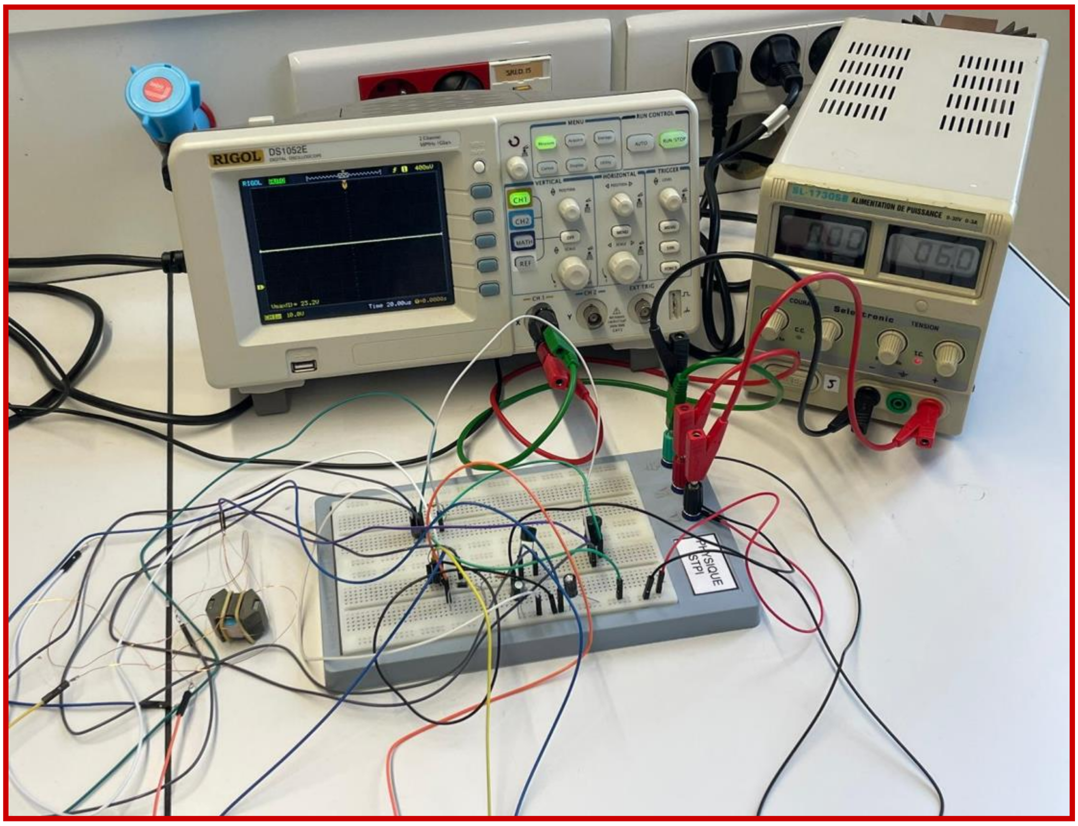
Projet de Physique P6
STPI/P6/2024 – 044

PORTABLE, BATTERY POWER SUPPLY FOR (PRE)AMPLIFIERS (AMPLIFICATEURS A LAMPES)



Students :
Etienne CROS
Muharrem FISGIN
Xiang Ning LIU

Professor in charge of the project :
Simon Busbridge

Acknowledgements

We would like to express our heartfelt gratitude to several individuals who have provided invaluable support and guidance throughout the duration of this project. Without their contributions, this project would not have been possible.

First of all, we are deeply grateful to Prof Busbridge, whose outstanding guidance and in-depth advice were crucial to the success of the project. His expertise and unwavering support were decisive at various key stages of our project. His ability to explain complex concepts in an easy-to-understand manner greatly enhanced our learning experience!

We are also profoundly grateful to the laboratory managers Pascal Williams and Michaël Jolly, whose assistance was indispensable in procuring essential components and providing access to the necessary equipment. Their prompt and efficient management of resources allowed us to maintain the project timeline and meet critical deadlines. Their willingness to facilitate our needs, even under tight schedules, demonstrated his commitment to supporting student projects.

Furthermore, we appreciate the administrative staff at INSA who ensured that our project logistics ran smoothly. Their behind-the-scenes efforts in coordinating laboratory schedules and managing the procurement process played a vital role in our project's progression.

In conclusion, the project has been a collaborative endeavor and we are deeply grateful to all those who have contributed to its success. We have gained invaluable knowledge and skills through this experience and we are very grateful for the opportunity to work with such supportive and knowledgeable people.

INSTITUT NATIONAL DES SCIENCES APPLIQUÉES ROUEN NORMANDIE

Projet title : *Portable, battery power supply for valve (pre)amplifiers (amplificateurs à lampes)*

Type of project : *Study – Simulation – Electronic realisation*

Project Objectives :

**The primary objective of this project is to design and construct a transformer that converts a low DC voltage into a high DC voltage. Specifically, we aim to:*

1.Develop a step-up transformer to achieve the necessary voltage increase.

2.Understand and apply the principles of electromagnetic induction to build and test the transformer.

3.Construct a functional oscillator to convert DC to AC voltage.

4.Design and implement a rectifier to convert AC back to DC voltage at a higher potential.

5.Ensure the final design is portable and complies with the EU's Low Voltage Directive (2014/35/EU) by maintaining output voltage below 50V.

Keywords of the project : *Electronics, Transformer, circuit, pot-core*

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1. INTRODUCTION

During our 4th semester in INSA, we have participated in a scientific project. Our project was entitled "Portable, battery power supply for valve (pre)amplifiers (amplificateurs à lampes)" .

So, The objective was to build a step-up transformer that converts a low DC voltage into a high DC voltage. But with the advice of our teacher, we decided to reduce the voltage below 50 volts because the European Union's Low Voltage Directive (LVD) law numbered 2014/35/EU pushed us to make this decision. This law brings various regulations to system operations above 50 volts. The most important thing that needed to be done to achieve the project was a transformer. For this reason, let's start by explaining what a transformer is and a brief history of it.

Transformers can be defined as an electrical device that converts alternating current (AC) from one voltage to another using the principle of electromagnetic induction(mutual induction). Although the mutual induction principle that enabled the development of the transformer was discovered by Micheal Faraday in the 1830s, it took more than half a century for the transformer to be developed for commercial purposes other than scientific research. During this process, various scientists and engineers produced some transformers (Ottó Bláthy, Miksa Déri, Károly Zipernowsk, Lucien Gaulard and John Dixon Gibbs). Although these developments were exciting, the first commercial transformer demonstration took place in 1886 by William Stanley. With this demonstration, Stanley proved that transformers could regulate alternating current properly. Nowadays, they are used in many applications such as transformers are widely used in various applications including electrical transmission, industrial processes, and electronic devices. In particular, in solar panels, the step-up transformer type that we made in our own project is used.

In this project report, we first explain how we theoretically created this power circuit, then the methods we tested using and how we created the system based on the test results. The problems we experienced in this project and our attempts to solve them from an engineer's perspective are also an important part of this report. Finally, in the conclusion section, we write about the contributions of this project to us and our ideas about the project.

2. METHODOLOGY / WORK ORGANISATION

Description of the organisation adopted for the progress of the work

Last semester, we did a project in mathematics and coding (informatique), but the project we did this semester was the first project we did in the laboratory. Foremost, I would like to talk about the work we did during class time.

We had a Zoom meeting every Monday from 16:15 to 18:15. For the first lessons, we connected to the Zoom meeting from our home because we needed to understand the theoretical part and be able to design a power supply that we need. This process lasted until approximately April. Subsequently, we needed to be able to do practical work during the meeting, therefore we figured out it would be a better idea to meet together in the lab room and connect to the Zoom call from there. Indeed, Mr Busbridge could see what we had done or what we were doing thanks to our phone's camera. It was also easier to communicate.

Secondly, I believe it is important for the group to explain how we communicate. We created a WhatsApp group to ensure strong communication between group members. Since there are 2 international students in the group and the main language of the group project is English, we always spoke in English except when we were just Ege and Etienne when we spoke in French. We have created a collaborative folder on Google Drive containing a Google Docs that allowed us to start writing ideas for the report right from the beginning. We also created on this document a project timeline that we lengthened after every lesson, hence keeping track of everything. Being only 3 members has not required a complex organization. For this reason, we did not have any problems for communication. Since there was only one task to perform at the same time, we didn't work on many things in parallel. We preferred instead working all together at the same time as much as possible.

Furthermore, We would like to explain our weekly working hours and the parts that challenged us. We worked on average 3 hours a week on the project. We worked for long periods of time in the laboratory to finish the system, especially after the parts were completed. It took us a long time to understand the electrical principle behind the circuit. It also took us a long time to make the coil and connect it with the system.

Organization chart of tasks carried out and students involved

In our opinion, one of the most important things to be an engineer is sharing tasks. For this reason, everyone in the group agreed on sharing the tasks and accepted our sharing. Firstly, everyone took part in writing the report and making our step-up transformer in the laboratory. Etienne had the role of communicating with Pascal Williams in French. In fact, when we talked about the problems related to the project in the group, he had the role of conveying what we talked about to our teacher Busbridge. He also did research on understanding the electrical aspects, as he would write the work we did and results part of the report, which is the longest part. Ege wrote the introduction and organization part of the report. Since he wrote the introduction, he did research on the history and current uses of the transformer. At the same time, he converted the report into a Latex document and edited it there. Xiang Ning was the person who wrote the conclusion of the report and corrected English mistakes. Apart from this, he undertook the production of the PowerPoint and poster, and his creativity in visual presentation was the key to solving our problems.

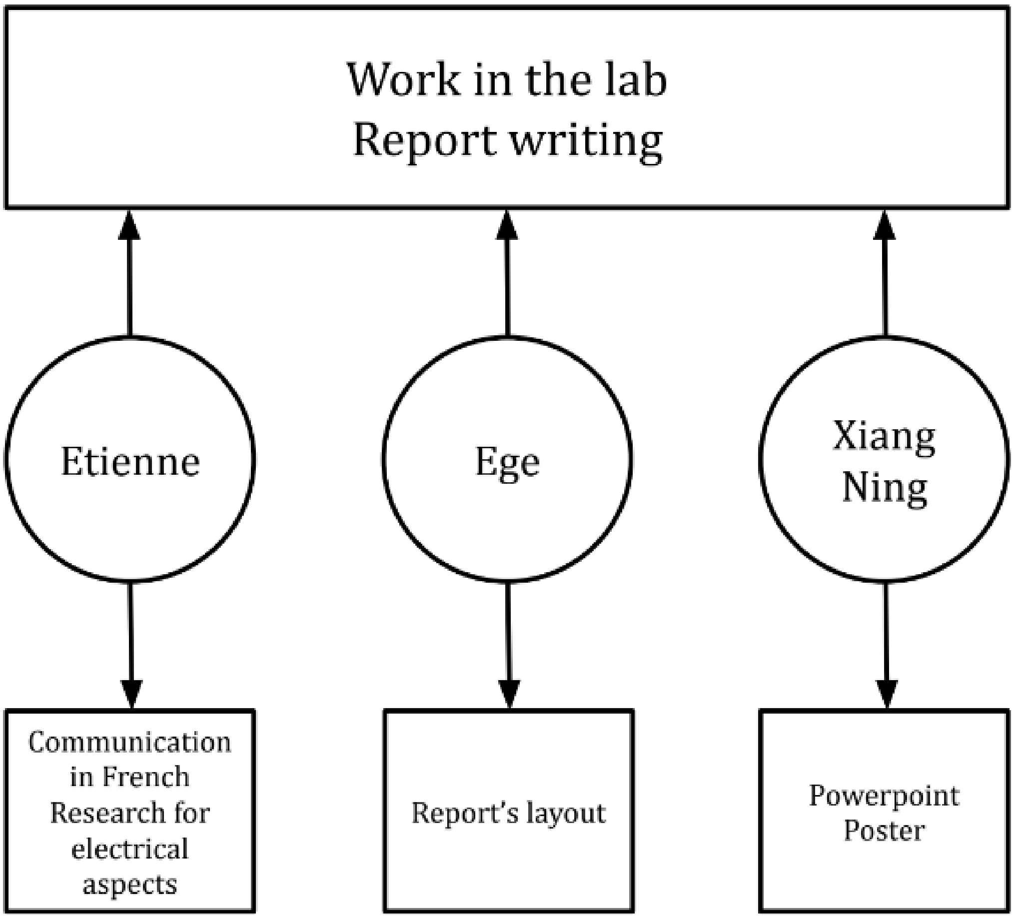


Figure 2.1 : Project organigram

3. WORK DONE AND RESULTS

We have divided this project into four main phases in the chronological order.

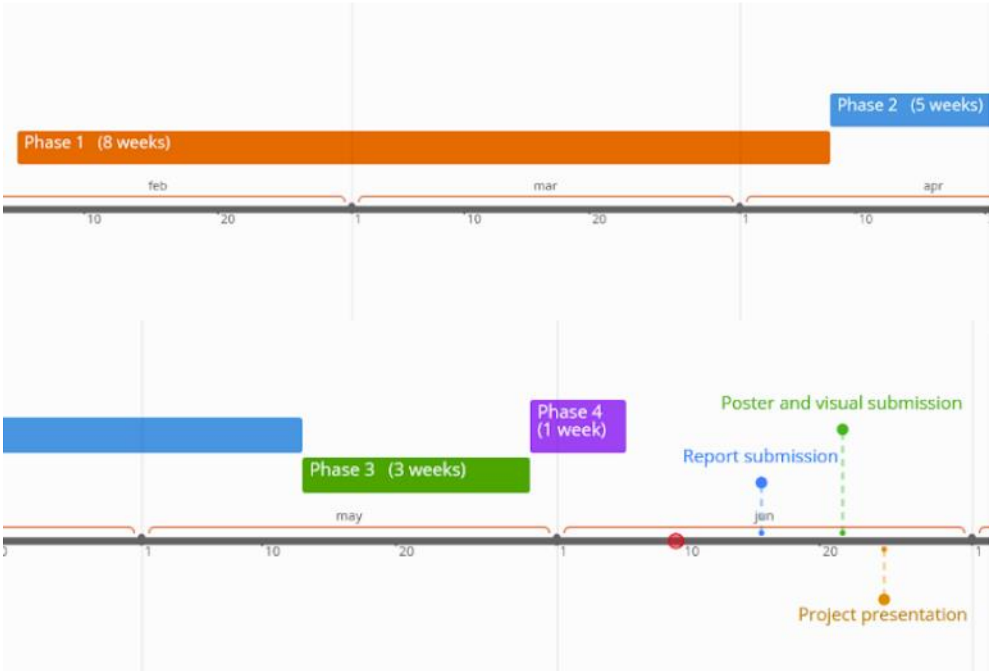


Figure 3.1 : Project timeline

3.1 Phase 1 : Project discovery and component procurement

During the first lesson, Mr Busbridge introduced to us the project.

We saw that the different steps of a project are :

1.Research 2.Planning 3.Design 4.Simulation 5.Construction 6.Testing, Measurement, Evaluation of performance 7.Write a report, Make a presentation

As an introduction, we calculated that with an input voltage of 6V, 67 1.5V batteries connected in series would be required to get 100 V. This number is indeed huge. Therefore, using a transformer is a more realistic option.

From the start, our teacher gave us the final circuit. The goal being more to build the transformer than to design it.

We used the software LTspice to simulate the circuit.

As we can see on figure 3.2, the transformer is made up of 2 parts : an oscillator on the right and a rectifier on the left.

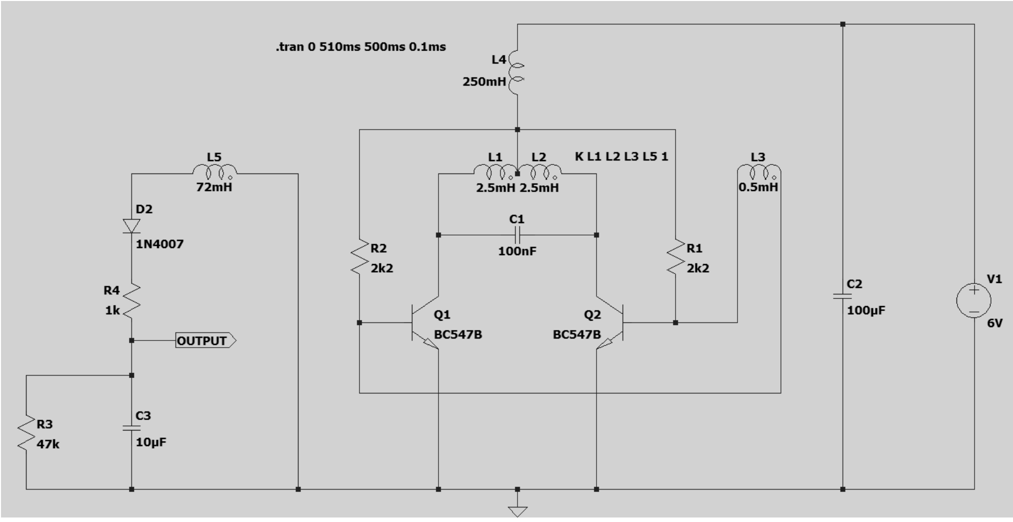


Figure 3.2 : Transformer final circuit on LTspice

We focused first on the oscillator.

The first task we undertook was to calculate the number of turns required to build L1, L2 and L3.

To do so, we asked Pascal Williams whether it was possible to order components. He then showed us the machine room and told us that we could take the components we needed and that the INSA could order the missing components.

We looked for an instrument capable of measuring inductance, such as a LCR metre but there were none at INSA. So we opted for another method called the RLC method. For this method, we had to set up a circuit containing a resistor, a capacitor and an inductor. The problem was that the INSA didn't have this last component, except for the big coils that didn't fit what we wanted to do. We also needed small diameter enamelled copper wires.

Therefore, we ordered a ferrite pot core and copper wire.

We had to choose those components very quickly so that the INSA could order them before the holidays and they would be delivered right after the holidays, and more importantly before Mr Busbridge came to INSA.

We had to consider many aspects before ordering the components.

First, we had to make sure the component met the desired specifications. For example, when we chose the wire, we had to pay attention that it was made out of copper, that it was long enough, that it would be enamelled and finally that the diameter was not too big since we could not get enough turns of wire on the bobbin, and not too small either since it would be difficult to use.

Another thing to consider was the country of origin of the component. Indeed, delivery times are often linked to this parameter.

And eventually, the product's price, in order to avoid unnecessary costs. When it was possible, we also tried to order components from the same manufacturer, since this often reduces shipping costs.

Taking all those things into consideration was a tricky task, but our teacher helped us. Moreover, placing the orders required good communication skills.

After the holidays, we ordered some other components which were necessary to complete the circuit, but less urgent than the components in the first order. These components were two NPN BC458A transistors and one 150 mH inductor.

Due to delays, the components all arrived one week after the holidays. Fortunately, it was on time for the week when Mr Busbridge was at INSA.

When Mr Busbridge checked the delivered components : everything was suitable except for one component.

Indeed, we had received the ferrite pot core, but the clips and the bobbin were missing. The purpose of the clips is just to hold the 2 halves together, so they can be easily replaced by rubber bands. However, the bobbin is essential and we could not have winded the wires directly to the ferrite pot core. We considered ordering this part on the internet but it was not available.

The only way was to build this part ourselves. We had 2 options : The first one was to design it on software and print it by rapid prototyping. The second option was to make it manually out of cardboard.

We opted for the second option because we figured out it would be faster, while leaving aside the first option in case we would have time later.

We started to take measurements of the pot core, using a calliper, to deduce the measurements of the bobbin. But then we had the idea to use the manufacturer bobbin's data sheet. See appendices.

We used thin cardboard as material.

First, we draw 2 rings with a pencil on the cardboard sheet and a rectangle of width the height of the bobbin and of length 2 times the perimeter of the bobbin, that is to say 2π times the bobbin's diameter.

Afterwards, we cut these shapes with a pair of scissors and obtained 3 pieces of cardboard. We folded the rectangle around itself with superglue to form a double-walled cylinder. We finally glued the two rings at the ends of this cylinder.

This process has required a lot of precision and patience.

When Mr Busbridge checked it, he noticed that the bobbin was too high, so much so that the two halves were not in contact and separated by some space. He mentioned that this detail made the bobbin out of use. Mr Busbridge suggested trying to gently remove the top ring and cut a little part of the cylinder to reduce the height and then glue back the top ring.

We tried to do so but the top ring was glued so much that it broke apart during the removal.

We had no choice but to build another bobbin. We understood that we had underestimated the height added by the glue during the glueing, so made a cylinder 0.2 millimetres less high.

It had the effect of reducing the height, but it was not enough. We tried to crush it to reduce the height. It did reduce the height but the shape was distorted and it did not fit in the pot core anymore.

So we started again a third time, with a height of 10 mm for the cylinder.

This third attempt was eventually successful and the bobbin fitted inside the pot core.

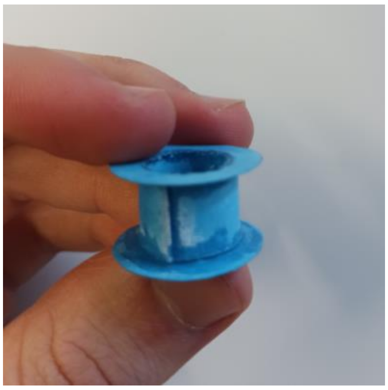


Figure 3.3 : Picture of the cardboard handmade bobbin

It meant that we had all the components we needed, and that we were ready to do the RLC method.

3.2 Phase 2 : RLC method

During this phase we calculated the number of turns for the inductors using the RLC method

3.2.1 Principle

The principle RLC method consists in finding the resonance frequency of an RLC circuit and then use the formula $f_{res} = \frac{1}{2\pi\sqrt{L_{res}C_{res}}}$ to deduce inductances or capacitances.

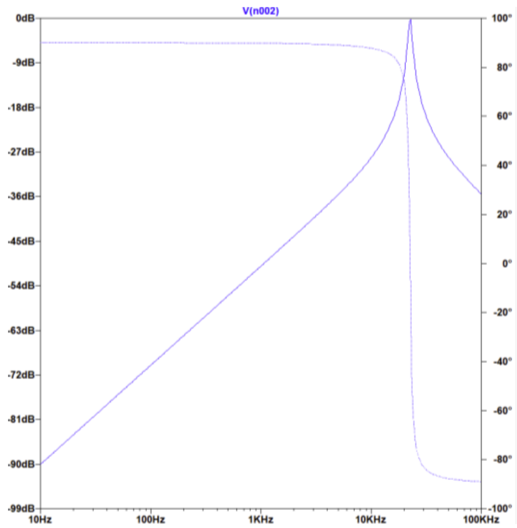
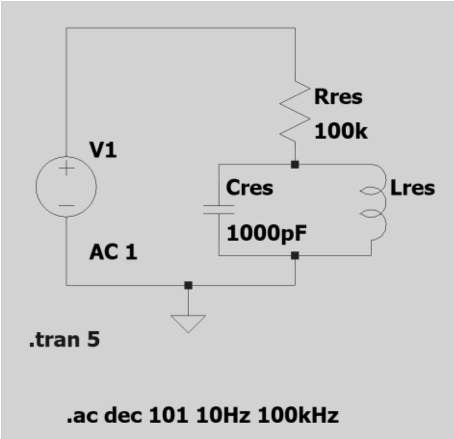


Figure 3.4 : Oscillogram of the RLC method simulated in LTspice

As we can see on the LTspice simulation of an RLC circuit (Figure 3.4), the amplitude increases until peaking at a particular frequency (the resonance frequency), and then decreases.

3.2.2 Experiments

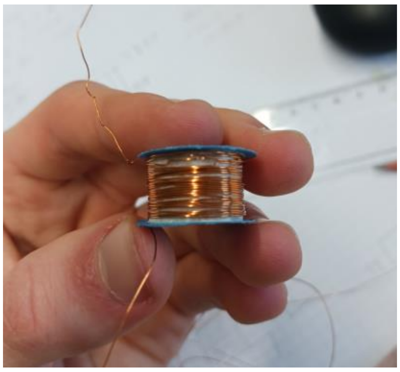


We set up this circuit in which the inductor Lres was handmade.

Figure 3.5 : RLC method Circuit in LTspice

We had to wind about a hundred turns around the pot core to build Lres.

We started winding and figured out it would be good to make layers of 20 turns. We winded 20 turns, then we put a layer of masking tape. After having repeated this operation 4 times we figured out there was no room for the fifth layer. 80 turns seemed



to be enough, so we stopped there.

Figure 3.6 : Picture of the bobbin during the windings

The copper wires were obviously too thin to be directly connected to the breadboard so we soldered the copper wires to bigger wires that fitted on the breadboard called jumper wires.

First, we had to remove the insulation part covering the last centimetre of the end of the wires.

Soldering looked dangerous and complicated at first sight, but with the right technique, it turned out to be pretty easy. To do so, we prepared a wet sponge. We turned on the solder iron and waited for it to heat up. Once hot enough, we covered the iron's tip with lead-tin alloy solder. We then applied the melted mixture at the junction between the copper wire and the bigger wire. One person approached the solder while another person held the wires. Once finished, we cleaned the tip with the sponge.

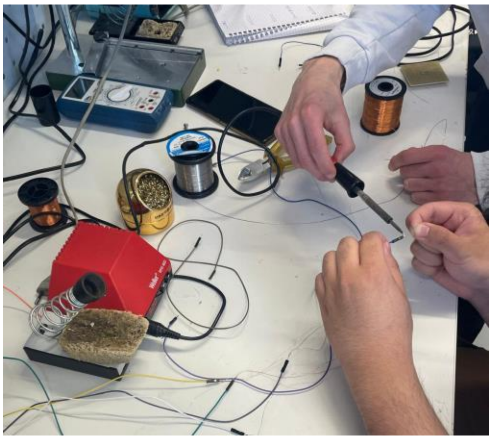


Figure 3.7a : Picture of the soldering

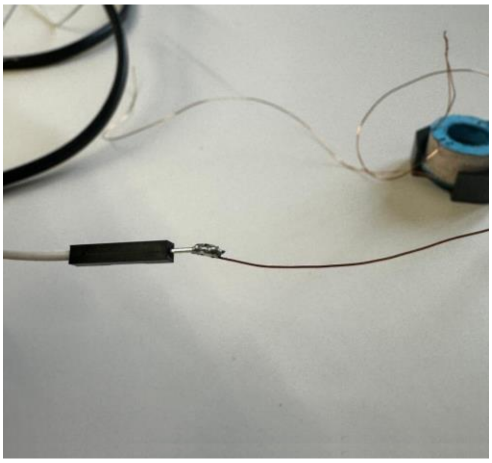


Figure 3.7b : Picture of a soldering connection

We set up the circuit, powered it with an AC signal generator, connected the oscilloscope in parallel to the inductor and adjusted the frequency to find the resonance frequency.

However the resistor's value was not suited and it resulted in a very flat signal.

After replacing the resistor by a better suited one, we could observe that changes in frequency resulted in changes in amplitude. We thought there was still something wrong since the signal was pretty unstable.

We learned how to adjust the oscilloscope's settings and started again another day. We found a frequency for which the amplitude was at its maximum. It was therefore the resonance frequency.

3.2.3 Results

We measured $f_{res} = 35\ kHz$.

The values of the components that we used were :

$R_{res} = 100\ k\Omega$ $C_{res} = 1000\ pF$ $N_{res} = 80$ turns

Thanks to the formula :

$$f_{res} = \frac{1}{2\pi\sqrt{L_{res}C_{res}}}$$

We have deduced the inductance of the 80 turns handmade inductor

$$L_{res} = \frac{1}{(2\pi f_{res})^2 C_{res}} = \frac{1}{(2\pi \times 35.10^3)^2 \times 1000.10^{-12}} = 2.07.10^{-2}H = 20.7\ mH$$

Using the formula :

$$L_{res} = x_{res}\, N_{res}^2$$

We have found the proportionality coefficient x_{res}

$$x_{res} = \frac{L_{res}}{N_{res}^2} = \frac{2.07.10^{-2}}{80^2} = 3.23.10^{-6}H$$

We could finally calculate the number of turns required for L1, L2 and L3

$N_1 = \sqrt{\frac{L_1}{x_{res}}} = \sqrt{\frac{2.5.10^{-3}}{3.23.10^{-6}}} = 27.8 \simeq 28$ turns

$N_2 = \sqrt{\frac{L_2}{x_{res}}} = \sqrt{\frac{2.5.10^{-3}}{3.23.10^{-6}}} = 27.8 \simeq 28$ turns

$N_3 = \sqrt{\frac{L_3}{x_{res}}} = \sqrt{\frac{0.5.10^{-3}}{3.23.10^{-6}}} = 12{,}4 \simeq 12$ turns but Mr Busbridge advised us to make 3 or 4 turns instead so we made 4 turns

3.3 Phase 3 : Oscillator

This phase consisted in building the oscillator.

3.3.1 Principle

An oscillator is an electrical device that converts a DC signal into an AC signal. The shape of the signal is therefore a sine wave.

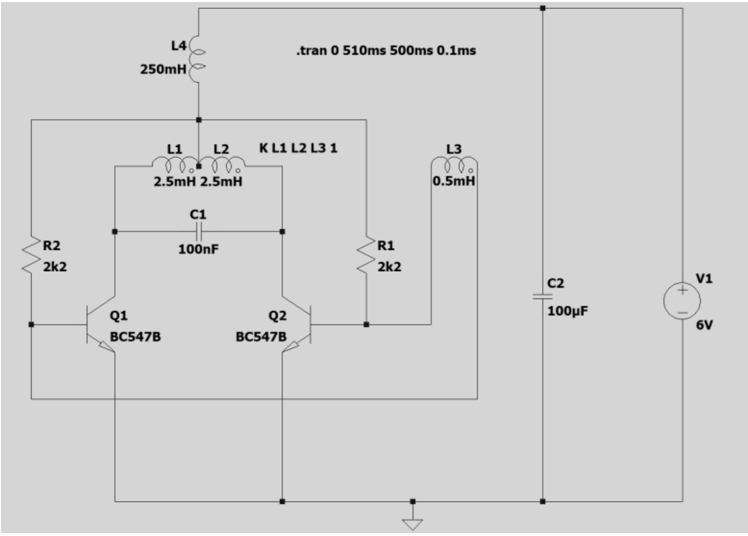


Figure 3.8 : oscillator circuit on LTspice

The oscillator is connected to the generator.

The oscillator is composed of an electrolytic capacitor (C2), two simple inductors (L3 and L4), two coupled inductors (L1 and L2), two resistors (R1 and R2), a capacitor (C1) and two transistors (Q1 and Q2).

C2 is a $100\ nF$ electrolytic capacitor. It is connected in parallel to the generator and its purpose is to reduce noise (this is often done in electrical circuits). Mr Busbridge warned us that the polarity of electrolytic capacitors had to be absolutely respected, otherwise they explode and can cause a lot of damage. L4 is a $250\ mH$ inductor. Its role in the circuit is complex. L3 is a feedback inductor. L1 and L2 are coupled in inductors. The total inductance of L1 and L2 is 4 times (the number of inductors (here 2) squared so $2^2 = 4$) the inductance of each one of L1 and L2. R1 and R2 are $2.2\ k\Omega$ resistors that are used to avoid connecting the generator directly to the base of the transistor, which would damage them.

The oscillator oscillates thanks to the transistors turning on and off, operating like closed and open switches.

When a voltage higher than the saturation voltage is applied to the base of a transistor, the transistor turns on and operates as a closed switch, meaning that current can flow from the collector to the emitter.

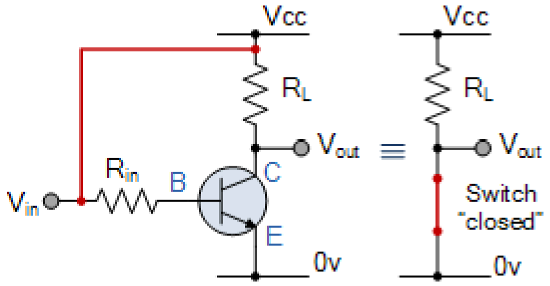


Figure 3.9a : Diagram demonstrating how transistors operate as closed switches

On the contrary, if $V_{BE} < V_{sat}$, the transistor turns off and operates as a closed switch. As shown in figure 3.9b.

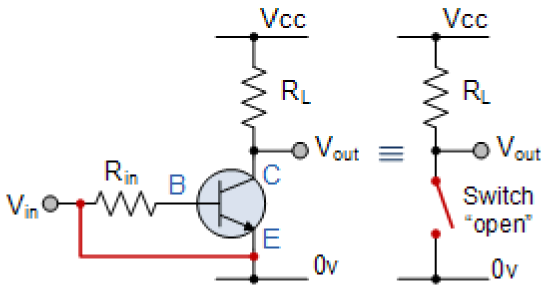


Figure 3.9b : Diagram demonstrating how transistors operate as closed switches

L1, L2 and C1 form together a resonance circuit.

When Q1 is turned off and Q2 is turned on, the current generated in the resonance circuit has nowhere to go but flowing from Q1 collector pin to Q1 emitter pin.

Thanks to L3, a feedback is created and the current direction is reversed so Q1 is now turned on and Q2 is now turned off.

This process is repeated over and over again at a π phase shift, creating the desired oscillations.

In addition to being converted from DC to AC, the voltage is also amplified.

Indeed,

The generator voltage $V_{DC\ IN} = 6V$

We know that the voltage after L1 at the junction between L1 and L2 is $V_{L_1\ OUT} = \frac{\pi}{2}\ V_{DC\ IN}$

In addition, the voltage after L2 is $V_{L_2\ OUT} = 2\ V_{L_1\ OUT}$

Hence, $V_{L_2\,OUT} = 2 \times \frac{\pi}{2} V_{DC\,IN} = \pi \ V_{DC\,IN} \simeq 19\ V$

So at this point the voltage has already been in theory multiplied by more than three.

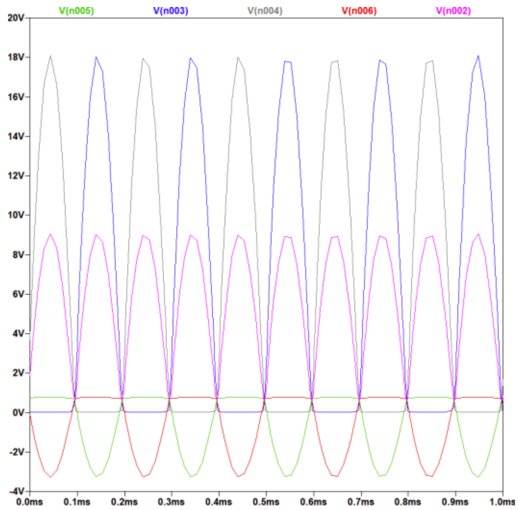


Figure 3.10 : Oscillogram of the oscillator simulated in LTspice

We simulated the oscillator on LTSpice and obtained the oscillogram in Figure 3.10..

The colours of the traces correspond to the following voltages :

In blue : $V_{Q1\,collector} = V_{L1\,IN}$, in grey : $V_{Q2\,collector} = V_{L2\,OUT}$, in purple : $V_{L4\,OUT}$, in green : $V_{Q1\,base}$ and in red : $V_{Q2\,base}$

We can observe that the voltage at the transistors collector pins form together a sine wave similar to the voltage coming out of L4, but higher in amplitude.

Moreover, when the voltage at Q1 base is above the saturation voltage (0.7 V), the voltage at Q1 collector equals 0 V. On the contrary, when the voltage at Q1 base is below the saturation voltage, the voltage at Q1 collector goes up and down to 0 V. The exact same process happens simultaneously with Q2, but with a delay in time.

3.3.2 Experiments

For the coupled inductors L1 and L2, we winded L1 then made a “buckle” and winded L2 paying attention to keep the same direction of winding. We also winded L3. It was hard to count the number of turns. The first method we used was to make some windings and then take a picture so that we could zoom on the picture and count the number of wires, but it was actually better to count the turns while we were winding.

This left us with a lot of wire ends. That’s why we needed a good method to remember which wire was. Mr Busbridge suggested cutting little slits on the bobbin, writing a number at each slit, and then making a diagram of the bobbin showing which wire should be connected to which slit. Since a slit contained both L1in and L2out we put small pieces of tape to distinguish L1in from L2out.

With the perspective of gaining time, we had built the oscillator on a website called Tinkercad while we were waiting for the components. As shown in figure 3.11.

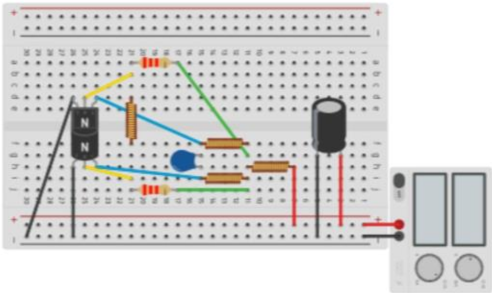


Figure 3.11 : Oscillator circuit on Tinkercad

We set up this circuit and connected the oscilloscope to the collector of one of the transistors.

We had received PNP transistors instead of NPN transistors which meant that positive and ground had to be reversed.

However, we could not simply do this and needed to also replace the generator with a battery. Since we knew Mr Busbridge would come to INSA on the following days, we preferred waiting for him to bring NPN transistors.

We also replaced C2 by a ceramic capacitor.

It took us some time to get the circuit working since we struggled finding where to connect all the wires coming out of the bobbin. Moreover, we were not aware that there was a disconnection in the middle of the positive power rail and the negative one too.

3.3.3 Results

We were surprised by the high pitch sound that came out when we powered the oscillator.

To avoid this annoying sound, we held tightly the two pot core halves together using two small rubber bands.

We have observed on the oscilloscope a sine wave of 27.0 V in amplitude.

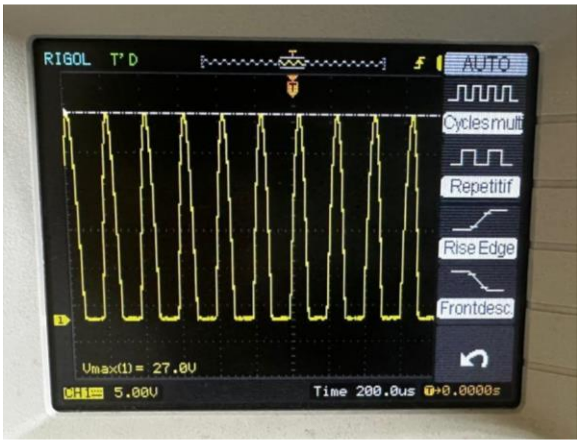


Figure 3.12 : Picture of the oscillations on the oscilloscope

3.4 Phase 4 : Rectifier

During this last phase, we built the rectifier.

3.4.1 Principle

A rectifier converts an AC signal into a DC signal.

The rectifier is composed of an inductor (L5), a diode (D1), two resistors (R3 and R4) and a capacitor (C3).

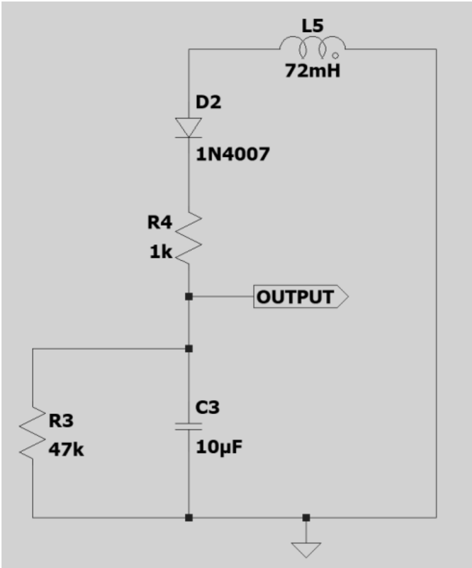


Figure 3.13 : Oscillator circuit on LTspice

L5 is a handmade inductor. Since it is winded around the same ferrite pot core as L1, L2 and L3, the energy created in the magnetic field can be transferred to L5.

D1 is a 1N4007 diode.

A diode is a semiconductor device that allows current to pass through it but in only one direction.

This means that by putting D1 next to L5 the negative part of the half sine wave created in the oscillator and then transferred to L5 is blocked.

To have a full wave rectifier, we would have needed 4 diodes to form a bridge rectifier. This would have been better but more complicated, that's why our teacher decided to use a single diode

R4 is a $1\ k\Omega$ resistor that reduces the current but it does not play a critical role in the circuit.

C3 is a $22\mu F$ electrolytic capacitor. It plays the role of a reservoir capacitor. We use it to smooth the signal.

R3 is $47\ k\Omega$ resistor connected in parallel to C3 therefore acting like a bleeder resistor.

Indeed if the two pins of a charged capacitor get in contact, a spark can be generated. Putting a bleeder resistor avoids this from happening.

As a consequence, if we connect a wire between R4 and C3, we obtain a DC signal in output of the rectifier.

In order to comply with the EU regulation *Low Voltage Directive (2014/35/EU)*, we did not want our DC output signal to exceed 50 V.

We know that

$$V_{DC\ OUT} = V_{AC} \times \frac{N_5}{N_1 + N_2} = \pi \times V_{DC\ IN} \times \frac{N_5}{N_1 + N_2}$$

Therefore

$$N_5 = \frac{V_{DC\ OUT}\ (N_1 + N_2)}{\pi \times V_{DC\ IN}} = \frac{50 \times (28 + 28)}{\pi \times 6{,}0} \simeq 150\ turns$$

3.4.2 Experiments

We had to wind L5 around the pot core on top of the windings from L1, L2 and L3. However, there was not much space left around the bobbin. That’s why we used a smaller diameter (0.1 mm instead of 0.25 mm).We winded 107 turns but we had to stop there since we could not wind more turns.

We soldered these wires.

It added two more wire ends to the bobbin, so we thought about another method to remember where all these wires had to be connected in our circuit. We had the idea to draw a diagram on LibreOffice draw (Figure 3.14) and note down the colors of each wire.

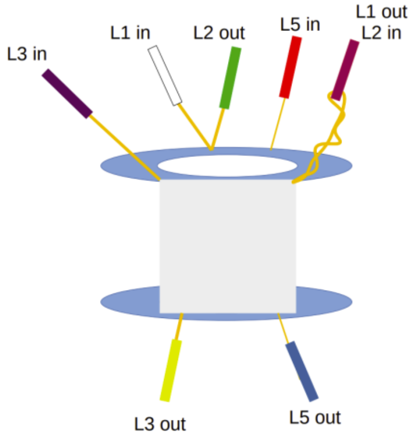


Figure 3.14 : Diagram showing every wire coming out of the bobbin

We set up the circuit and connected the oscilloscope between R4 and C3.

We have measured $V_{DC\ OUT,measured} = 23.2\ V$

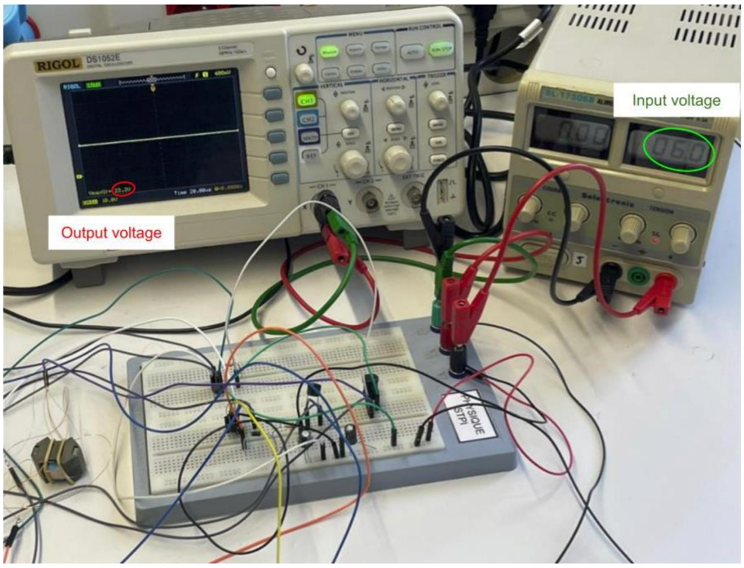


Figure 3.15 : Picture of the final set up showing the voltage increase

In theory this voltage is :

$$V_{DC\ OUT,expected} = \pi \times\ V_{DC\ IN} \times \frac{N_5}{N_1 + N_2} = \pi \times 6{,}0\ \times \frac{107}{28 + 28} = 36{,}0\ V$$

Relative error calculation :

$$\eta = \frac{\left|V_{DC\ OUT,expected}\ -\ V_{DC\ OUT,measured}\right|}{V_{DC\ OUT,expected}} \times 100 = \frac{|36{,}0 - 21{,}6|}{36{,}0} \times 100 = 40\ \%$$

We can explain this considerable difference by :

- The fact that we have winded 107 turns instead of 150 turns for L5
- Possible mistakes in the measurement of the resonance frequency
- Possible mistakes in counting during the windings
- Uncertainties linked to the electronic devices we used

Although the voltage increase is far from what was expected, if we calculate the transformation ratio (K) :

$$K = \frac{V_{DC\ OUT}}{V_{DC\ IN}} = \frac{23.2}{6.0} = 3.9$$

We can observe that this ratio is pretty high, and since it is greater than 1, we can conclude that we have built a step-up transformer.

4. CONCLUSIONS AND PROSPECTS

Conclusions on the work carried out

Overall, we are very satisfied with the work we have completed and proud of the results. However, the output voltage was not as high as expected. We discovered that we are capable of performing complex electronic tasks, and achieving a rather positive outcome has been very rewarding. We successfully created a working oscillator, which was a significant milestone in our project. Despite some initial challenges, we were able to understand and apply key electrical principles to build our oscillator, rectifier and transformer circuits.

Conclusions on the personal contribution of this project course

The practical aspect of this project was particularly strong, allowing us to apply our theoretical knowledge in a hands-on environment and work closely with our team members and tutors. Delivering the course through ZTE presented difficulties in communication and practical work, with the soldering room often closed, causing delays and requiring us to wait for other opportunities to continue the project. Despite these difficulties, we persevered and were ultimately successful in achieving our goals. The way of learning electronics was really different from P3, being funnier and less stressful.

This project has first taught us about electronics, obviously. We have learned about the principles of electricity as well as its dangers and how to protect ourselves from it.

We have been able to practice our group organization, project management, English and communication skills.

None of us envisage to keep studying electronics in the years to come. However, this project has contributed to our general scientific knowledge, and we might encounter electronics in our future profession since they appear in many areas. It has been precisely a great opportunity to go deep into a subject that we would have otherwise perhaps never studied. Besides, knowing about electronics is useful in a personal life.

Prospects for the continuation of this project

As a prospect for the continuation of this project, we could envisage connecting our transformer's output to a device that needs a high voltage to operate.

We could have also made our circuit more elegant as well as more portable.

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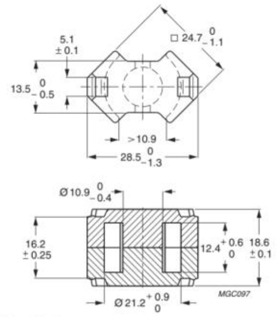
6. APPENDICES

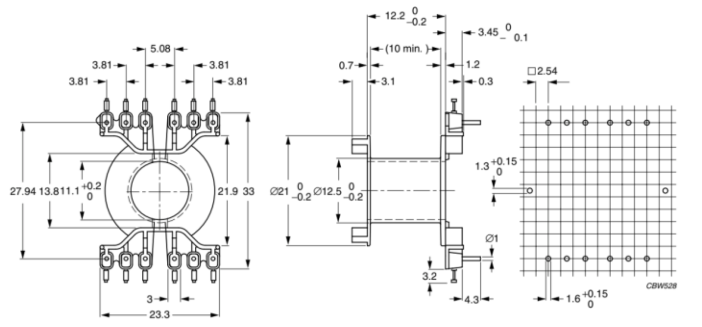
Technical documentation

Data sheet of the pot core and its bobbin
https://download.ferrite.de/pdf/rm10i.pdf



Dimensions in mm.

Fig.1 RM10/I core set.



Dimensions in mm.

Fig.2 RM10/I coil former (DIL).