Exercise 7

DA Converters

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Index

1 Objective

This laboratory exercise focus on the on the A/D converter with current sources, during the realization of the exercise we will understand the wayt that it works and how to implement it on Matlab,we then will see the diffenrece between Differential and Non Differential signal, and,yet again, obtain DNL and INL.

2 Exercise 1: Model of D/A converter realized with current sources

We will implement the formulas in Matlab and begin by obtaining the output linear voltage and plotting it:

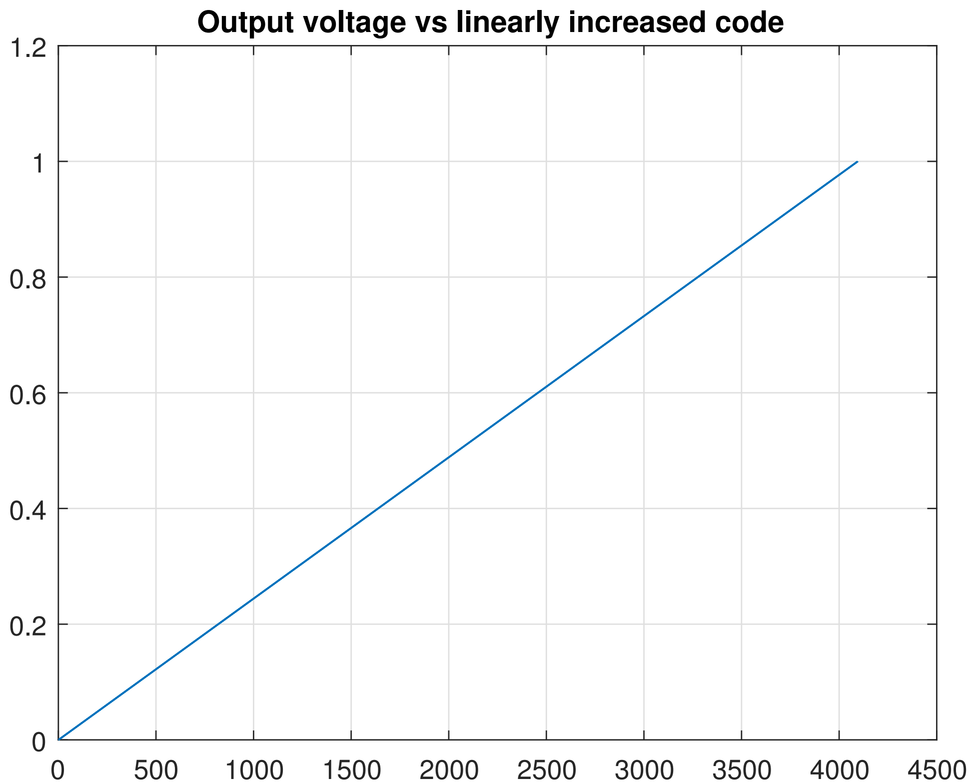

Figure 1: Output Voltage versus Input Code

Then we will obtain DNL and INL as did in previous laboratory exercises and plot them:

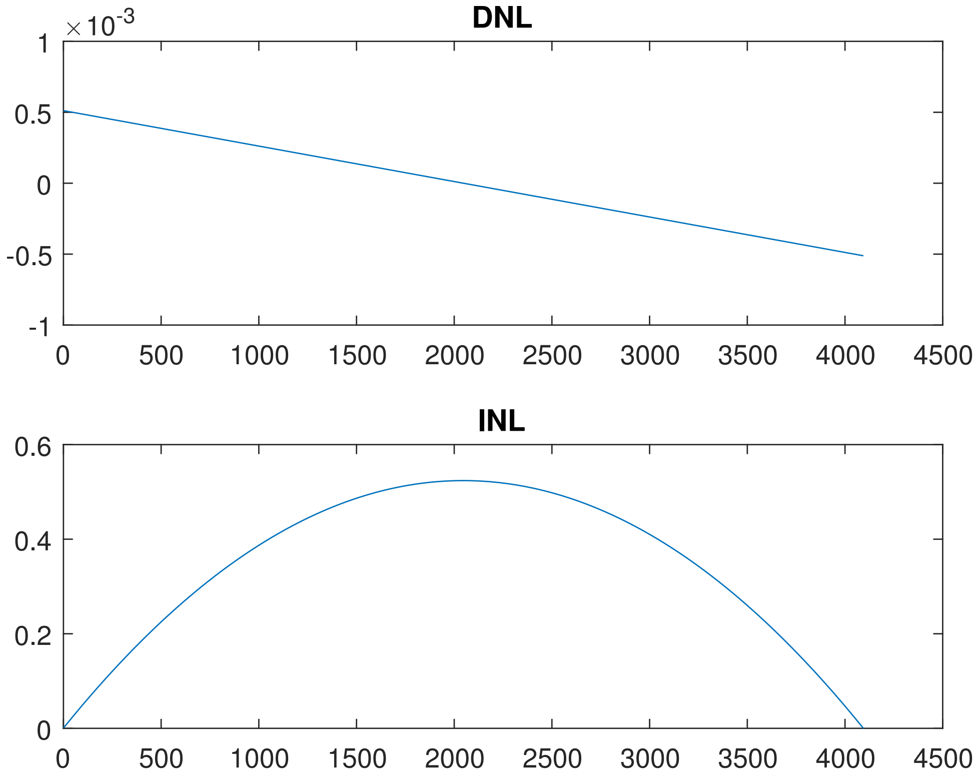

Figure 2: DNL and INL

We can see how DNL is a decreasing line,while INL is a parabole.

Finally, we obtain the output function Vout sin and the same signal delayed by π.Then we will plot the first signal and the difference between both.

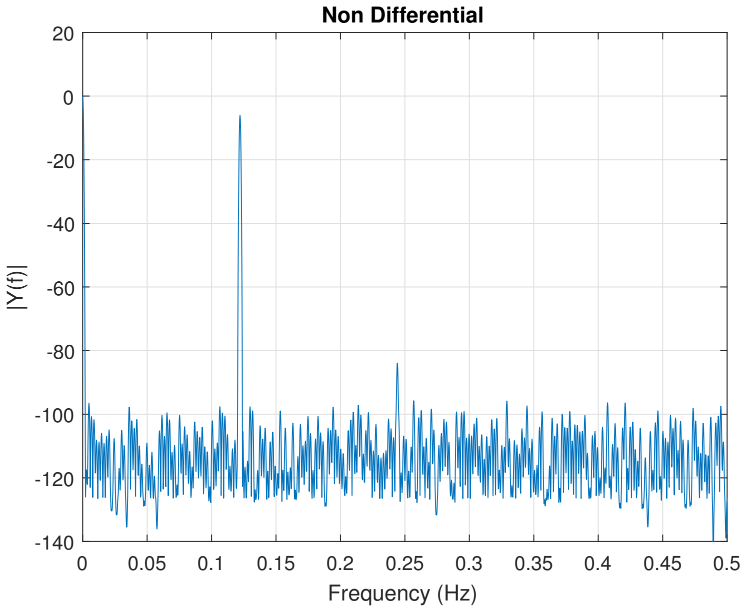

Figure 3: Non Differential

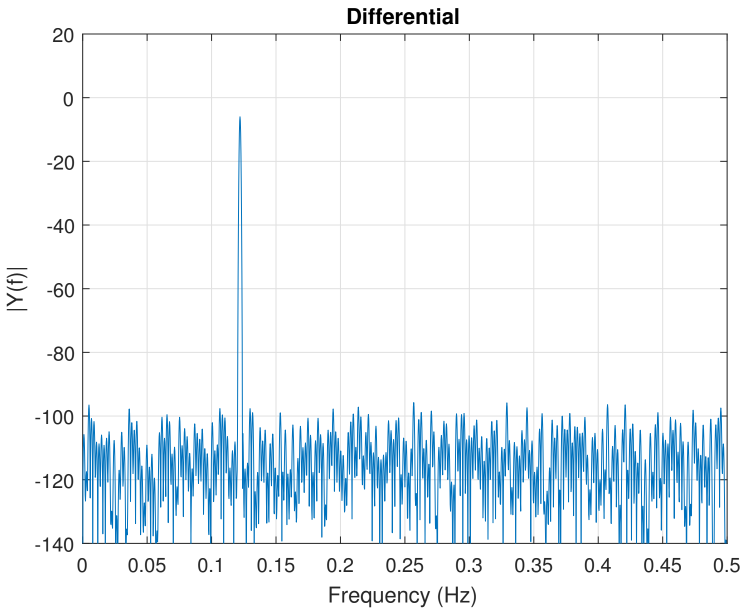

Figure 4: Differential

We can notice the difference between both modes,in non differential we have all the harmonics,while in the differential mode we delete all of them and only the first (the desired one)reminds

3 Appendix

```
clear all;
close all;
% We define all the variables
Fs=1;                % Sampling Freq
Vdd=1;               % Voltage input
B=12;                % Number of bits
RL=25;               % Load Resistor
Ron=100;             % Switch serial resistor
RU=200e6;            % Current source resistor
Iu=Vdd/(RL*(2^B-1));
Ron_n=Ron*ones(1,2^B);
RU_n=RU*ones(1,2^B);
Rn_n=Ron_n+RU_n;
In_n=Vdd./Rn_n + Iu;

x_lin=0:2^B-1;
% We obtain the Vout_lin
for i=1:2^B
     Vout_lin(i)=sum(In_n(1:x_lin(i)))./(1/RL+sum(1./(Rn_n(1:x_lin
        (i)))));
end
% Output voltage vs code
figure(1)
stairs(x_lin,Vout_lin);
grid on;
title('Output voltage vs linearly increased code')

% We define delta and get DNL and INL
delta=Vdd/(2^B-1);
DNL=(diff(Vout_lin)-delta)/delta;
for j=1:length(DNL)
     INL(j)=sum(DNL(1:j));
```

```
end

% We plot DNL and INL
figure(2)
subplot(2,1,1)
plot(x_lin(1:4095),DNL)
title('DNL')
subplot(2,1,2)
plot(x_lin(1:4095),INL)
title('INL')


% We now calculate Vout sin (Single)
n=0:2^B-1;
x_sin=(2^B-1)*(0.5*sin(2*pi*500./length(n).*n)+0.5);
  for g=1:length(x_sin)
        Vout_sin(g)=sum(In_n(1:x_sin(g)))./(1/RL+sum(1./Rn_n(1:
           x_sin(g))));
  end

 fft_plot(Vout_sin,1,'lin','dB')
 title('Non Differential')
 ylim([-140 20])

% We now calculate Vout sin 180 (Diff)
x_sin_180=(2^B-1)*(0.5*sin(2*pi*500./length(n).*n+pi)+0.5);
for g=1:length(x_sin)
      Vout_sin_180(g)=sum(In_n(1:x_sin_180(g)))./(1/RL+sum(1./Rn_n
         (1:x_sin_180(g))));
end

fft_plot((Vout_sin-Vout_sin_180)/2,1,'lin','dB');
ylim([-140 20])
title('Differential')
```