the level is, the more lights will be turned on.

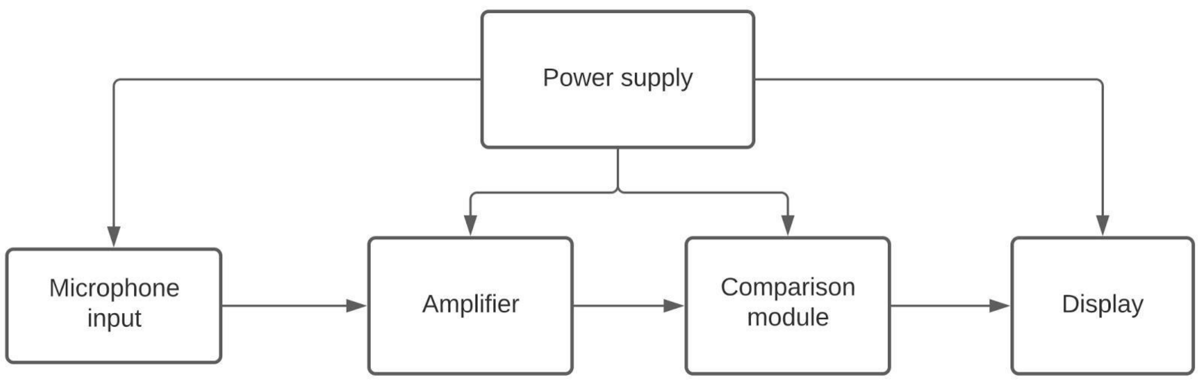
Every component is important in the sonometer and has its role. This circuit is composed of active and passive components.

When a component is active, it increases the power of the signal (amplifier for example).

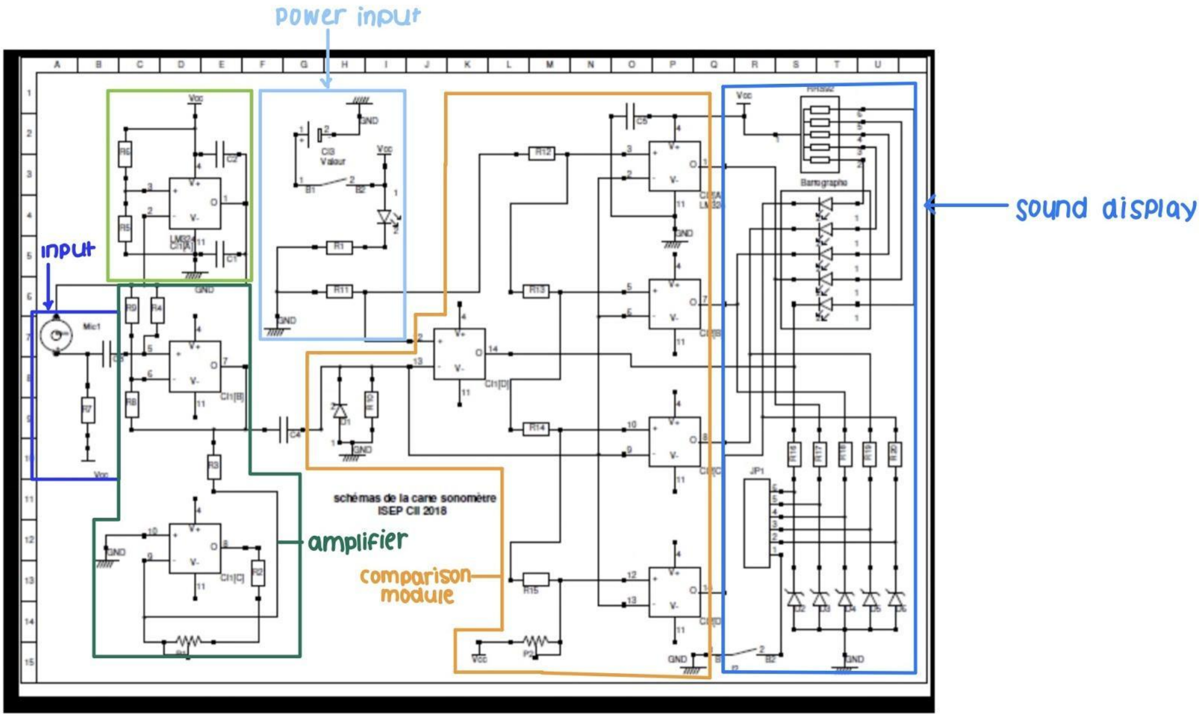
However when a component is passive, it restricts the power and intensity of the signal (resistances, capacitors...)

## I. Theoretical aspect

### I.1. Functional diagram




This sonometer can be divided into 4 main modules, which are the microphone input, amplifier, comparison and display module. There is also a power supply which distributes the voltage to the different modules. See the different parts below for further explanation on each module.




## I.2. Values of our components

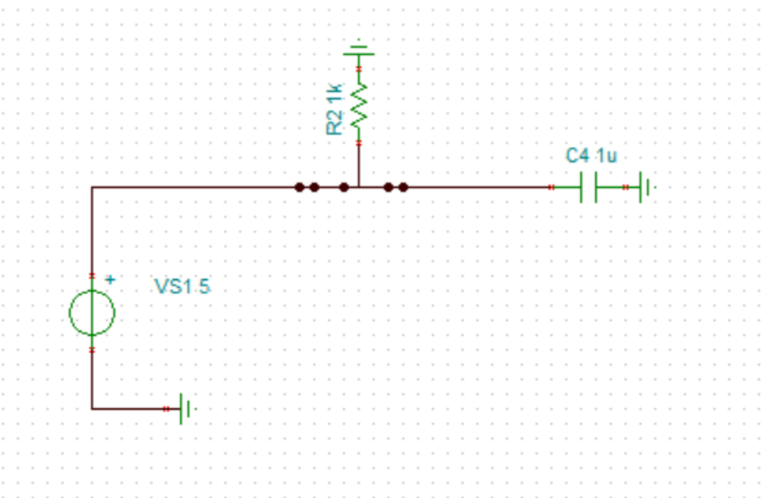
| Resistances & Capacitors | Values (in , or F) |
|---|---|
| R1 | 10k |
| R2 | none |
| R3 | 820 |
| R4 | 1,5k |
| R5 | 10k |
| R6 | 10k |
| R7 | 2.2k |
| R8 | none |
| R9 | 1,2k |
| R10 | 1k |
| R11 | 2k |
| R12 | 2k |
| R13 | 2k |
| R14 | 2k |

| | |
|---|---|
| R15 | 2k |
| R16 | 1.2k |
| R17 | 1.2k |
| R18 | 1.2k |
| R19 | 1.2k |
| R20 | 1.2k |
| RRS92 | 470 |
| C1 | 100p |
| C2 | 100p |
| C3 | 1 micro |
| C4 | 1 micro |
| C5 | 1 micro |

## I.3. Modeling of the different modules with Tina

The 4 main modules could be represented as 5 blocks which are the receiver, the amplifier, the comparator and display and the virtual mass. Here, we are going to present them.

- **Receiver:**




In this module, we can find an electret microphone. The electret can be compared to a capacitor. Indeed, it has a polarity. Because it's similar to a capacitor, it has to be constantly charged. Its goal is to transform a sound signal into an electric signal which is usually in mV. This signal then goes on to the amplifier module.

## ❖ <u>Amplifier block :</u>

Let's take a look at the Op-Amp (or operational amplifiers). The Op-Amp is an electrical amplificator which amplifies the difference of potential present at his input. The reason why we put capacitors just before the amplifier is to make sure current can go through without risks of damaging the Op-Amp.

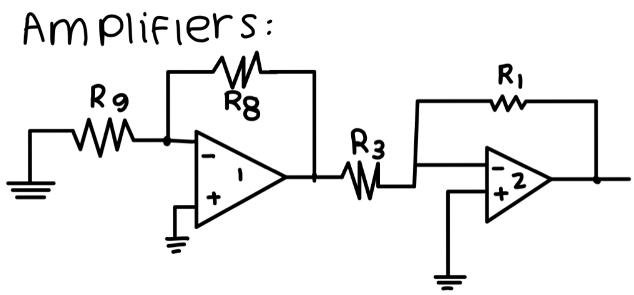
For this amplifier module, we assembled 2 amplifiers connected to the comparator.

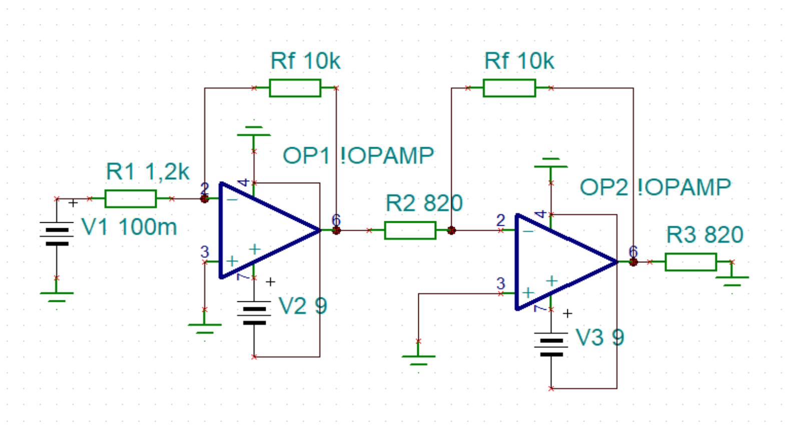
We are searching for the different resistance values, in order to obtain a total gain of 100. We have two amplifier modules, so we can use the following formula:

$$A = A1*A2$$

$$A = \left(-\frac{Rf}{R1}\right) * \left(-\frac{Rf}{R2}\right)$$

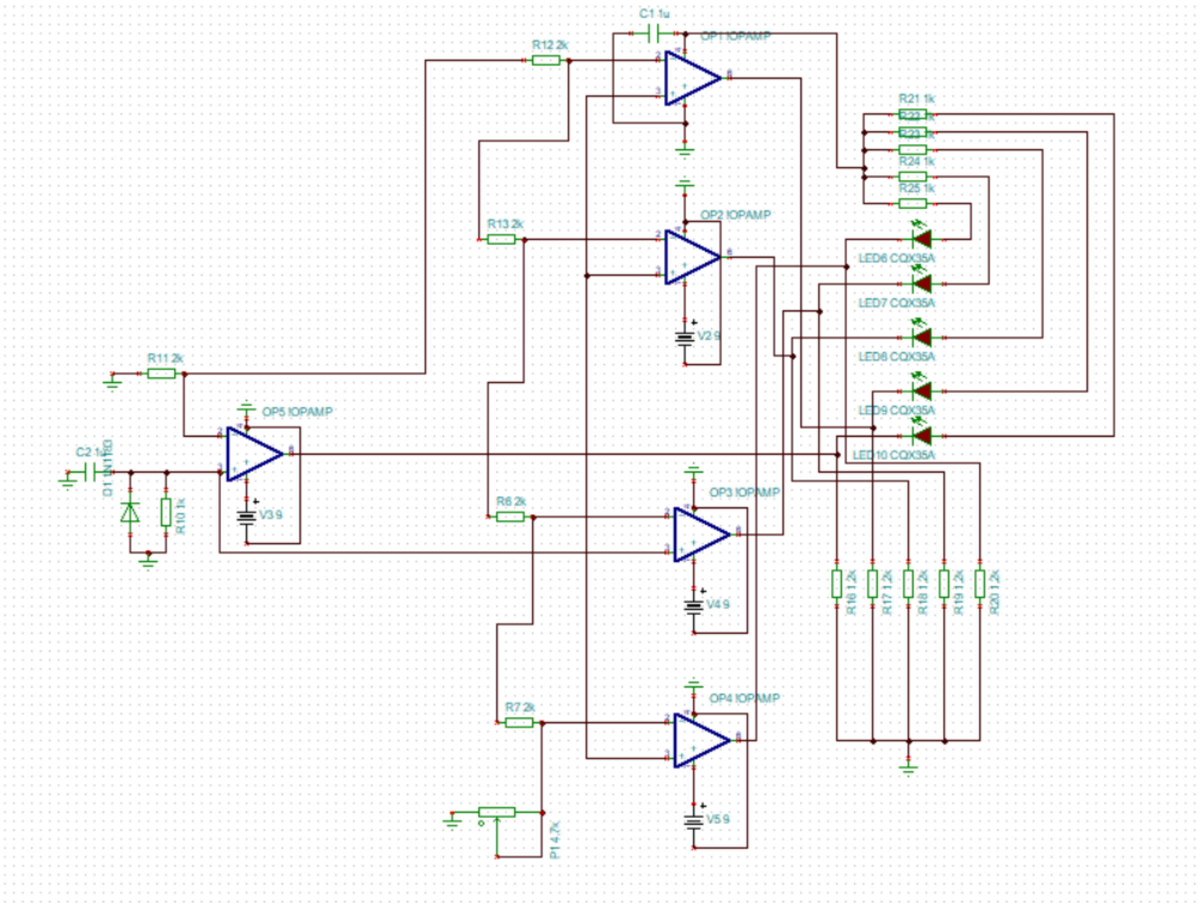
With here R8 being Rf for the first amplifier  A1 and R1 for the second one, A2. R9 represents R1 and R3 represents R2.



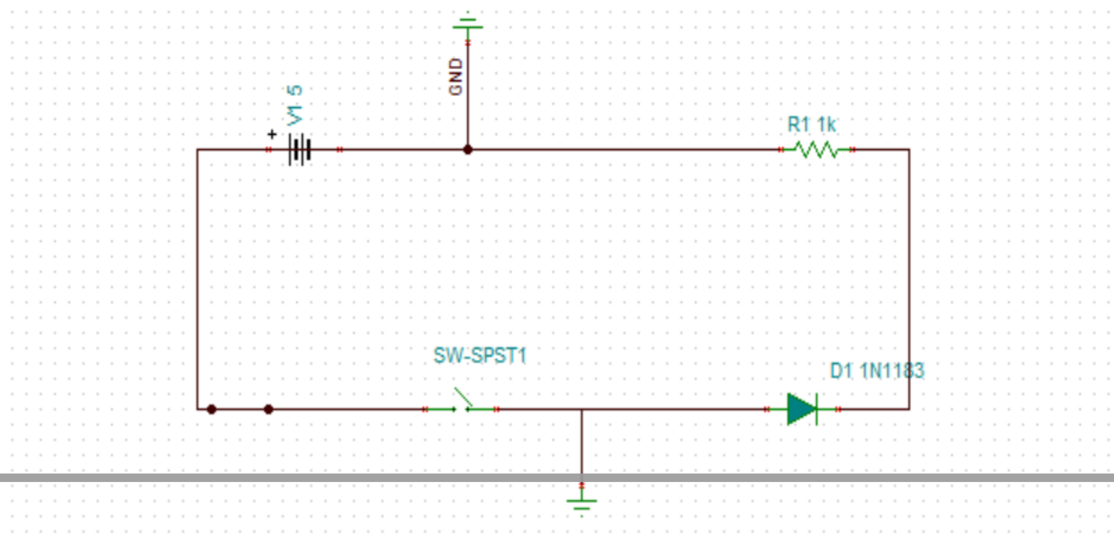

We obtained, $G_{exp} = \frac{Vout}{Vin} = \frac{82.5}{0.1} = 82.5$ using $R_f = 10k\Omega$, $R_1 = 1,2k\Omega$, $R_2 = 820\Omega$.

## ❖ Comparator and display block:



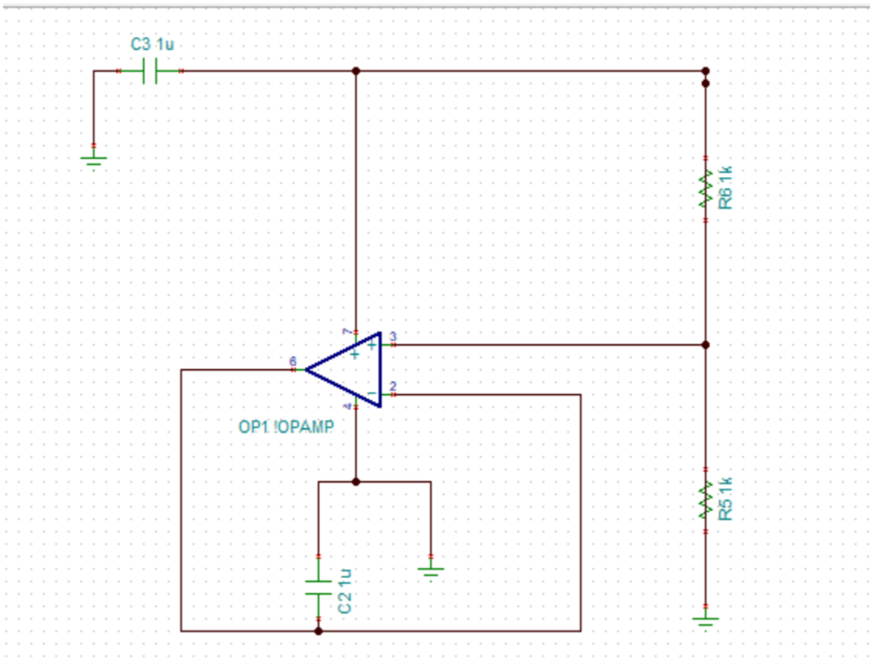
The comparator will compare the sounds it receives from the microphone to a threshold value. The sound level will then be displayed with the led. The diodes are all connected to other diodes that represent different levels. If the current flows through two diodes, two lights will get turned on.

## ❖ Power supply block:



The power supply is designed to provide a constant DC voltage of predetermined value (9V)

### ❖ Virtual mass:




The 9V power supply implies the necessity of creating a virtual mass to obtain Perfect Operational Amplifiers (POA), this way the power supply is symmetric. In addition, the virtual mass permits us to have another reference than GND (0V), so we can keep the negative part of the signal.

In the sonometer, the operational amplifiers are built in follower assembly. So we used the voltage divider, which divides the given voltage before each LED so that we can create a scale at the LEDs. As a result, we can observe a progressive increase depending on the voltage supplied by the electret microphone (sound sensor).

## II. Technical plan

After having a complete idea about the circuit and having each part drawn and simulated we started building our sonometer.

Using the table of components with all the correspondent values that we made we regrouped first all the components separately to make it easier and cleaner. We started to weld the switch first and then the power supply module and leading at the end to the receivers part of the circuit.

After finishing all the welding work and placing all our correspondent capacitors and resistors we cut the remaining tins that were dangling from above the integrated circuit.

It's time for our first testing :

When we tested our sonometer for the first time, the light didnt turn on while sound was emitted to the receiver (micro). After multiple troubleshooting we found out that the problem was coming from the switch which was burned. In this case our problem was a false soldering of a component into the circuit. To solve this issue we exposed our switch to high temperature so we can unsolder it and be able to remove it without damaging the integrated circuit.

After soldering a new switch the light blinked one time but our problem wasn’t fully fixed. So we noticed that the resistances 2 and 8 had too high values thanks to the diagram. We had to remove them.

So we un-solder it and we reversed it successfully. We plugged the power source again (9V battery) but it didn't work.

**Our solution :**

We removed R2 and R8 because they have very high resistance (10 000 ohms) and we replaced them with lower resistances values.

And finally everything worked.

# CONCLUSION

To conclude, a sonometer is a device that measures the sound level of its environment.

This project taught us to work in teams, in a limited amount of time. We had to calculate each component's value quickly at the beginning because we knew we wouldn’t have too much time afterwards.

The project allowed us to apply the lesson’s formulas in a real life situation. We had to stay organised and give everyone specific tasks. By doing this we were able to be pretty productive.

We learn how to use Tina and how to model a complex circuit diagram. We took notes after each session to avoid forgetting anything and then at the end, we completed the report, to make it the most understandable.

We  communicate by teams and that is how we were able to complete the report.

Finally, during this project we developed  problem solving skills to fix the device after multiple failed tests.