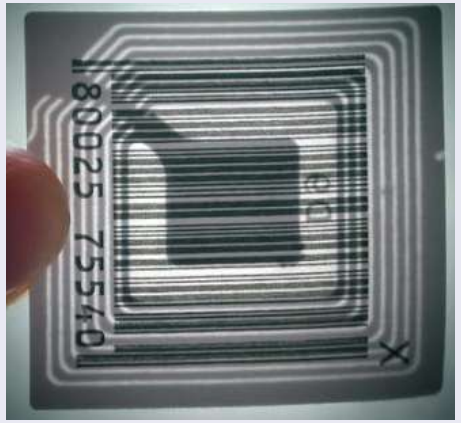
Communication des cartes à puce sans contact : principe et applications

Thème de l'année : la ville

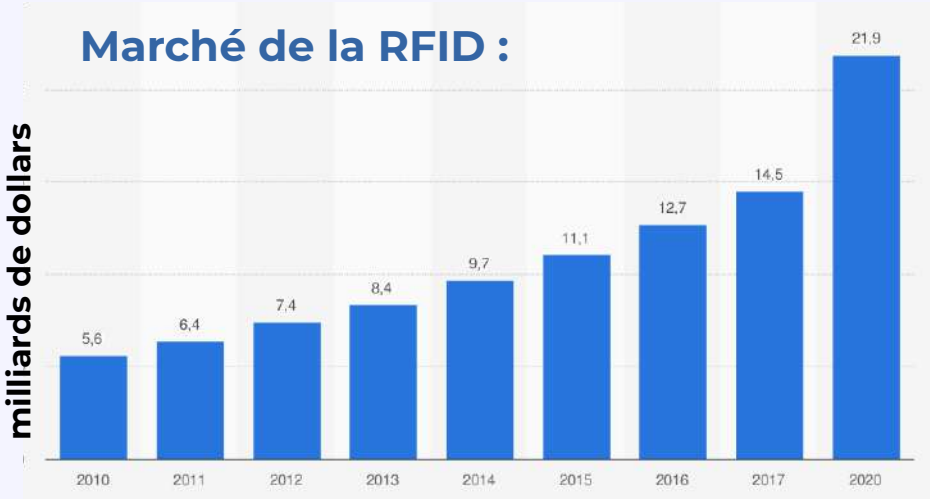
Numéro de candidat : 12545
Rezaï Mathis

https://onewave.io/transport-rennes/

Applications :



Nouveaux dispositifs :



-contact/

https://actu.fr/auvergne-rhone-alpes/lyon_69123/payer-avec-sa-carte-bancaire-dans-les-tcl-a-lyon-c-est-possible-ce-qu-il-faut-savoir_51310134.html

Problématique :

Comment dialoguer et récupérer les informations contenues sur une carte de transport ?

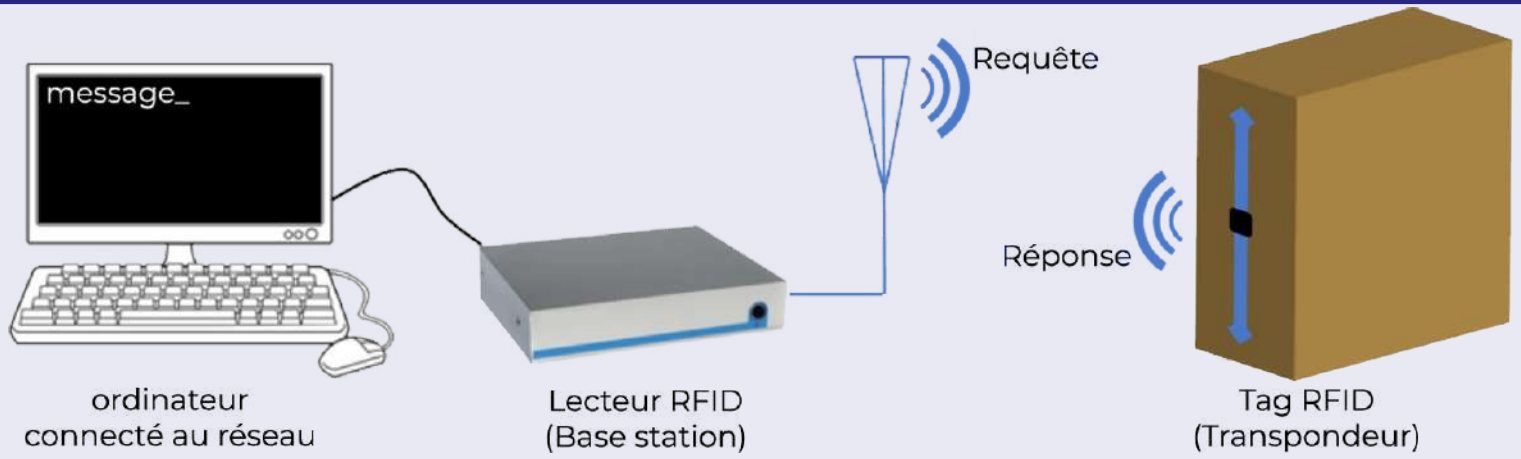
I – Communication par la technologie RFID

II – Modélisation de la liaison carte-lecteur

III – Transmission de notre propre message

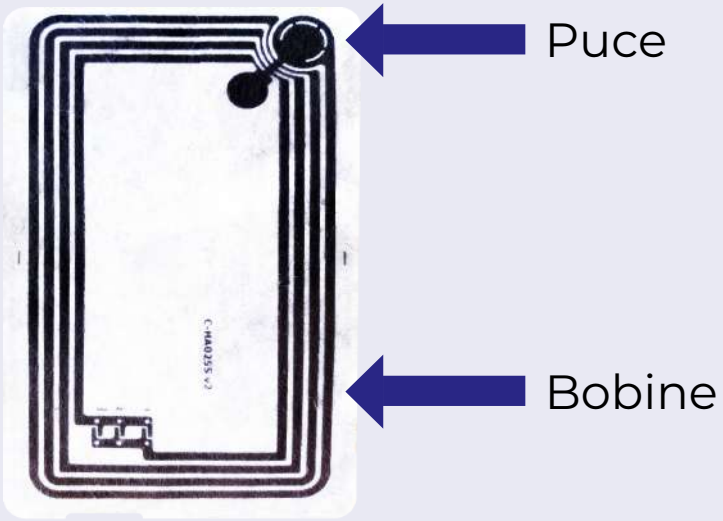
I / Communication par la technologie RFID

RFID : Radio Frequency Identification



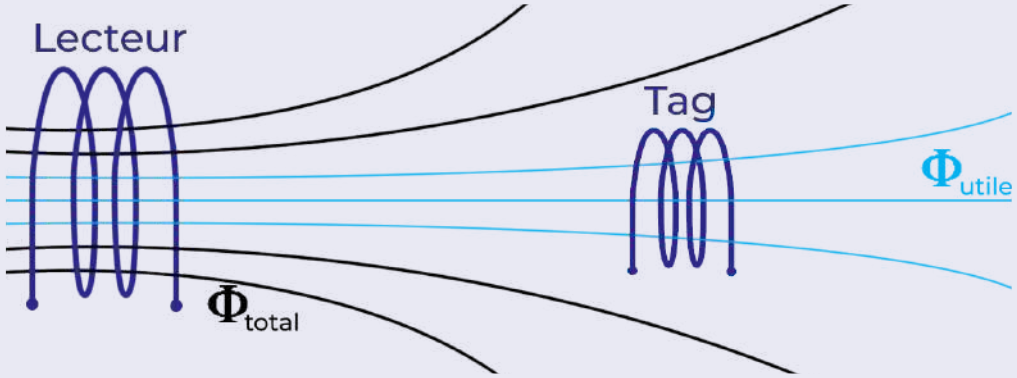
Lecteur :

Carte de bus :



I / Communication par la technologie RFID

PRINCIPE : Induction magnétique



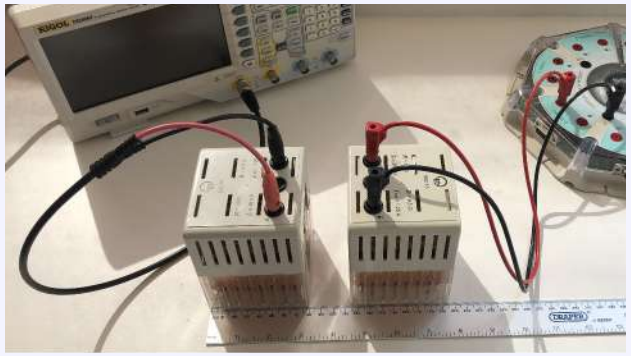
Loi de Faraday :

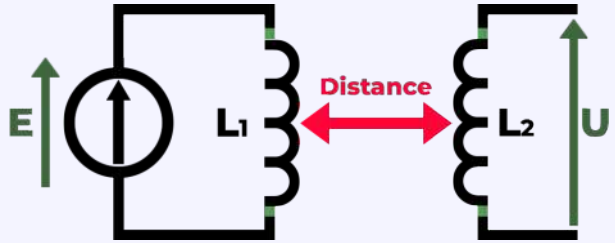
$$e = -\frac{\partial \Phi}{\partial t}$$

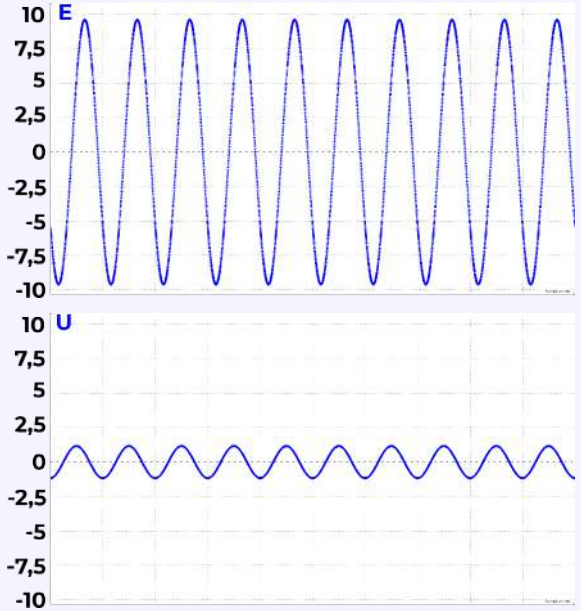
Flux :

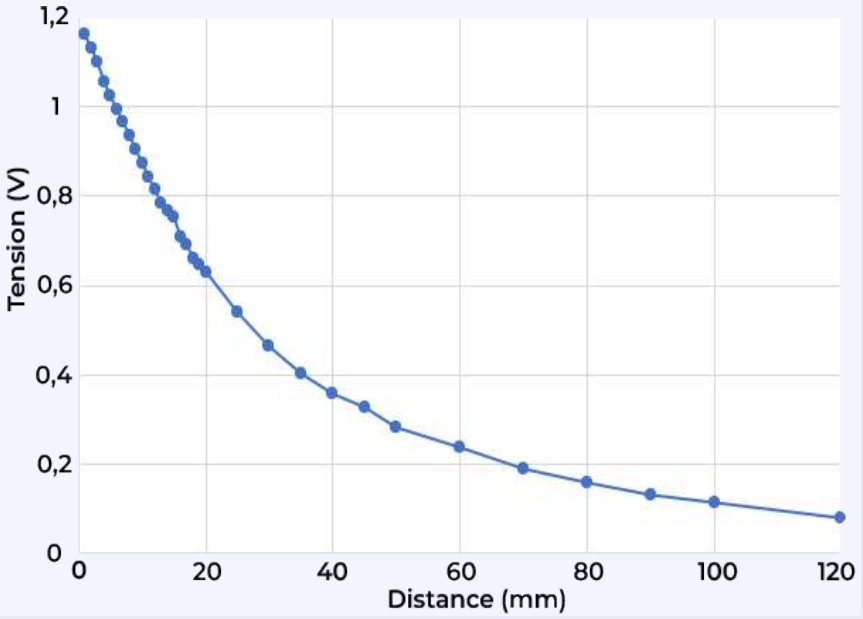
$$\Phi = \iint \vec{B} \cdot \overrightarrow{ds} = BNs$$

EXPÉRIENCE :



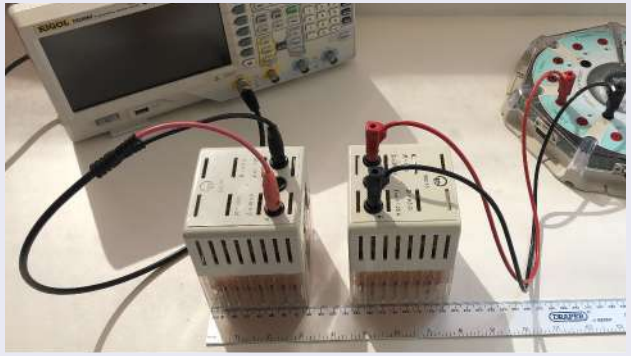


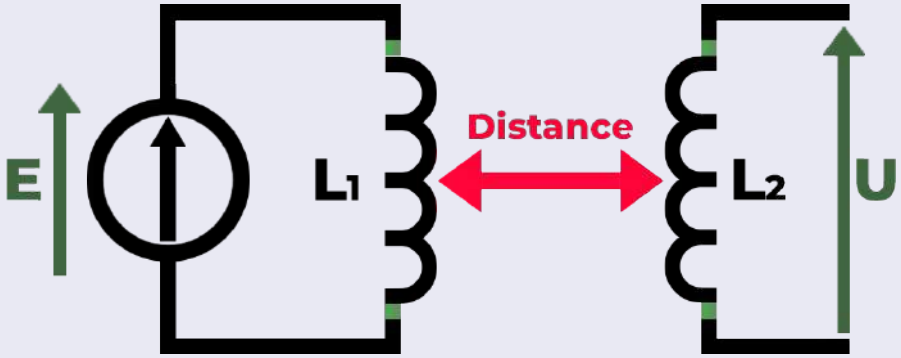




I / Communication par la technologie RFID

EXPÉRIENCE : Influence de la fréquence sur l'induction

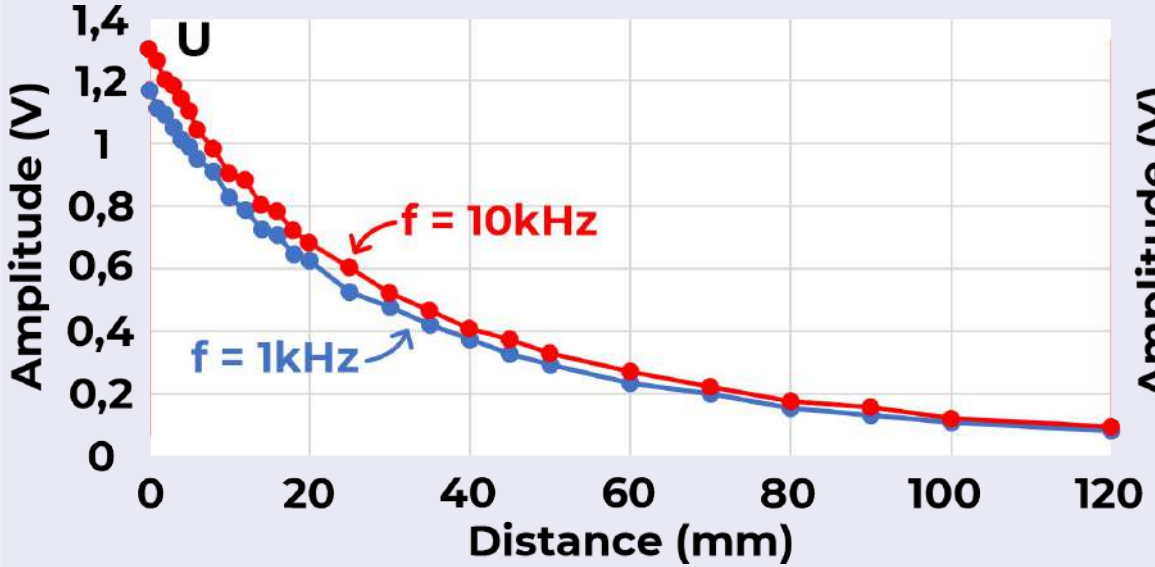


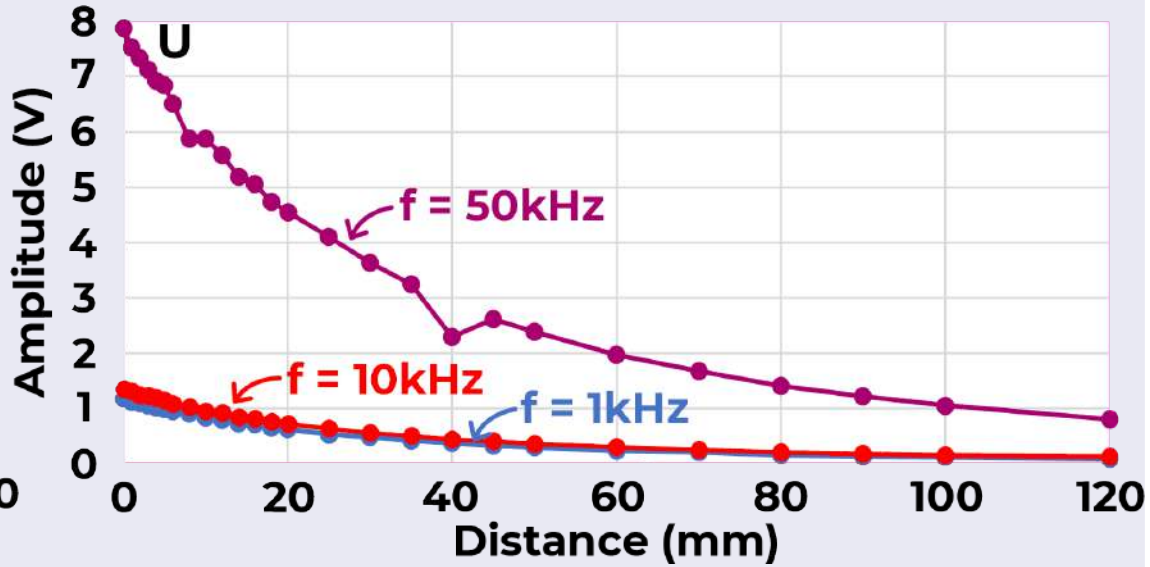


Signal :

Amplitude : **10V**

Fréquence : **1kHz**
10kHz
50kHz





I / Communication par la technologie RFID

FONCTIONNEMENT :

Gammes de fréquence :

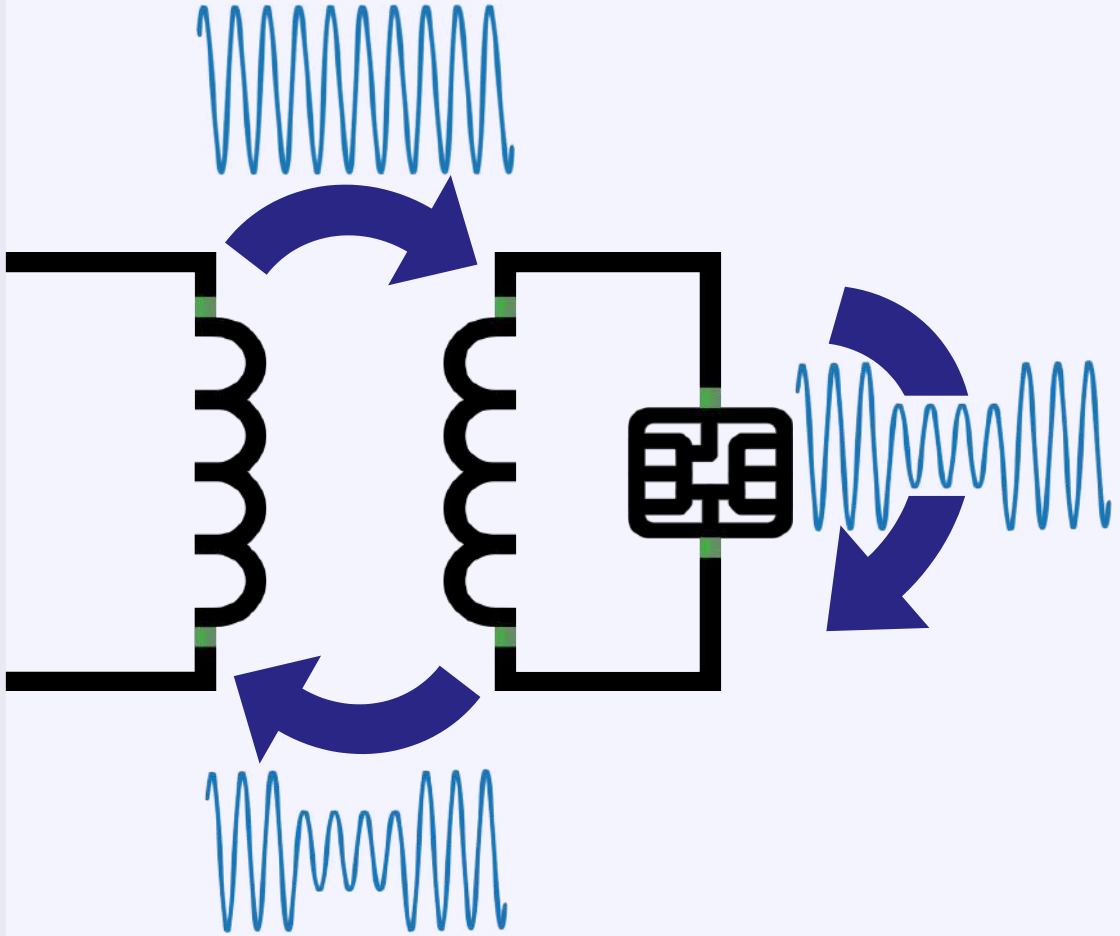
135 kHz : BF
cartes de cantine
identification animale

13,56 MHz : HF
titres de transport
paiements sans contact

5,8 GHz : UHF
péages routiers

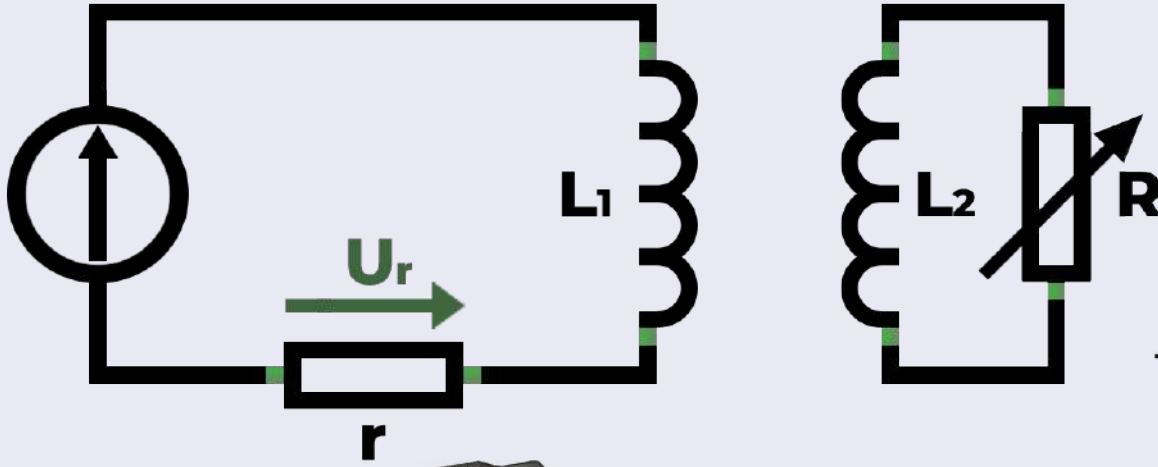
Couplage magnétique

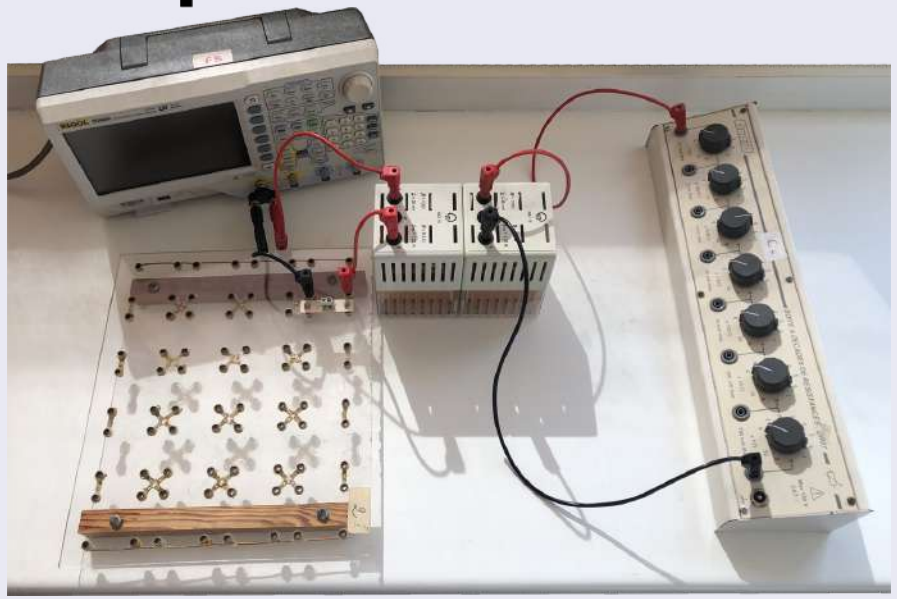
Modulation :

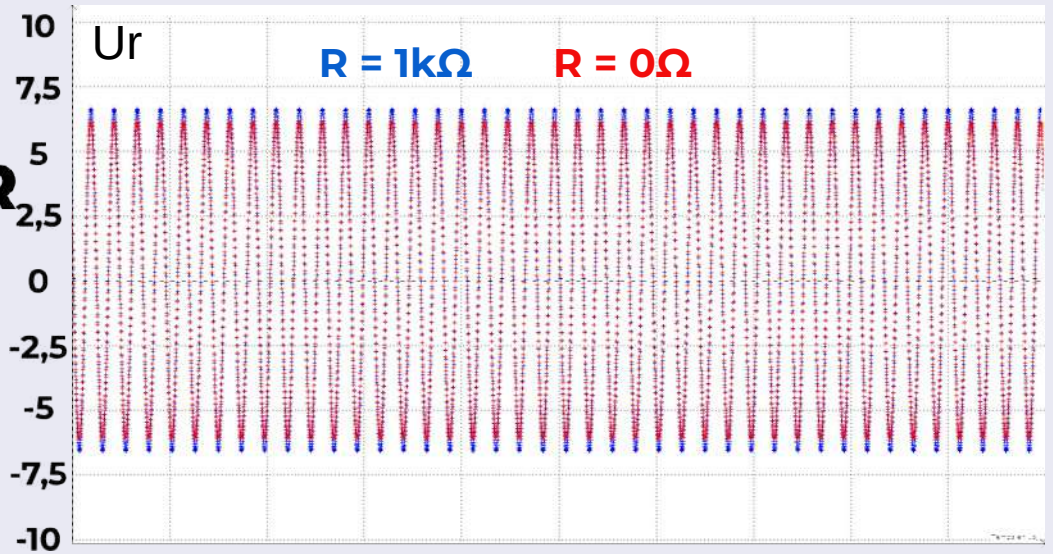


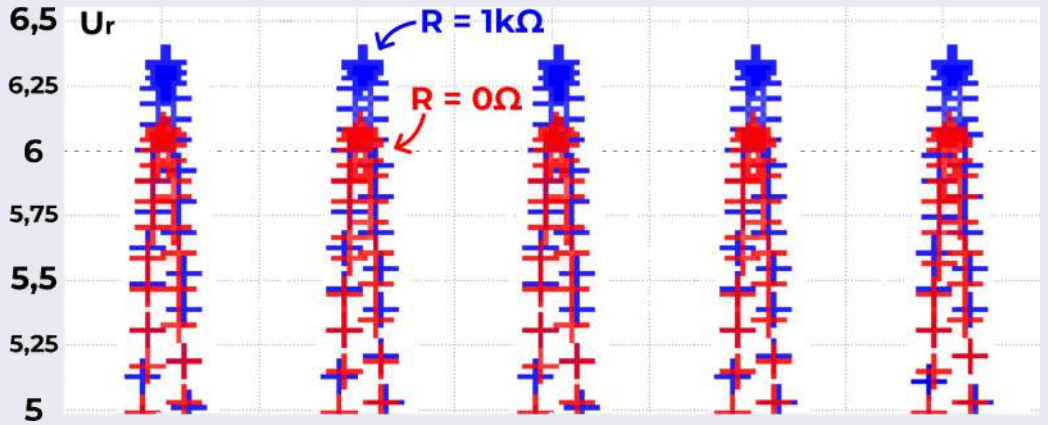
II / Modélisation de la liaison carte-lecteur

Modélisation initiale :



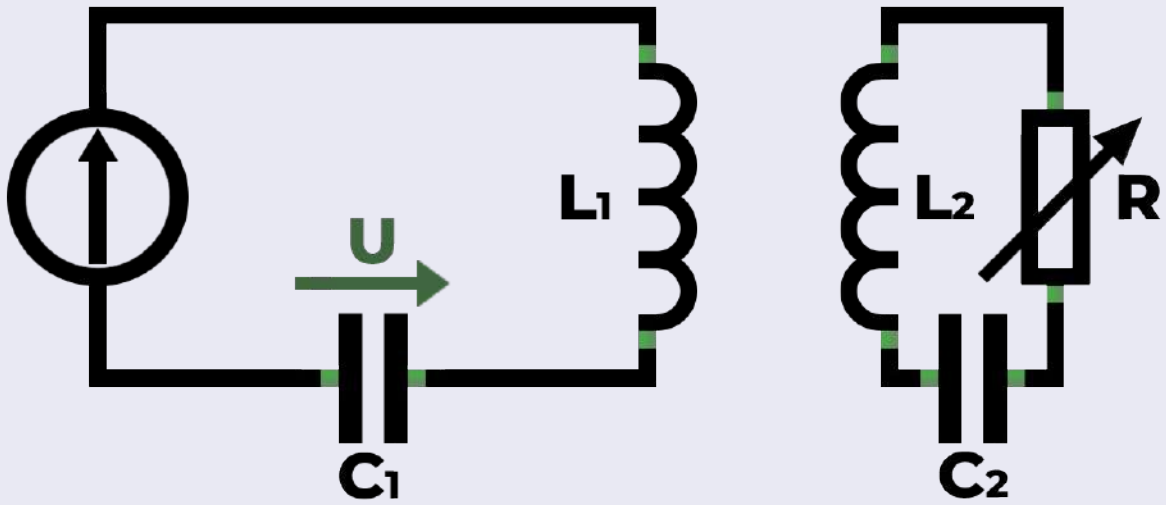


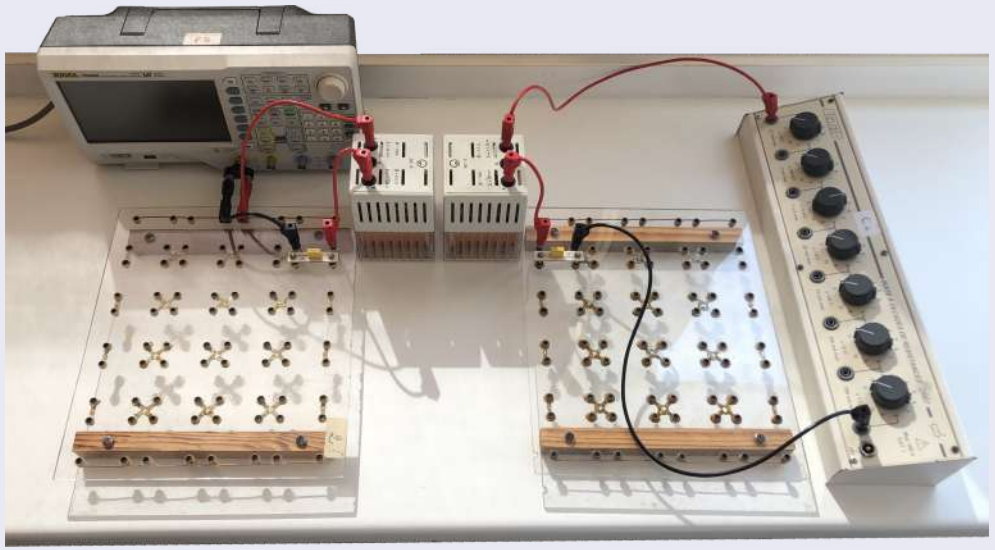




II / Modélisation de la liaison carte-lecteur

Modélisation finale :





Caractéristiques :

Lecteur :

- L_1 = 9 mH
- C_1 = 0,22 µF

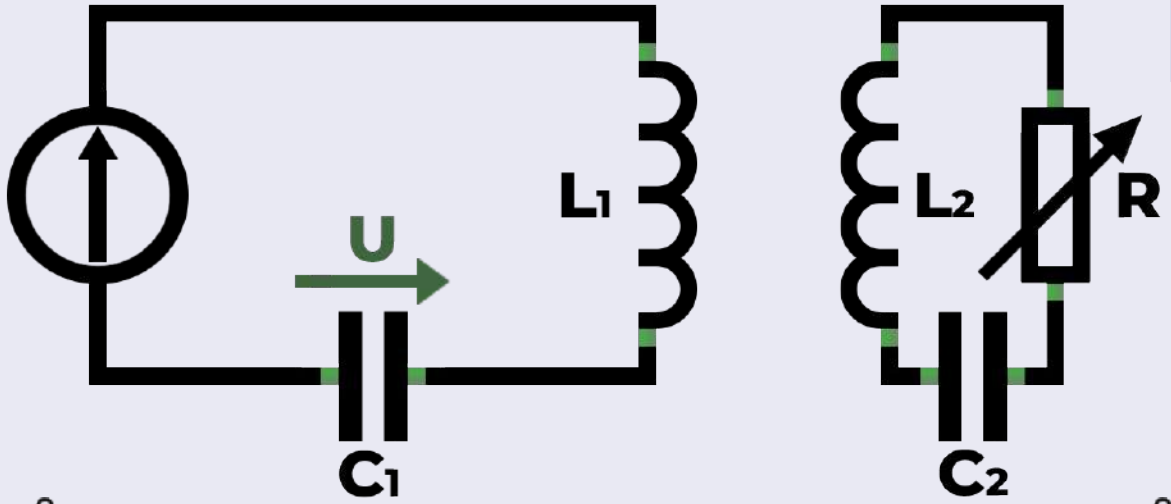
Carte :

- L_2 = 9 mH
- C_2 = 0,22 µF
- R = 0 ou 1kΩ

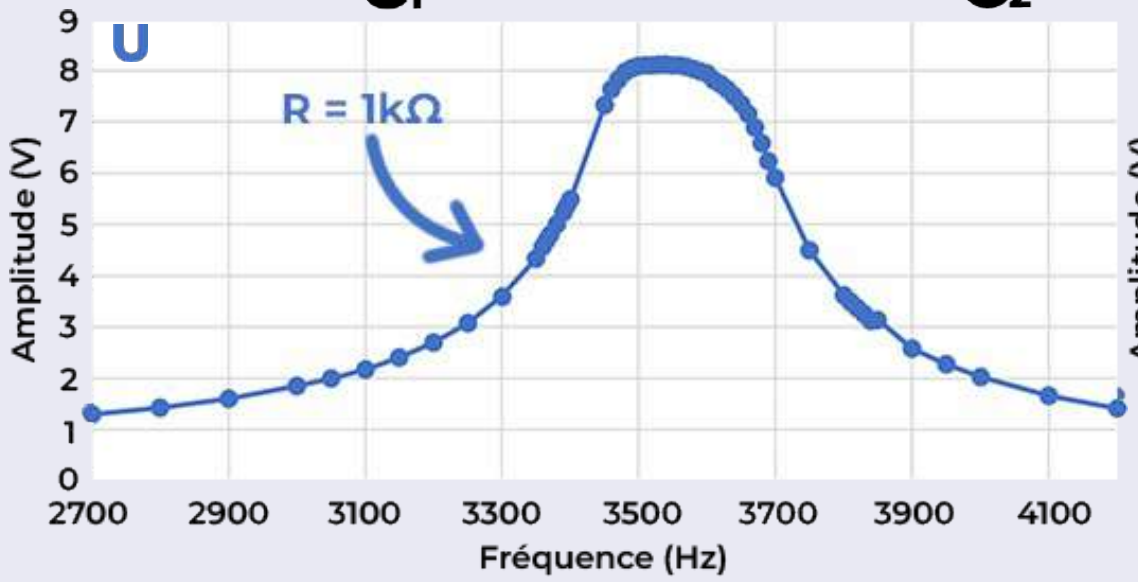
Fréquence de résonance de la carte et du lecteur : **3500 Hz**

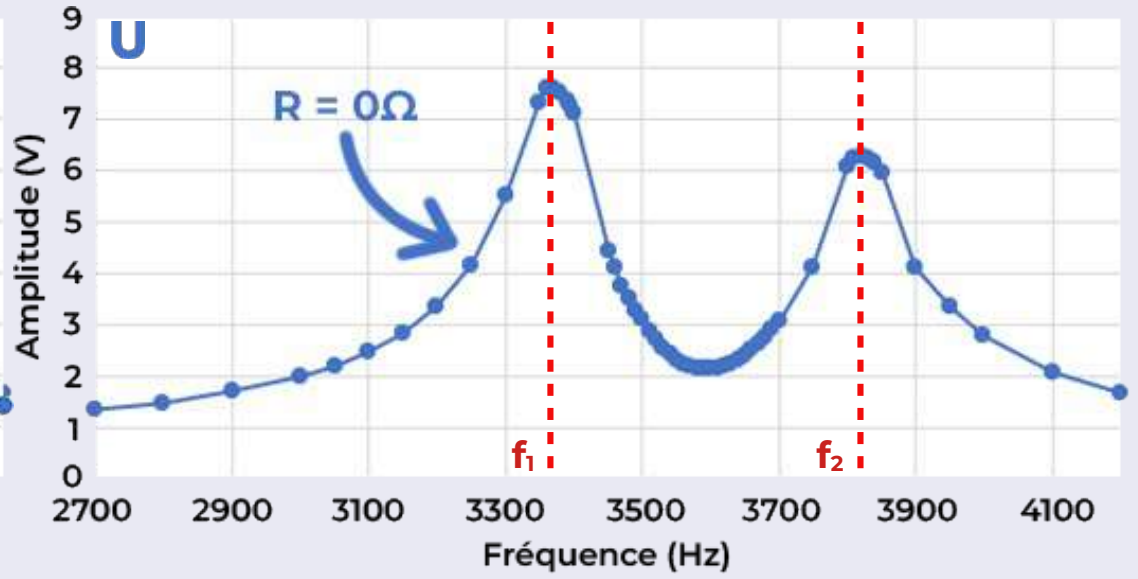
II / Modélisation de la liaison carte-lecteur

Fréquences de résonnance :



Équations de couplage :	Fréquences
$u_e = u_{C1} + L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$	$f_1 = \frac{f_0}{\sqrt{1+k}}$
$0 = u_{C2} + u_R + L_2 \frac{di_2}{dt} + M \frac{di_1}{dt}$	$f_2 = \frac{f_0}{\sqrt{1-k}}$





II / Modélisation de la liaison carte-lecteur

Optimisation du montage :

Bande passante :

$$A(f_{C1}) = A(f_{C2}) = \frac{A_{max}}{\sqrt{2}}$$

Résultats :

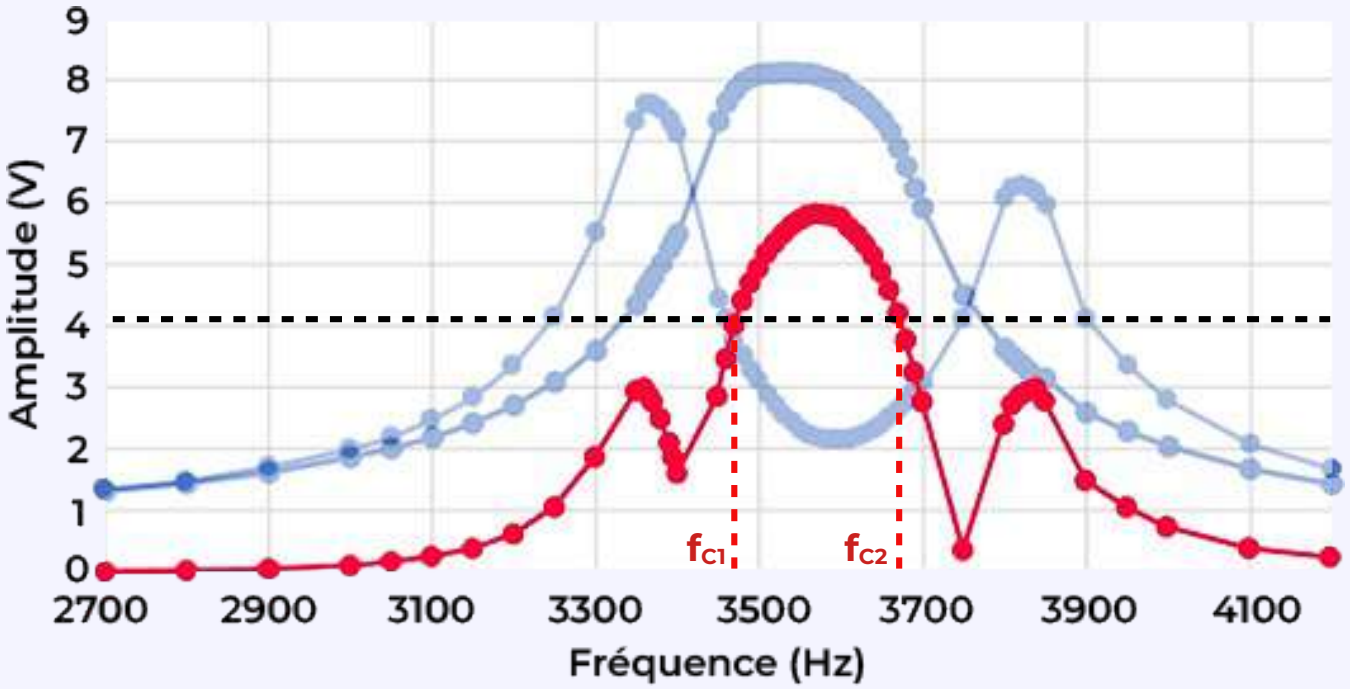
f_{C1} = 3470 Hz

f_{C2} = 3670 Hz

Δf = 200 Hz

EXPÉRIENCE : choix de la fréquence

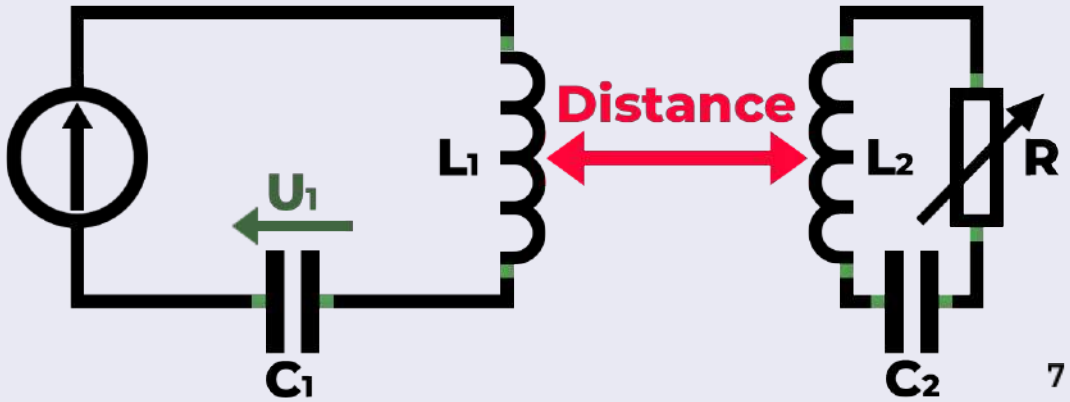
Écart de tension aux bornes du condensateur du lecteur



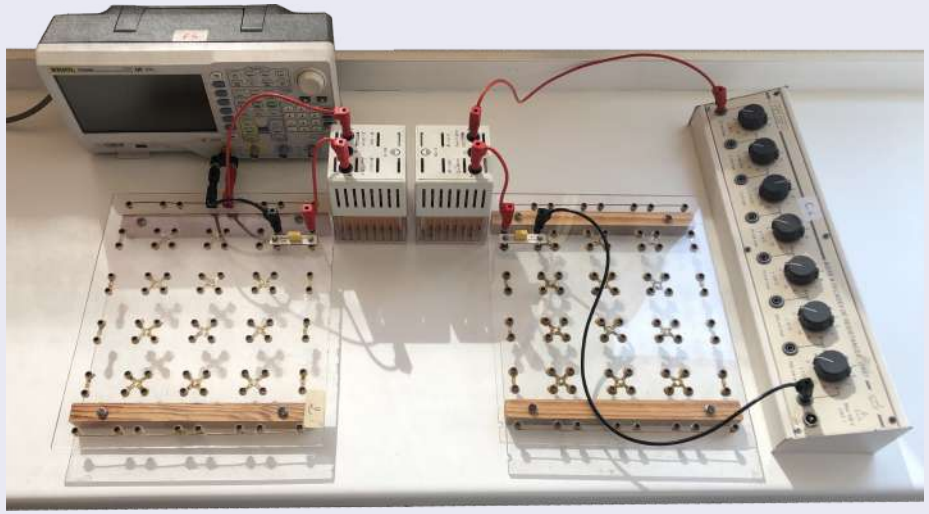
écart maximal entre les 2 courbes pour f = 3540 Hz

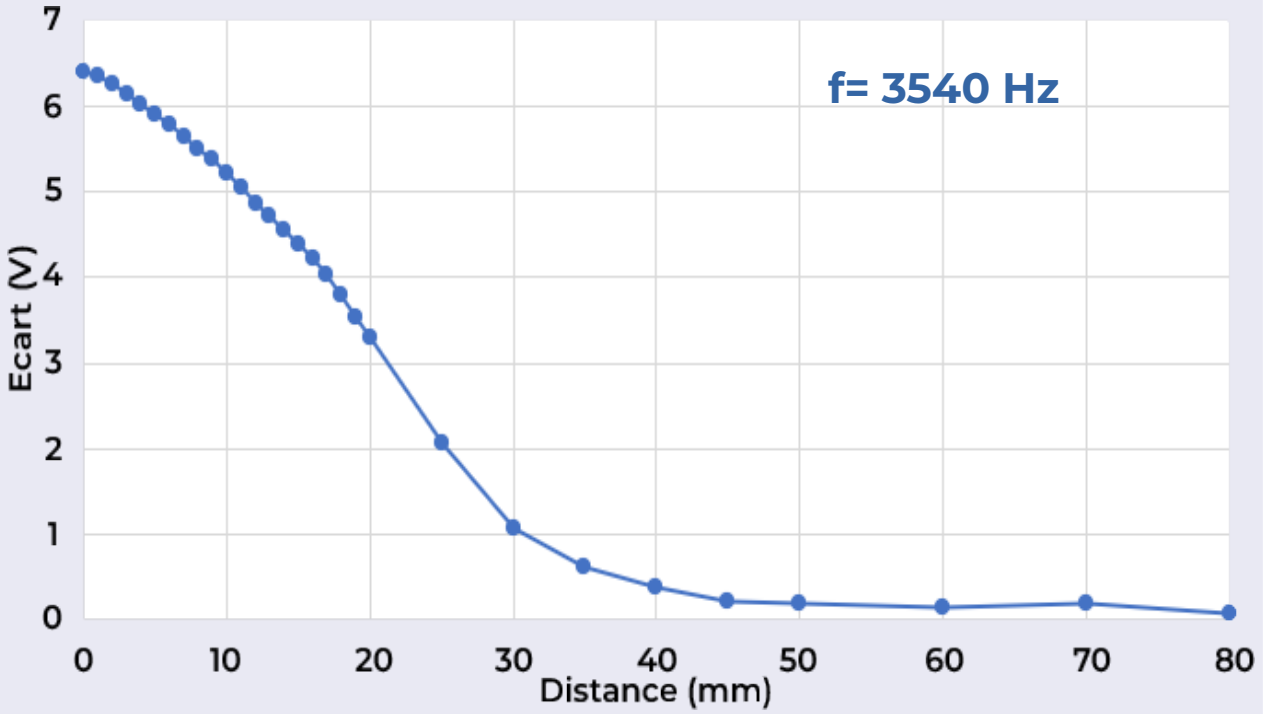
II / Modélisation de la liaison carte-lecteur

EXPÉRIENCE : Écart en fonction de la distance



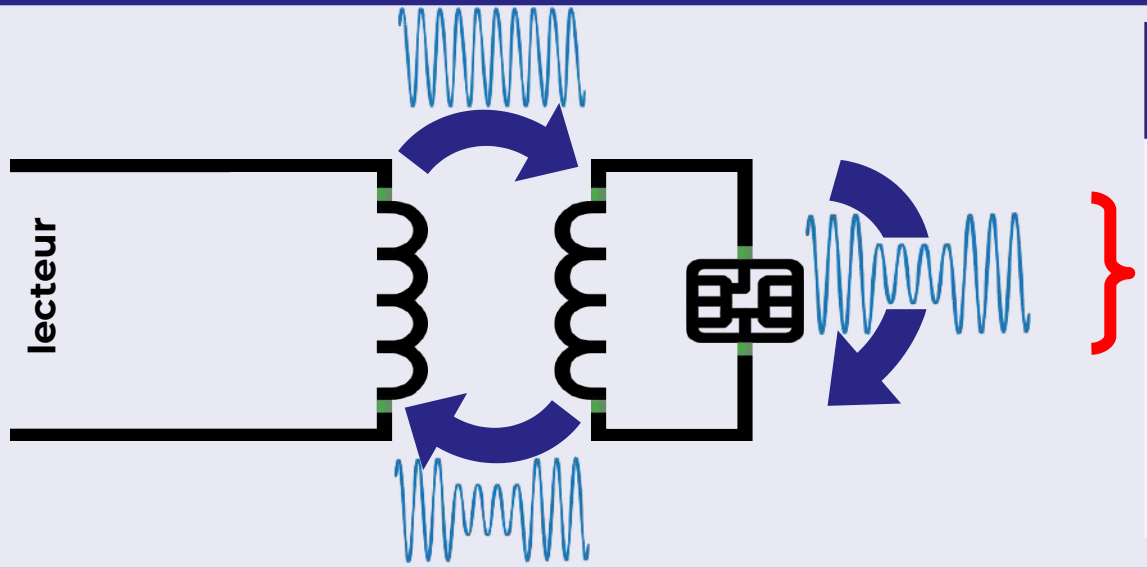
Écart = $U_{R=0\Omega} - U_{R=1k\Omega}$



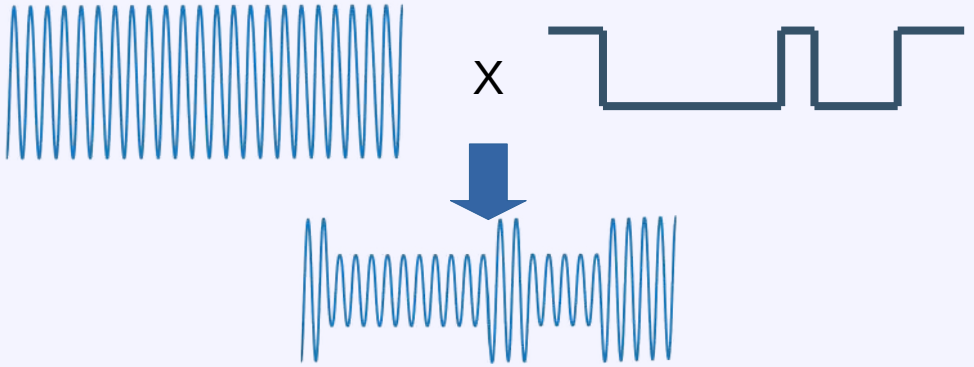


III / Transmission de notre propre message

Envoi du message :

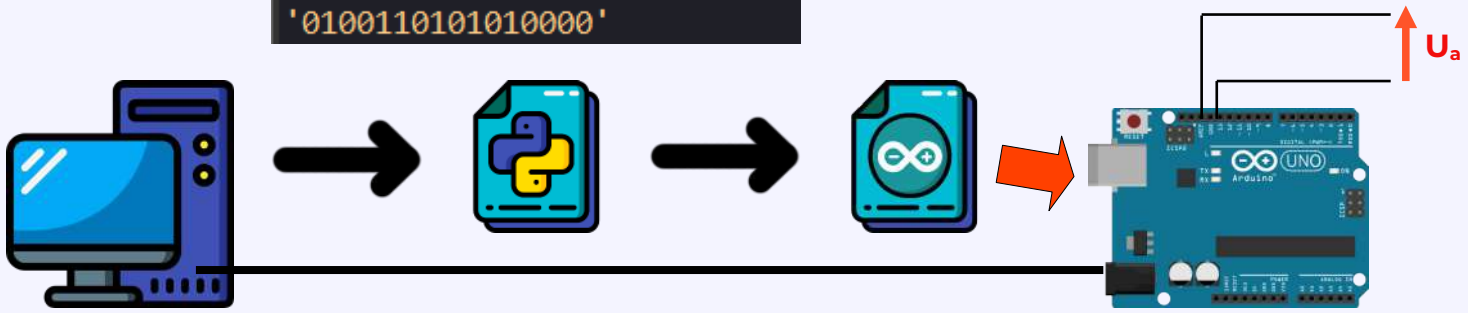


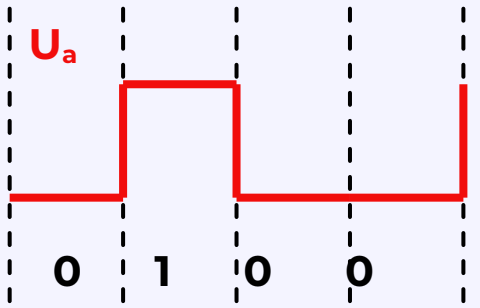
Réalisation :



Création signal créneau :

```
>>> texte_vers_binaire('MP')
'0100110101010000'
```





III / Transmission de notre propre message

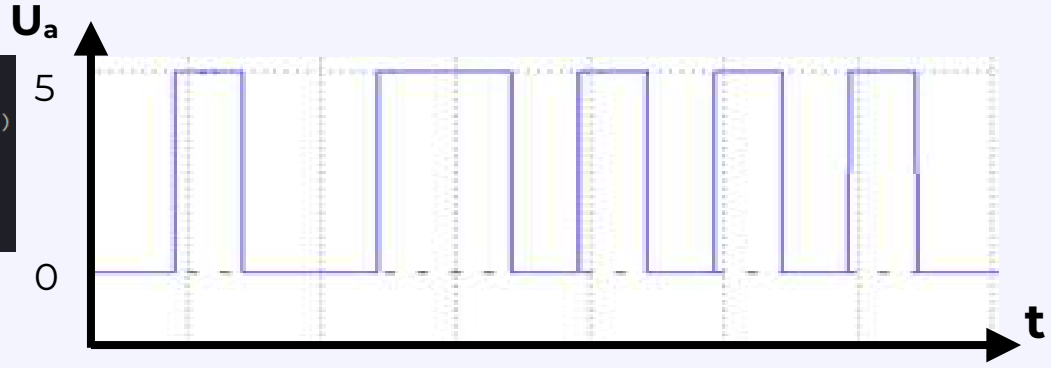
Envoi du message :

Résultat :

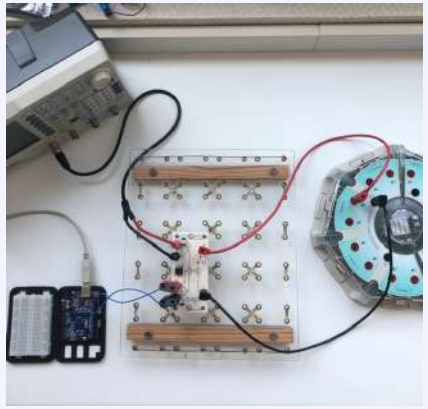

```
import serial
def texteversArduino(text):
    chaine_binaire=texte_vers_binaire(text).encode('utf-8')
    print(chaine_binaire)
    arduino=serial.Serial("COM8",baudrate=9600,timeout=.1)
    for i in range (len(chaine_binaire)):

        arduino.write((chaine_binaire[i]))
```

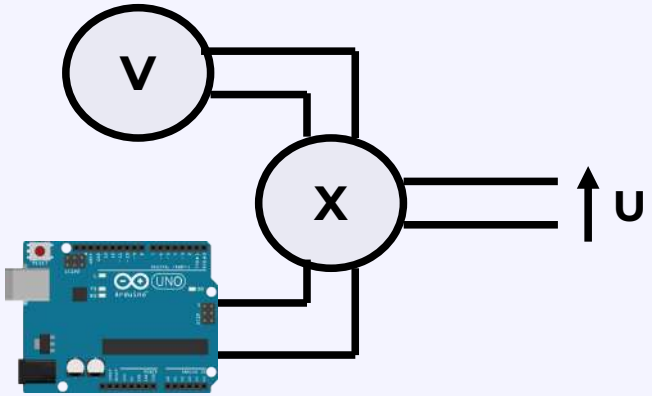
Sortie Moniteur série ×

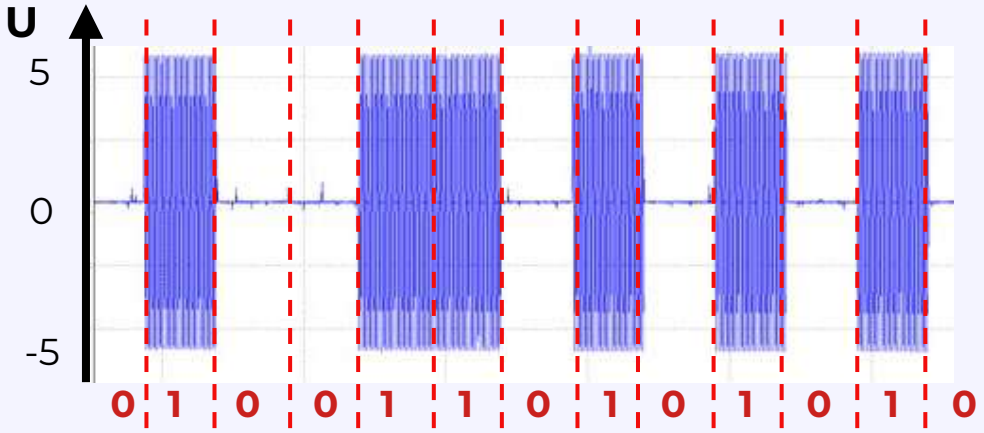
```
0100110101010000
```



Avec multiplieur :



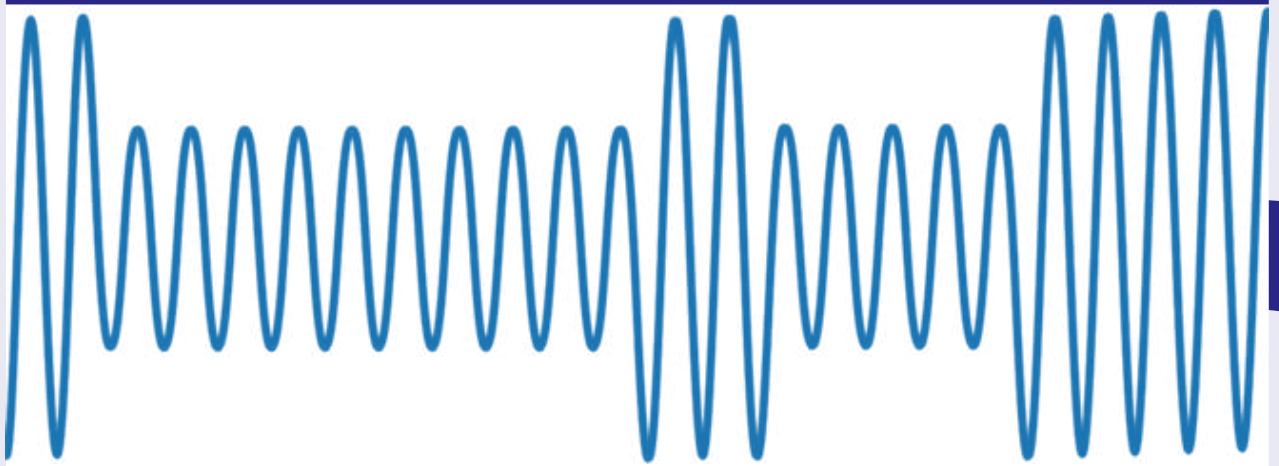




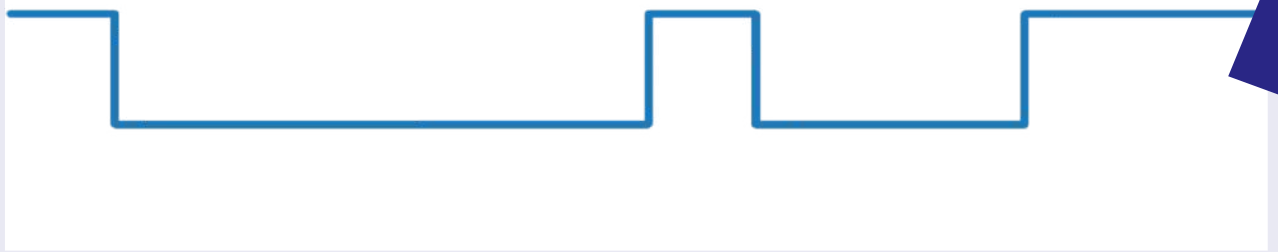
III / Transmission de notre propre message

Réception du message :

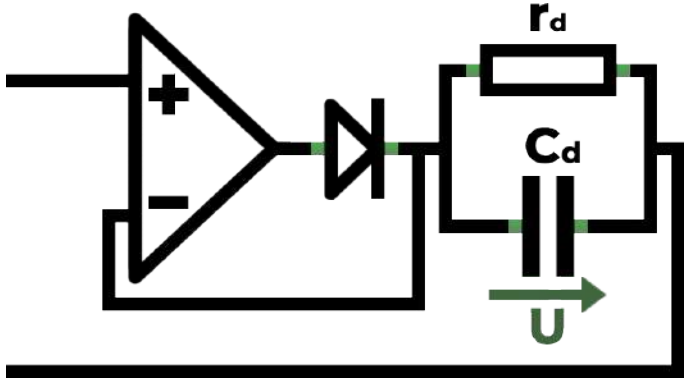
Signal observé dans le lecteur :

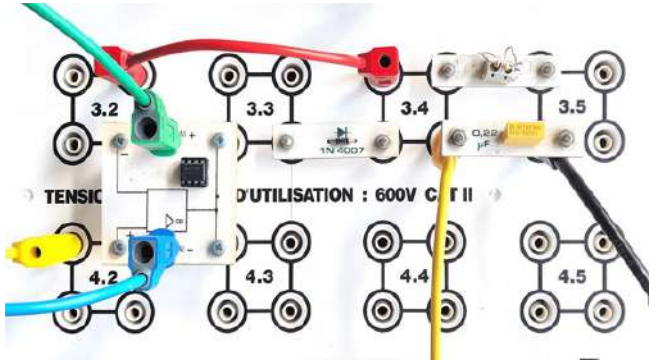


Signal porteur de l'information :



Démodulation :

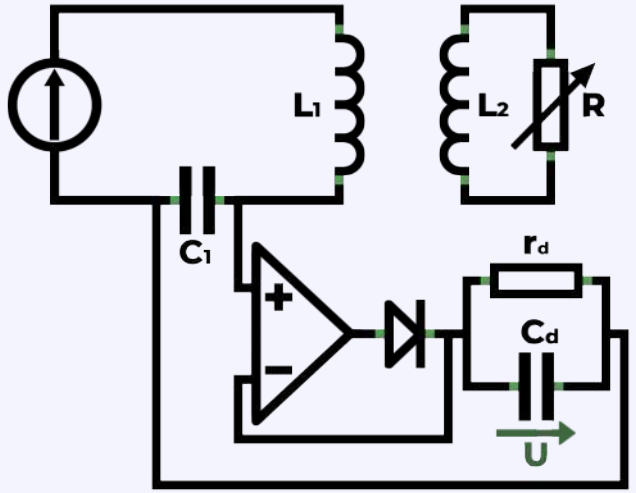


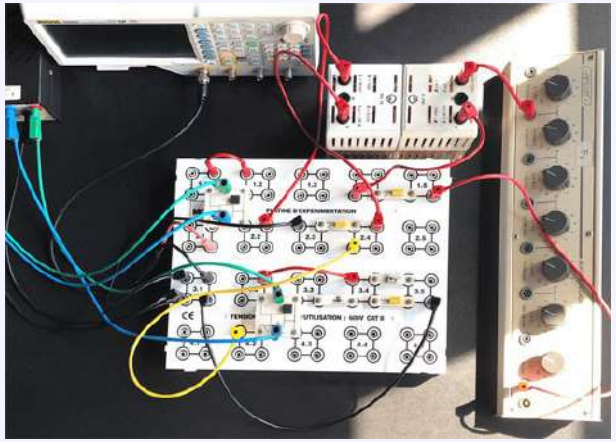


II / Modélisation de la liaison carte-lecteur

Démodulation d'amplitude :

Dispositif :

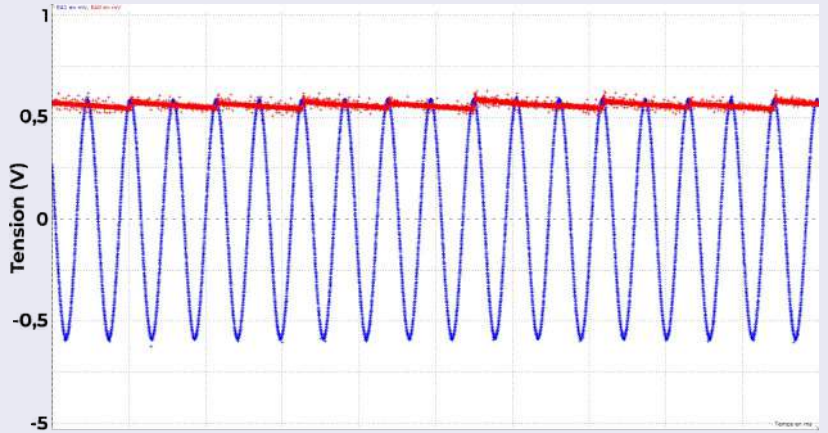


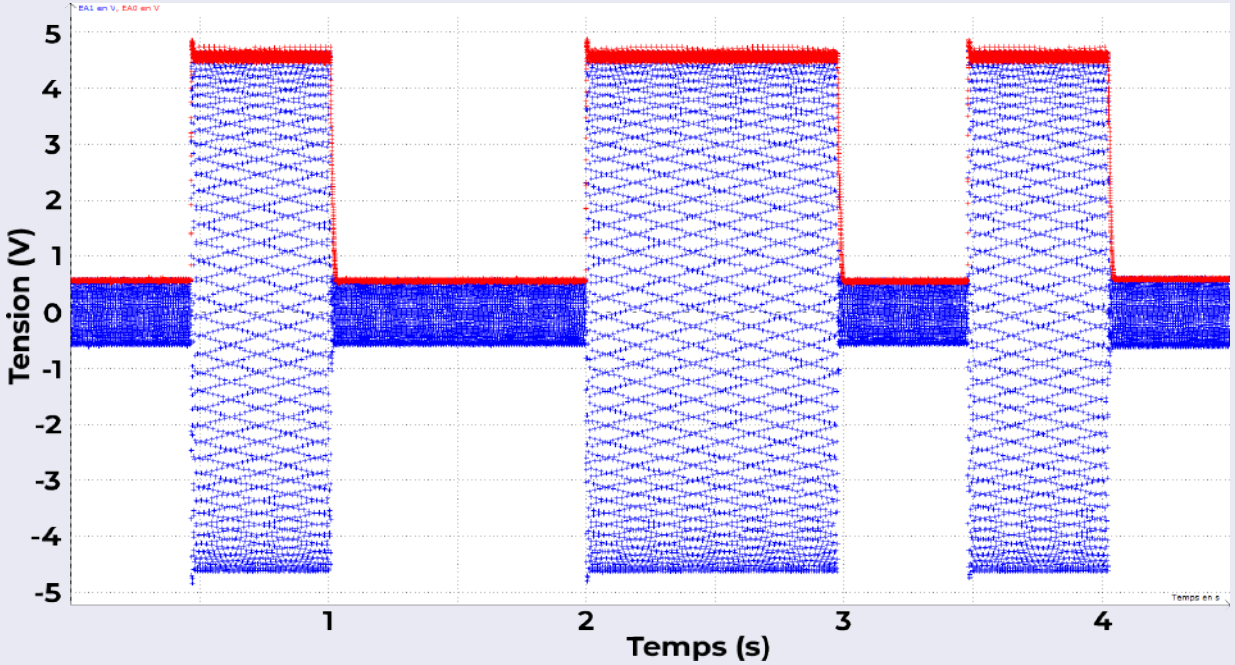


Caractéristiques :

$r_d = 10k\Omega$

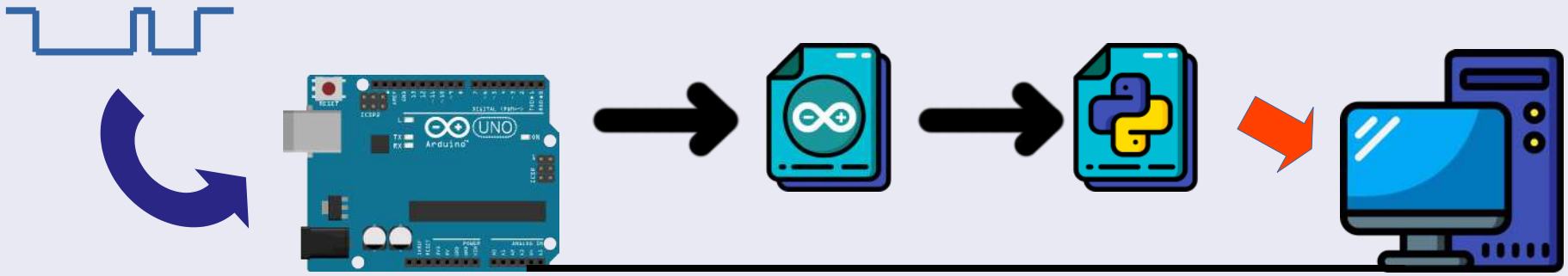
$C_d = 2{,}4\ \mu F$





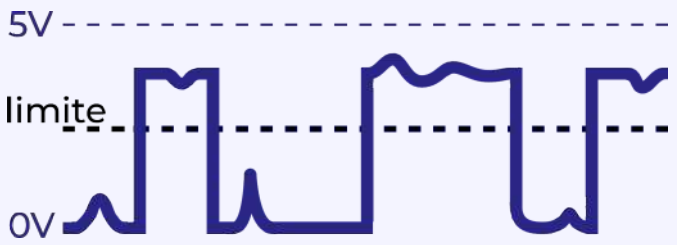
III / Transmission de notre propre message

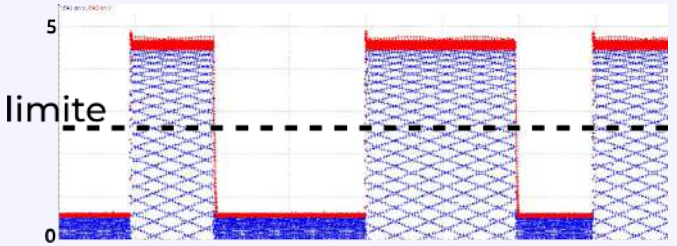
Réception du message :



Résultat :

```arduino
const int tension = A0;

int current_tension;

// Fonction d'initialisation
void setup() {
Serial.begin(9600);
pinMode(13, OUTPUT);
}

// Boucle d'acquisition
void loop() {
current_tension = analogRead(tension);
Serial.println(current_tension);
delay(500);
}
```






```
In [47]: runfile('D:/Spe MP CaJu/TIPE/code/code_re
cleaned_data :  [0, 0, 0, 0, 0, 1021, 0, 1021, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
binaire_data :  [0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0,
message :  MP
```

CONCLUSION

Comment dialoguer et récupérer les informations contenues sur une carte de transport ?

Annexes : partie envoi

```
float messagerecubinaire;
void setup() {
  Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
pinMode(13,OUTPUT);
}
void loop(){
if (Serial.available()>0){
    messagerecubinaire=Serial.read();//sinon Serial.parseInt()
    //messagerecubinaire=messagerecubinaire - 48;


      ;if (messagerecubinaire=='0') {
        digitalWrite(13,LOW);
        delay(50);
      }

       else if (messagerecubinaire=='1'){
         digitalWrite(13,HIGH);
         delay(50);}


     digitalWrite(13,LOW);
    }}
```

Annexes : partie envoi

```python
def texte_vers_binaire(text):
    # Initialise une chaine binaire vide
    binary_string = ""

    # Itère sur chaque caractère du texte
    for car in text:
        # Convertit le caractère en sa valeur ASCII
        ascii_val = ord(car)
        # Convertit l'ASCII en binaire
        binary_val = bin(ascii_val)[2:]

        # ajoute des zéros si la valeur binaire est de moins de 8 bits
        while len(binary_val) < 8:
            binary_val = "0" + binary_val

        # ajoute la valeur binaire à la chaine binaire
        binary_string += binary_val

    return binary_string
```

Annexes : partie envoi

```python
import serial
def texteversArduino(text):
    chaine_binaire=texte_vers_binaire(text).encode('utf-8')
    print(chaine_binaire)
    arduino=serial.Serial("COM8",baudrate=9600,timeout=.1)
    for i in range (len(chaine_binaire)):

        arduino.write((chaine_binaire[i]))
```

Annexes : partie réception

code.ino

```
1   const int tension = A0;
2
3   int current_tension;
4
5   // Fonction d'initialisation
6   void setup() {
7   Serial.begin(9600);
8   pinMode(13, OUTPUT);
9   }
10
11  // Boucle d'acquisition
12  void loop() {
13  current_tension = analogRead(tension);
14  Serial.println(current_tension);
15  delay(500);
16  }
```

Annexes : partie réception

```
"""Initialisation des variables"""
tension_max = 5     # valeur max en Volt enregistrée par l'arduino
tension_low = 0     # valeur max en Volt lorsque la tension est basse
tension_mid = 2.5   # valeur en Volt du seuil

limit = int(tension_mid * 1023/tension_max)

nb_vals = 40

rawdata = []        # données brutes
```

```
def nettoie(L:list)->list :
    """
    arg : L=["b'xxx\\r\\n'", "b'xxx\\r\\n'", ...]
    result : [xxx, xxx, ...] """
    result = []
    for elt in L :
        temp = elt[2:-5]            # "b'xxx;y\\r\\n'" -> "xxx;yy"
        result.append(int(temp))    # ["xxx","yy"] -> [xxx,yy]
    return result
```

Annexes : partie réception

```
def compare(L:list)->list:
    """ arg :liste de tensions entre 0 et 1023
        résultat : liste des valeurs binaires"""
    result=[]
    for elt in L :
        if elt > limit :
            result.append(1)
        else :
            result.append(0)
    return newL
def traduit(L:list)->str:
    """ arg : L=[0,1,0, ...]
        result : texte correspondant"""
    result = ""
    octets = [L[i:i+8] for i in range(0, len(L), 8)]

    for octet in octets:
        ascii_val = 0

        for i in range (8):
            ascii_val += octet[7-i]*(2**i) #calcul du chiffre codé par l'octet

        char = chr(ascii_val) #transforme le code ascii en caractère
        result += char

    return result
```

Annexes : partie réception

```
def traduit(L:list)->str:
    """ arg : L=[0,1,0, ...]
        result : texte correspondant"""
    result = ""
    octets = [L[i:i+8] for i in range(0, len(L), 8)]

    for octet in octets:
        ascii_val = 0

        for i in range (8):
            ascii_val += octet[7-i]*(2**i) #calcul du chiffre codé par l'octet

        char = chr(ascii_val) #transforme le code ascii en caractère
        result += char

    return result
def write(L:list):
    """inscrit les valeurs de L dans data.txt"""
    compt=0
    file = open("data.txt",mode="w")
    for elt in L :
        compt+=1
        temp = str(elt)
        file.write(temp+';'+str(compt)+'\n')
    file.close()
```