# Université Grenoble Alpes

## Compte Rendu

# TP Conversions numérique-analogique analogique-numérique

### Table de Matiéres :



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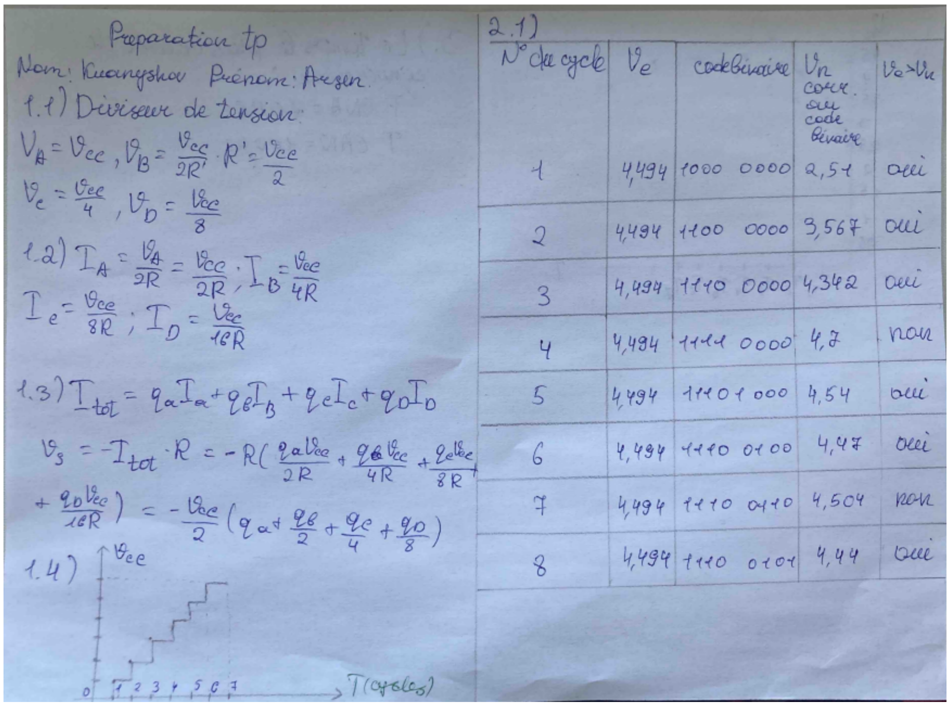
# 1 Introduction

During this practical work we are going to study the functioning of Analog-Digital Converter(ADC eng ; CAN fr) and Digital-Analog Converter(DAC eng ; CNA fr). The ADC is a classic 8-bit converter with successive approximations.The DAC is a classic so-called R-2R scale converter.

# 2 Preparation



Preparation tp

Nom: Kuanyshov Prénom: Arzen

1.1) Diviseur de tension

$V_A = V_{cc}$, $V_B = \frac{V_{cc}}{2R'} \cdot R' = \frac{V_{cc}}{2}$

$V_c = \frac{V_{cc}}{4}$, $V_D = \frac{V_{cc}}{8}$

1.2) $I_A = \frac{V_A}{2R} = \frac{V_{cc}}{2R}$; $I_B = \frac{V_{cc}}{4R}$

$I_c = \frac{V_{cc}}{8R}$; $I_D = \frac{V_{cc}}{16R}$

1.3) $I_{tot} = q_a I_a + q_b I_B + q_c I_c + q_D I_D$

$V_s = -I_{tot} \cdot R = -R\left(\frac{q_a V_{cc}}{2R} + \frac{q_b V_{cc}}{4R} + \frac{q_c V_{cc}}{8R} + \frac{q_D V_{cc}}{16R}\right) = -\frac{V_{cc}}{2}\left(q_a + \frac{q_b}{2} + \frac{q_c}{4} + \frac{q_D}{8}\right)$

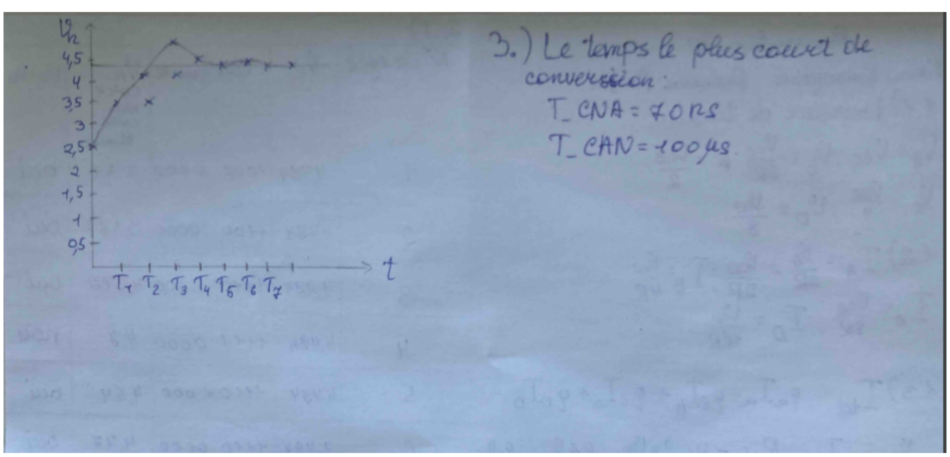
1.4)



2.1)

| N° de cycle | $V_e$ | code binaire | $V_n$ corr. au code binaire | $V_e > V_n$ |
|---|---|---|---|---|
| 1 | 4,494 | 1000 0000 | 2,51 | oui |
| 2 | 4,494 | 1100 0000 | 3,567 | oui |
| 3 | 4,494 | 1110 0000 | 4,342 | oui |
| 4 | 4,494 | 1111 0000 | 4,7 | non |
| 5 | 4,494 | 1110 1000 | 4,54 | oui |
| 6 | 4,494 | 1110 0100 | 4,47 | oui |
| 7 | 4,494 | 1110 0110 | 4,504 | non |
| 8 | 4,494 | 1110 0101 | 4,44 | oui |

FIGURE 1 – Preparation work 1.





3.) Le temps le plus court de conversion :

T_CNA = 70 ns

T_CAN = 100 µs

FIGURE 2 – Preparation work 1.

# 3 Etude dynamique CAN-CNA

## 3.1 Etude dynamique CAN

In this part we will only use CAN. For this I disconnected CAN from CNA and put a reference voltage at 2.5V and an Offset at 0.

1.1) First of all we want to see an exit voltage which responds to 255 in binary(all 8 bits of ADC are enabled). After connecting a voltage source of about 5 volts to the entrance of CAN I observed measuring on multimetre shows 2.47V. For 127 value of ADC we could notice that the exit voltage is 5.02 volts.
When we change the reference voltage we can observe how it influences the maximum output voltage possible. I put Vref=5V and now the output corresponding to b=127 is 4.9V and increasing the enter value doesn't gradually change the output. The maximum is around 5 volts. The conclusion is that the reference voltage is the one that shows the maximum value of output, but this value is never reached. The error I had finding 5.02 volts is

1.2) Going further we will remove the reference voltage. Here I retried the measurements done on 1.1) and I noticed that the output corresponding to 127 bits is 2.45V and the one corresponding to 255 bits is 4.95V. So we can say that the nominal reference value in CAN is 2.5 Volts.

1.3) By regulating manually the offset I've had 127 bits +2.43 volts in entrance + regulated offset and the outcome was 460mV. So basically I reduced the final value by applying an offset. Offset serves to vary the entrance voltage either in positive or negative direction.

## 3.2 Étude statique du CNA

Now we choose the reference voltage as 5 volts. As well we've put all the bits at 1 except for the d7.
2.1)Vs= 1.6V

2.2)Emax=20V(all bits at 1) ; Emin= 1.6V(7 bits at 0 and d0 at 1)

So E=20-1.6=18.4V

Q=18.4/255=72mV

2.3)Resolution is 8 bits

2.4)The resolution can vary depending on resistances in the circuit. For example it can be 4.999kOhm instead of 5kOhm.

## 3.3 Étude dynamique

In this part, the two converters are connected. According to the manufacturer's documentation, it is noticed that the conversion time of the DAC(70ns) is much less than that of the ADC.

3.3)Having an entrance value of 500mV I received 5V as an output. With 280mV there is 2.8V in output. For 480mV-4.880V, 660mV-6.56V et cetera.

3.1)To find the maximum number of voltage to have invariant binary number we need to resolve the quantum which is (Emax-Emin)/255

For 50Hz and 500 we have :

Emax=2.95V.... Emin=0.02V.... Q=2.93/255=11.2mV For 80Hz we have :

Emax=3.83V.... Emin=0.03V.... Q=3.8/255=15mV

3.2)The frequency changes the step for the digital bits. By that I want to say that if we put 0.83V at 200Hz frequency, we'll see that the number corresponding for that output is not exact(d5 to d0 are all on. And if we put low input frequency such as 10Hz with the same voltage, d5 to d3 will blink pretty fast. In my estimation this happens because the number of the output we obtain is not exactly d0=1,d1=1...d5=1,d6=0,d7=0 but it's varies among the numbers of quantum

3.3)Now we need to find dVe/dt variation where dVe is the minimal voltage difference and dt is the temporal difference of 1 conversion for dVe. Also dVe is our quantum. We are taking the one for 80Hz.

dVe/dt=15.4mV/1.22ms=12.6V/s

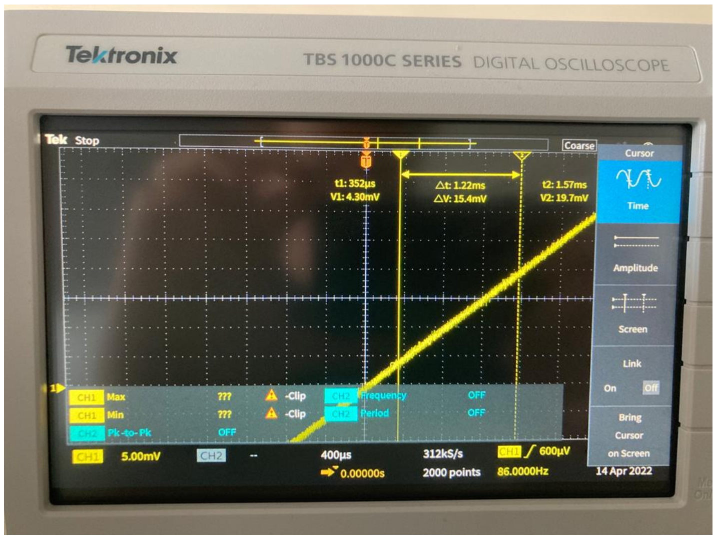



FIGURE 3 – .

And the time for 1 conversion is 2ms/16=125us(2ms for all conversions and 16-number of conversions)

3.4)Watching d0 shows us nearly the same result-180us

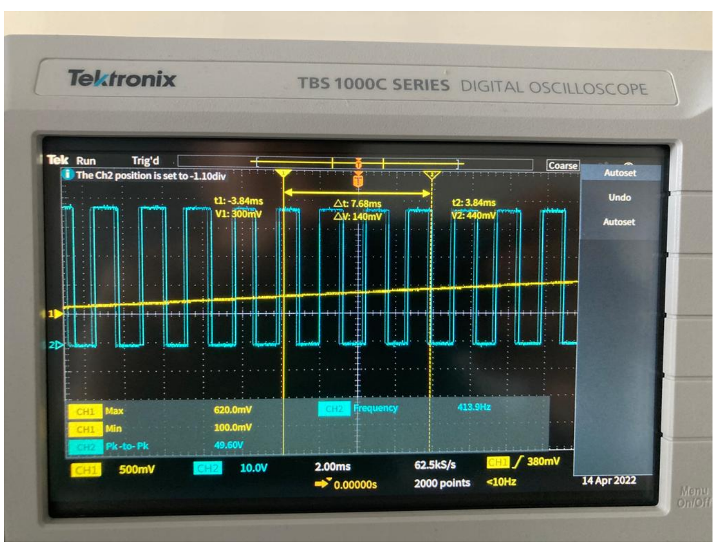



FIGURE 4 – .

3.5)Now connecting a rectangular signal we receive this result.

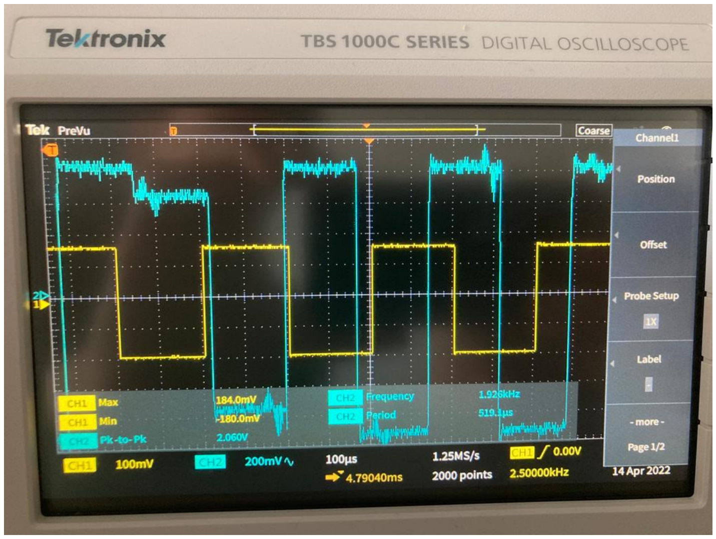



Figure 5 – .

Can we measure the settling time supposing that the conversion time of CNA could be ignored ? Yes.

## 4 Conclusion

-I found the difference of working with and without reference voltage on ADC. Not only allows ADC and DAC to establish the correspondence scale between the digital quantity and an analog voltage but it corresponds to the highest possible value for the output of ADC for example.

-The quantum can show us how much value divides the conversions and helps to find the conversion time as we did in 3.3)

-I studied the influence of the frequency of the input