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LAMPIRAN

Delta Modulasi (Signal Output)

```
T_sample = 100;%N_sample
Amp = 0.5; %choose: 0.5,1
un=Amp*sin(2*pi*1./T_sample*[0:(T_sample)]);%input signal
en=0;
en_delay=0;
delta=2;

L = length(un);
Delta_step = 0.05 ; %choose: 0.05,0.1
xn = 0;
for i=1:L;
if un(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

for i=1:D;
if D(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

figure ()
plot (un, '--');
%grid on;
hold on;
stairs (xn, 'r');
hold on;
stairs (D, 'k'); %Delta Mod
legend ('signal input', 'Integrated signal','DeltaMod quantized
signal output');
xlabel ('Sample Number')
ylabel ('Amplitude')
title ('Delta Modulation')
xlim([1 100]);
ylim([-1 1]);
```

Delta Modulasi (Output Spectrum)

```
T_sample = 10000;%N_sample
Amp = 0.5; %choose: 0.5,1
sin(2*pi*1./T_sample*[0:(T_sample)]);%input signal

y=0;
```

```
L = length(un);
Delta_step = 0.05 ; %choose: 0.05,0.1
xn = 0;
for i=1:L;
if un(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

for i=1:D;
if D(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

un1_fft_DM = 20*log10(abs(fft(D)));
un1_fft_fftshift_DM =fftshift(un1_fft_DM);
F= [-T_sample/2 : T_sample/2]/T_sample;

figure()
plot(F,un1_fft_fftshift_DM, 'r')
xlabel('Frequency/fs')
ylabel('Ouput to Input Power Spectrum Frequency (dB)')
title ('Output spectrum of Delta Modulation')
grid on
```

Delta-Sigma Modulasi [MOD1 (Signal Output)]

```
T_sample = 100; %N_sample
Amp = 0.5; %choose: 0.5,1
un=Amp*sin(2*pi*1/T_sample*[0:(T_sample)]); %input signal
en=0;
en_delay=0;
delta=2;

for aa=1:length(un)
    yn=un(aa) + en_delay;

            if yn>=0  % imilar with %vn=sgn(yn); as quantizing
            %if yn>0  % imilar with %vn=sgn(yn); as quantizing
            vn=1;
            else
            vn=-1;
            %vn=0;
            end
= yn - vn;
_delay=en;
```

```
     output_vn(aa)=vn;
end

diff = (un-output_vn);
average_power= vn ./ T_sample;

figure ()
t=0:T_sample;
plot(t, un(t+1),'--')
hold on
grid on
stairs(t, output_vn(t+1),'r')
legend ('signal input','DSMod quantized signal output');
xlabel ('Sample Number')
ylabel ('Amplitude')
title ('Delta-Sigma Modulation')
```

Delta-Sigma Modulasi [MOD1 (Output Spectrum)]

```
T_sample = 10000;%N_sample
Amp = 0.5; %choose: 0.5,1
un=Amp*sin(2*pi*1/T_sample*[0:(T_sample)]); %input signal
en=0;
en_delay=0;
delta=2;

for aa=1:length(un)
    yn=un(aa) + en_delay;

            if yn>=0  % imilar with %vn=sgn(yn); as quantizing
            %if yn>0  % imilar with %vn=sgn(yn); as quantizing
            vn=1;
            else
            vn=-1;
            %vn=0;
            end
     en = yn - vn;
     en_delay=en;

     output_vn(aa)=vn;
end

diff = (un-output_vn);
average_power= vn ./ T_sample;

un1_fft = 20*log10(abs(fft(output_vn)));
un1_fft_fftshift =fftshift(un1_fft);
F= [-T_sample/2 : T_sample/2]/T_sample;

          ()
          un1_fft_fftshift)
          'Frequency/fs')
          'Ouput to Input Power Spectrum Frequency (dB)')
          'Output spectrum of Delta-Sigma MOD1')
```

```
grid on
```

Delta Modulasi dan Delta-Sigma Modulasi [MOD1] (Output Spectrum)

```
T_sample = 10000; %N_sample
Amp = 0.5;
un=Amp*sin(2*pi*1/T_sample*[0:(T_sample)]); %input signal
en=0;
en_delay=0;
delta=2;

L = length(un);
Delta_step = 0.05 ;
xn = 0;
for i=1:L;
if un(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

for i=1:D;
if D(i) >= xn(i)
D(i) = 1;
xn(i+1) = xn(i) + Delta_step;
else
D(i) = -1;
xn(i+1) = xn(i) - Delta_step;
end
end

un1_fft_DM = 20*log10(abs(fft(D)));
un1_fft_fftshift_DM =fftshift(un1_fft_DM);
F= [-T_sample/2 : T_sample/2]/T_sample;

for aa=1:length(un)
    yn=un(aa) + en_delay;
            if yn>=0  % imilar with %vn=sgn(yn); as quantizing
            %if yn>0  % imilar with %vn=sgn(yn); as quantizing
            vn=1;
            else
            vn=-1;
            %vn=0;
            end
     en = yn - vn;
     en_delay=en;
     output_vn(aa)=vn;

(un-output_vn);
_power= vn ./ T_sample;

 = 20*log10(abs(fft(output_vn)));
_fftshift =fftshift(un1_fft);
```

```
F= [-T_sample/2 : T_sample/2]/T_sample;

figure()
plot(F,un1_fft_fftshift_DM, 'r')
hold on
plot(F,un1_fft_fftshift)
xlabel('Frequency/fs')
ylabel('Ouput to Input Power Spectrum Frequency (dB)')
title ('Output spectrum')
legend('DeltaMod','DeltaSigmaMod')
grid on
```

Noise Transfer Function (NTF) Delta Sigma Modulasi Orde 1 (MOD1)

```
close all;
clear all;
clc;

%% generate input
ffc= 3.584*10^9; %generate input frekuenesi carrier choose : 2.3
Ghz(2.355) and 3.5 Ghz (3.584)
ffs= 7.168*10^9; %Sampling Frequency choose 4.710 for (2,3 GHz)
BBW= 56*10^6; %Choose 36,8 for (2,3 GHz)

N=50;
OSR = 50;

fc = 0: 1/(OSR*N) : 1;

for i=1:length(fc);

NTFMOD1(i) = 2.*sin(pi.*fc(i))^2;
end

% Figure NTF_DS_out
figure()
plot (20.*log10 (abs(NTFMOD1))), 'k';

figure()
plot ( (abs(NTFMOD1))), 'r--';
```

Deret Fourier Transform – Penentuan *R* (OSR 4, 8, 16, 32, dan 64)

Np=4=OSR

```
even4nol = [0,0,0,0];
even4pos = [1,1,1,1];
even4neg = [-1,-1,-1,-1];
even_g0  = max(abs(fft([     0,0,0,0,       0,0,0,0,       0,0,0,0,
    0,0,0,0,          0,0,0,0,       0,0,0,0,       0,0,0,0,
    0,0,0,0,          0,0,0,0,       0,0,0,0,       0,0,0,0,
    0,0,0,0,          0,0,0,0,       0,0,0,0,       0,0,0,0,
    0,0,0,0,          0,0,0,0,       0,0,0,0,       0,0,0,0,
    0,0,0,0,          0,0,0,0,       0,0,0,0,       0,0,0,0,
```

```
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,]))/256)*2
even_c2 =  max (abs(fft([    1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,]))/256)*2
```

Np=8=OSR

```
even4nol = [0,0,0,0];
even4pos = [1,1,1,1];
even4neg = [-1,-1,-1,-1];
even_c0  = max(abs(fft([     0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,]))/256)*2
even_c2 =  max (abs(fft([    0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,    -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
1,-1,                   -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
1,-1,                   -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
1,-1,                   -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
1,-1,                       0,0,0,0,      0,0,0,0,       0,0,0,0,
,                           0,0,0,0,      0,0,0,0,       0,0,0,0,
,]))/256)*2
```

```
even_c4 =  max (abs(fft([    1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,]))/256)*2
Np=16=OSR
even4nol = [0,0,0,0];
even4pos = [1,1,1,1];
even4neg = [-1,-1,-1,-1];
even_c0  = max(abs(fft([     0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,]))/256)*2
even_c2  = max (abs(fft([    0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       1,1,1,1,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,                -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,            -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,                0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,]))/256)*2
even_c4 =  max (abs(fft([    0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
1,1,1,1,    1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
[illegible] 1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
[illegible] 1,1,1,1,        1,1,1,1,      1,1,1,1,       1,1,1,1,
[illegible] 0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
[illegible] 0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
[illegible] 0,0,0,0,        0,0,0,0,      0,0,0,0,       0,0,0,0,
[illegible] 0,0,0,0,    -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
```

```
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,                 0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,                     0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,]))/256)*2
even_c6 =  max (abs(fft([    0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
0,0,0,0,    0,0,0,0,         0,0,0,0,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,         0,0,0,0,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,      0,0,0,0,       0,0,0,0,
0,0,0,0,    0,0,0,0,]))/256)*2
even_c8 =  max (abs(fft([    1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,       1,1,1,1,
1,1,1,1,    1,1,1,1,         1,1,1,1,      1,1,1,1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,   -1,-1,-1,-1,
-1,-1,-1,-1,              -1,-1,-1,-1,  -1,-1,-1,-1,]))/256)*2
```

Function Theta (Even Quantisation Polar Plane Scale, OSR 4, 8, 16)

OSR 4

```
% even
% steps_in_pi=2, NA=2, NP=OSR=4.
function [even_r_pwm, even_R, even_theta]=
         evenquan4(input_qr_yr,input_qtheta_ytheta);
%NA=2;
if (input_qr_yr <0.6367);
    even_R=0;
    even_r_pwm=0/2;

    n_R=1.2733;
    n_r_pwm=2/2;
```

```
%% NP=4;
if (input_qtheta_ytheta >= (-4/32*2*pi)) &
    (input_qtheta_ytheta < (4/32*2*pi));
    even_theta = (0/32*2*pi);
elseif (input_qtheta_ytheta >= (4/32*2*pi)) &
    (input_qtheta_ytheta <= (12/32*2*pi));
    even_theta = (8/32*2*pi);
elseif (input_qtheta_ytheta >= (12/32*2*pi)) &
    (input_qtheta_ytheta < (16/32*2*pi));
    even_theta  = (16/32*2*pi);
elseif (input_qtheta_ytheta >= (-12/32*2*pi)) &
    (input_qtheta_ytheta < (-16/32*2*pi));
    even_theta  = (-16/32*2*pi);
else (input_qtheta_ytheta  >= (-12/32*2*pi)) &
    (input_qtheta_ytheta < (-4/32*2*pi));
    even_theta  = ((-8/32)*2*pi);
end

end
```

OSR 8

```
% even
% steps_in_pi=4, NA=3, NP=OSR=8.
function [even_r_pwm, even_R, even_theta]=
          evenquan8(input_qr_yr,input_qtheta_ytheta);
%NA=3;
if (input_qr_yr < 0.4502);
    even_R=0;
    even_r_pwm=0/4;

elseif (input_qr_yr >= 0.4502)&(input_qr_yr < 1.0869);
    even_R=0.9003;
    even_r_pwm=2/4;

else
    even_R=1.2733;
    even_r_pwm=4/4;

end

%% NP=8;
if(input_qtheta_ytheta >= (-2/32*2*pi)) & (input_qtheta_ytheta <
    (2/32*2*pi));
    even_theta = (0/32*2*pi);
elseif(input_qtheta_ytheta >= (2/32*2*pi)) & (input_qtheta_ytheta
     < (6/32*2*pi));
    even_theta = (4/32*2*pi);
    input_qtheta_ytheta >= (6/32*2*pi)) & (input_qtheta_ytheta
    10/32*2*pi));
    _theta = (8/32*2*pi);
    input_qtheta_ytheta >= (10/32*2*pi)) & (input_qtheta_ytheta
    (14/32*2*pi));
    _theta = (12/32*2*pi);
```

```
elseif(input_qtheta_ytheta >= (14/32*2*pi)) & (input_qtheta_ytheta
     < (16/32*2*pi));
    even_theta = (16/32*2*pi);
elseif(input_qtheta_ytheta  >= (-14/32*2*pi))&(input_qtheta_ytheta
     < (-16/32*2*pi));
    even_theta = (-16/32*2*pi);
elseif(input_qtheta_ytheta >= (-14/32*2*pi))&(input_qtheta_ytheta
     < (-10/32*2*pi));
    even_theta = (-12/32*2*pi);
elseif(input_qtheta_ytheta >= (-10/32*2*pi))&(input_qtheta_ytheta
     < (-6/32*2*pi));
    even_theta = (-8/32*2*pi);
else(input_qtheta_ytheta >= (-6/32*2*pi)) & (input_qtheta_ytheta <
    (-2/32*2*pi));
    even_theta = (-4/32*2*pi);
end

end
```

OSR 16

```
% even
% steps_in_pi=8, NA=5, NP=OSR=16.
function [even_r_pwm, even_R, even_theta]=
          evenquan16(input_qr_yr,input_qtheta_ytheta);
%NA=5;
if (input_qr_yr < 0.2437);
    even_R=0;
    even_r_pwm=0/8;
 elseif (input_qr_yr >= 0.2437)&(input_qr_yr < 0.6939);
    even_R=0.4873;
    even_r_pwm=2/8;

elseif (input_qr_yr >= 0.6939)&(input_qr_yr < 1.4885);
    even_R=0.9003;
    even_r_pwm=4/8;

elseif (input_qr_yr >= 1.4885)&(input_qr_yr < 1.2248);
    even_R=1.1763;
    even_r_pwm=6/8;

else
    even_R=1.2733;
    even_r_pwm=8/8;

end

%% NP=16
% even is in fractional
if (input_qtheta_ytheta >= (-1/32*2*pi)) & (input_qtheta_ytheta <
    2*2*pi));
    n_theta = (0/32*2*pi);
    (input_qtheta_ytheta >= (1/32*2*pi)) & (input_qtheta_ytheta
    3/32*2*pi));
    n_theta = (2/32*2*pi);
```

```
elseif (input_qtheta_ytheta >= (3/32*2*pi)) & (input_qtheta_ytheta
     < (5/32*2*pi));
    even_theta = (4/32*2*pi);
elseif (input_qtheta_ytheta >= (5/32*2*pi)) & (input_qtheta_ytheta
     < (7/32*2*pi));
    even_theta = (6/32*2*pi);
elseif (input_qtheta_ytheta >= (7/32*2*pi)) & (input_qtheta_ytheta
     < (9/32*2*pi));
    even_theta = (8/32*2*pi);
elseif (input_qtheta_ytheta >= (9/32*2*pi)) & (input_qtheta_ytheta
     < (11/32*2*pi));
    even_theta = (10/32*2*pi);
elseif (input_qtheta_ytheta >= (11/32*2*pi))& (input_qtheta_ytheta
     < (13/32*2*pi));
    even_theta = (12/32*2*pi);
elseif (input_qtheta_ytheta >= (13/32*2*pi))& (input_qtheta_ytheta
     <=(15/32*2*pi));
    even_theta = (14/32*2*pi);
elseif (input_qtheta_ytheta >= (15/32*2*pi))& (input_qtheta_ytheta
     < (16/32*2*pi));
    even_theta = (16/32*2*pi);
elseif (input_qtheta_ytheta >= (-15/32*2*pi))&(input_qtheta_ytheta
     < (-16/32*2*pi));
    even_theta = (-16/32*2*pi);
elseif (input_qtheta_ytheta  < (-15/32*2*pi))&(input_qtheta_ytheta
     < (-13/32*2*pi));
    even_theta = (-14/32*2*pi);
elseif (input_qtheta_ytheta >= (-13/32*2*pi))&(input_qtheta_ytheta
     < (-11/32*2*pi));
    even_theta = (-12/32*2*pi);
elseif (input_qtheta_ytheta >= (-11/32*2*pi))&(input_qtheta_ytheta
     < (-9/32*2*pi));
    even_theta = (-10/32*2*pi);
elseif (input_qtheta_ytheta >= (-9/32*2*pi))& (input_qtheta_ytheta
     < (-7/32*2*pi));
    even_theta = (-8/32*2*pi);
elseif (input_qtheta_ytheta >= (-7/32*2*pi))& (input_qtheta_ytheta
     < (-5/32*2*pi));
    even_theta = (-6/32*2*pi);
elseif (input_qtheta_ytheta >= (-5/32*2*pi))& (input_qtheta_ytheta
     < (-3/32*2*pi));
    even_theta = (-4/32*2*pi);
else (input_qtheta_ytheta >= (-3/32*2*pi)) & (input_qtheta_ytheta
     < (-1/32*2*pi));
    even_theta = (-2/32*2*pi);
end

end
```

Cartesian to Polar

```
r_yr = sqrt((vn_i ).^2 + (vn_q).^2);
theta_ytheta = atan2 (vn_q,vn_i);
```

Cartesian

```
y_i = even_R .*cos(even_theta);
```

```
en_delay_q = even_R .*sin(even_theta);
```

Quantisation Even

```
if      (steps_in_pi == 2)
        [even_r_pwm, even_R, even_theta] =
        evenquan4(input_qr_yr,input_qtheta_ytheta);
elseif (steps_in_pi == 4)
        [even_r_pwm, even_R, even_theta] =
        evenquan8 (input_qr_yr,input_qtheta_ytheta);
elseif (steps_in_pi == 8)
        [even_r_pwm, even_R, even_theta] =
        evenquan16(input_qr_yr,input_qtheta_ytheta);
end

R_feedback = even_R;
theta_feedback = even_theta;

R_feedback_array (i)        = R_feedback;          %feedback ke DS
theta_feedback_array (i)    = theta_feedback;      %feedback ke DS

even_R_array (i)             = even_R;
even_theta_array (i)         = even_theta;
even_r_pwm_array (i)         = even_r_pwm;

input_qr_yr_array (i)          = input_qr_yr;
input_qtheta_ytheta_array(i)   = input_qtheta_ytheta;
```

Keseluruhan Code Pemrograman (Even Matlab)

```
%% generate input
fc= 2.355*10^9; %generate input frekuenesi carrier
                choose : 2.355 (2.3 GHz),3.584 (3.5 GHz)
fs= 4.710*10^9; %Samplng Frequency  choose : 4.710,7168
BW= 36.8*10^6;  %choose 56

steps_in_pi =2;  %choose: 2,4,8
NP=2*steps_in_pi; %OSR_r=RF = 4,8,16
fs_rf= NP*fs;

T_sample =4710; %N_sample = OSR   choose: 4710,7168
No_of_periods=1;
sample_max = (T_sample*No_of_periods);
offset=1; %Offset signal from carrier  choose: 1,.....

noise = (randn(1,1)+j*(randn(1,1)))*10^-4;
%noise= [-0.000120748692268504 + 7.17238651328839e-05i]; %test
only

max_num= offset/No_of_periods;


and proses
ak=1:max_num;
ble_max;
```

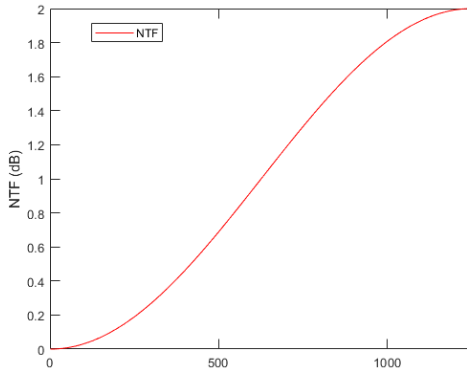
```
p=1;
Amp(p)=0.5;
input_un=Amp(p)*exp(j*2*pi*i/T_sample*jarak)+ noise;  %Input
signal

%% input I dan Q dalam format Cartesian/Rectangular
input_i = real(input_un);
input_q = imag(input_un);

%% Modulasi Delta Sigma Orde 1
yn_delay_i=0;
en_delay_i=0;
yn_delay_q=0;
en_delay_q=0;
     for i=1:sample_max;
%% MOD1
    yn_i = input_i(i)- en_delay_i;
    vn_i = yn_i + yn_delay_i;
    yn_delay_i = vn_i;

    yn_q  = input_q(i)- en_delay_q;
    vn_q = yn_q + yn_delay_q;
    yn_delay_q = vn_q;

    yn_i_array(i)        = yn_i; %Input signal of I-plane
    yn_q_array(i)        = yn_q; %Input signal of Q-plane

    en_delay_i_array(i)  = en_delay_i;
    en_delay_q_array(i)  = en_delay_q;

    vn_i_array (i)       = vn_i;
    vn_q_array (i)       = vn_q;

%% Cartesian to Polar
    input_qr_yr = sqrt((vn_i ).^2 + (vn_q).^2);
    input_qtheta_ytheta = atan2 (vn_q,vn_i);

%% Quantization: EVEN
    if      (steps_in_pi == 2)
            [even_r_pwm, even_R, even_theta] =
            evenquan4(input_qr_yr,input_qtheta_ytheta);
    elseif (steps_in_pi == 4)
            [even_r_pwm, even_R, even_theta] =
            evenquan8 (input_qr_yr,input_qtheta_ytheta);
    elseif (steps_in_pi == 8)
            [even_r_pwm, even_R, even_theta] =
            evenquan16(input_qr_yr,input_qtheta_ytheta);
    end

edback = even_R;
a_feedback = even_theta;

edback_array (i)        = R_feedback;      %feedback ke DS
a_feedback_array (i)    = theta_feedback;  %feedback ke DS
```

```
    even_R_array (i)              = even_R;
    even_theta_array (i)          = even_theta;
    even_r_pwm_array (i)          = even_r_pwm;

    input_qr_yr_array (i)           = input_qr_yr;
    input_qtheta_ytheta_array(i)    = input_qtheta_ytheta;

%% Polar to Cartesian
      en_delay_i = even_R .*cos(even_theta);
      en_delay_q = even_R .*sin(even_theta);
end
%% RF to PWM/PPM
[pwm] = SIRMARF (even_r_pwm_array,even_theta_array,steps_in_pi);
end

%  FIGURE RESULT
figure();
stem(20*log10(abs(fft(pwm))),'.r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum RF Signal');
legend ('Even');
xlim([1000 6500]);
xlim([300 4500]);
%ylim ([-30   100]);

figure();
plot(20*log10(abs(fft(pwm))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum RF Signal');
legend ('Even');

figure();
plot(20*log10(abs(fft(pwm))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum RF Signal');
legend ('Even');
xlim([500 1600]);

figure();
plot(20*log10(abs(fft(vn_i_array))),'r','LineWidth',1)
plot(20*log10(abs(fft(vn_q_array))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum Blok DS');
legend ('Even');

 Filter-DS
out=fft(vn_i_array(sample_max/2+1:sample_max)+j.*vn_q_array
    (sample_max/2+1:sample_max));
out=abs(fft_DS_out);
n_DS_out=20*log10(abs_DS_out);
```

```
figure()
plot (fftshift(spectrum_DS_out), 'r','LineWidth',1)
title ('Output spectrum Blok DS');
legend ('Even');

figure();
plot(20*log10(abs(fft(input_qr_yr_array))),'r','LineWidth',1)
plot(20*log10(abs(fft(input_qtheta_ytheta_array))),'r','LineWidth'
,1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum Blok Q');
legend ('Even');

%output-Q
fft_Q_out=fft(input_qr_yr_array(sample_max/2+1:sample_max)+j.*inpu
t_qtheta_ytheta_array(sample_max/2+1:sample_max));
abs_Q_out=abs(fft_Q_out);
spectrum_Q_out=20*log10(abs_Q_out);
figure()
plot (fftshift(spectrum_Q_out),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Output spectrum Blok Q');
legend ('Even')

% Input I
figure();
plot(20*log10(abs(fft(yn_i_array))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Input I');
legend ('Even');
% Input Q
figure();
plot(20*log10(abs(fft(yn_q_array))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Input Q');
legend ('Even');

%Feedback Block
figure()
plot(20*log10(abs(fft(R_feedback_array))),'r','LineWidth',1)
plot(20*log10(abs(fft(theta_feedback_array))),'r','LineWidth',1)
xlabel('Frequency/fs');
ylabel('Ouput Power Spectrum Frequency (dB)');
title ('Feedback I, OSR 4,8,16');
title ('Feedback Q, OSR 4,8,16');
legend ('Even');

 Sigma Delta Filter

*log10(abs(fft(en_delay_i_array))),'r','LineWidth',1)
*log10(abs(fft(en_delay_q_array))),'r','LineWidth',1)
'Frequency/fs');
```

```
ylabel('Output Power Spectrum Frequency (dB)');
title ('OSR 4,8,16');
legend ('Even');
```

Figure Result
Ploting Noise Transfer Function Delta Sigma MOD1

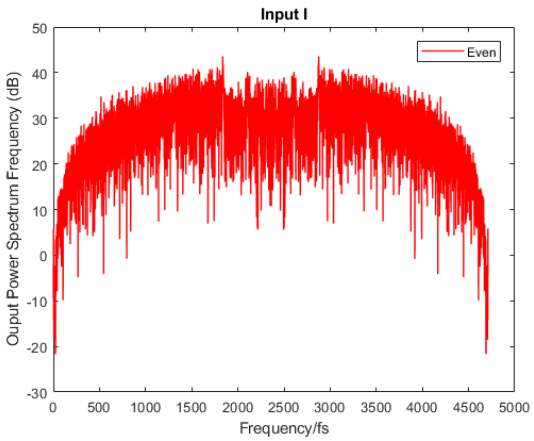


Normalized Frequnecy

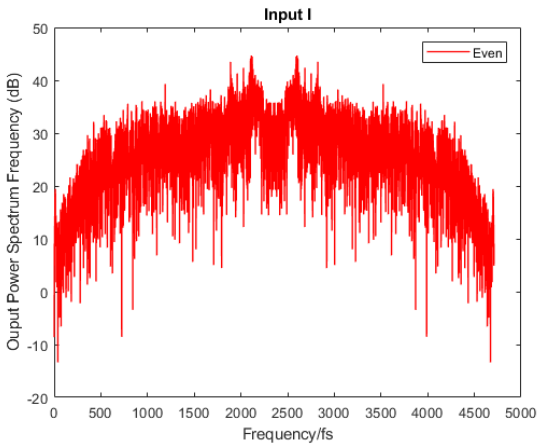
Ploting Output Spectrum Input I dan Q

a) Frekuensi 2,3 GHz

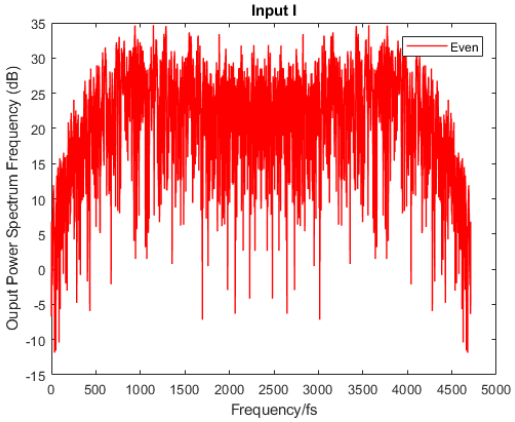
- **Input I**



OSR 4

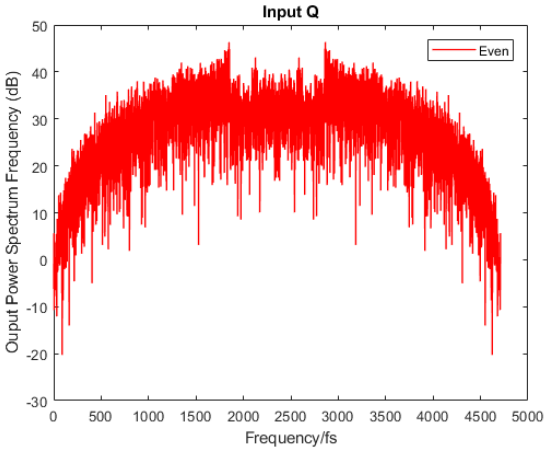


OSR 8

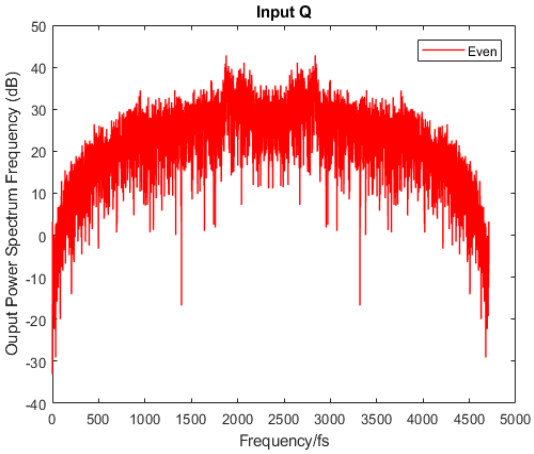


OSR 16

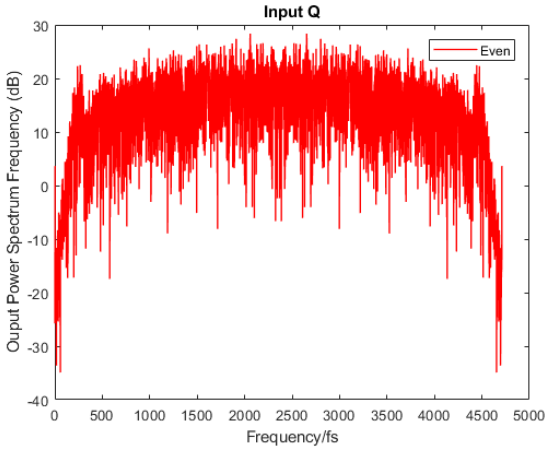
- **Input Q**



OSR 4



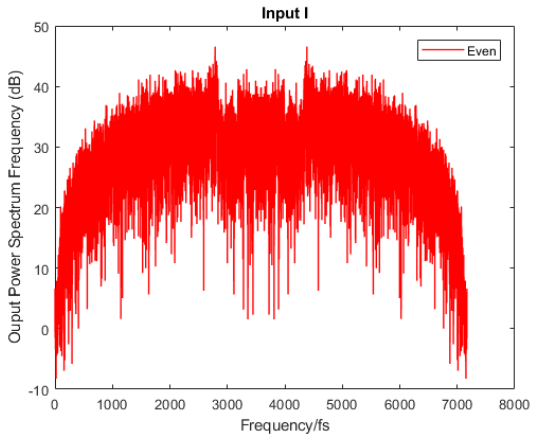
OSR 8



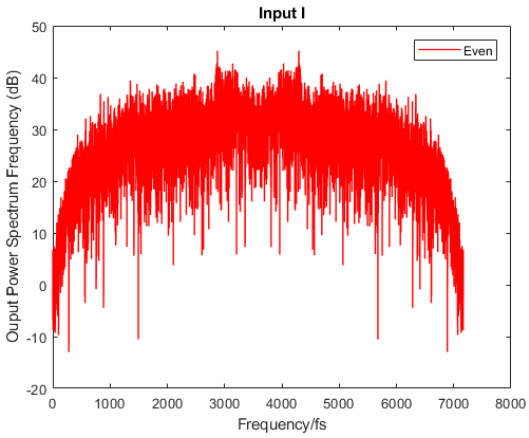
OSR 16

b) Frekuensi 3,5 GHz

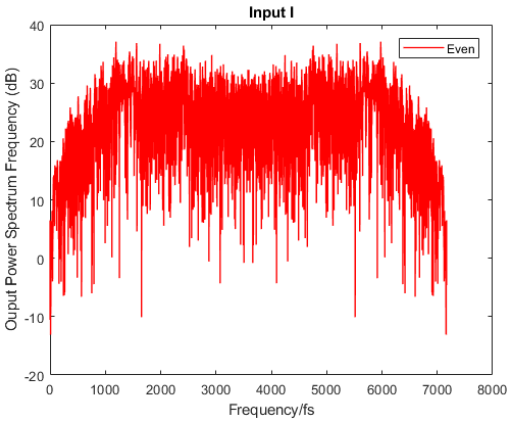
- **Input I**



OSR 4

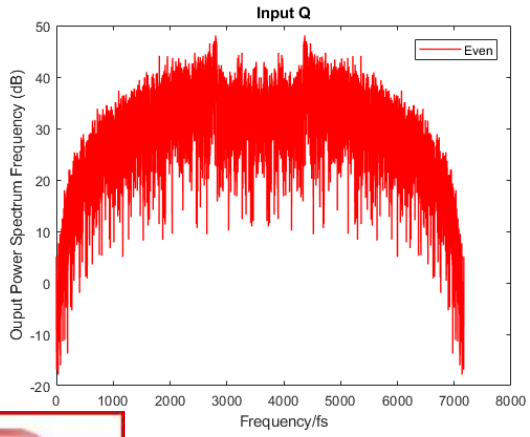


OSR 8

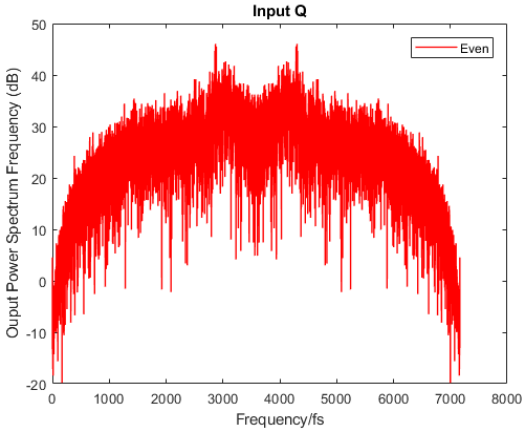


OSR 16

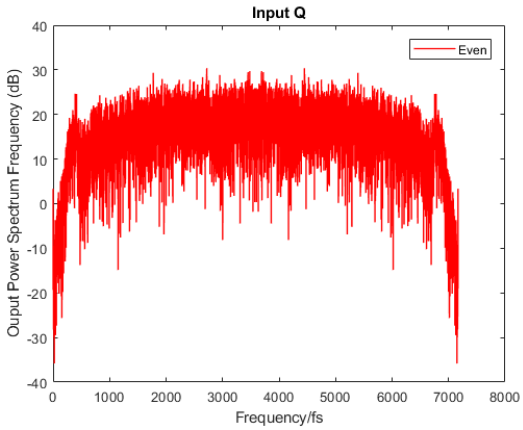
- **Input Q**



OSR 4



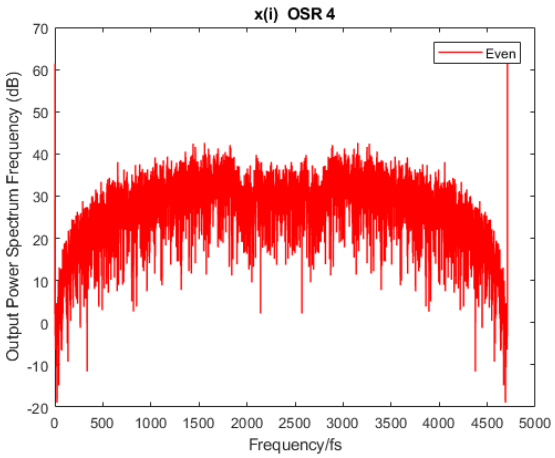
OSR 8

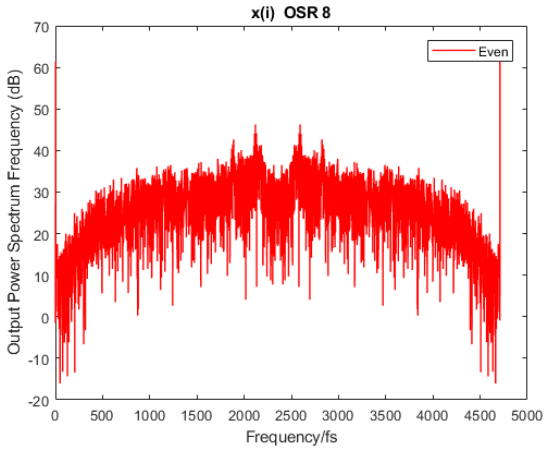


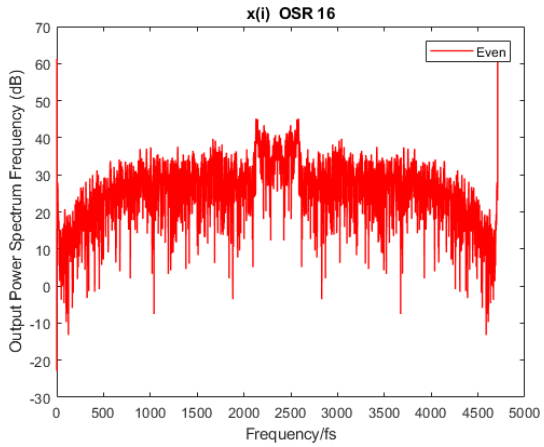
OSR 16

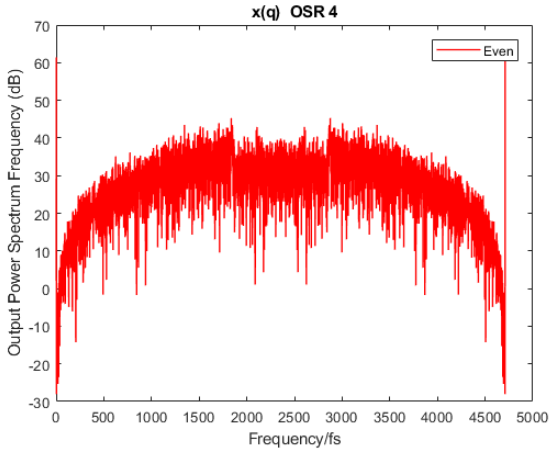
Ploting Input Sigma Delta (x_i dan x_q)

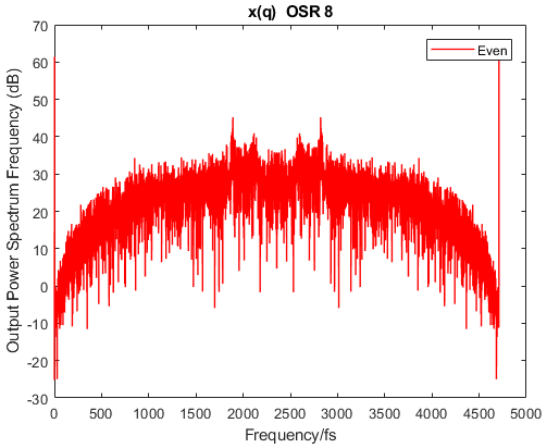
a) Frekunesi 2,3 GHz

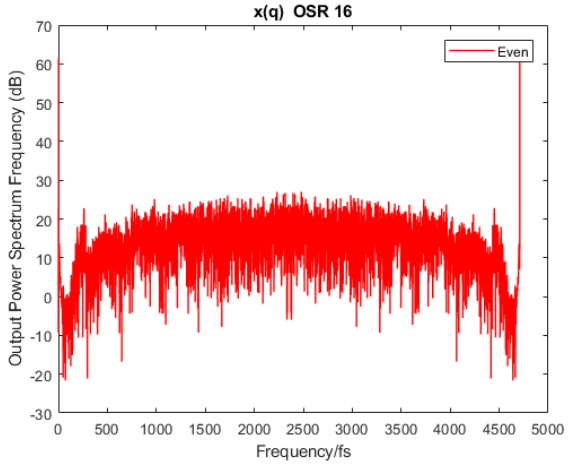




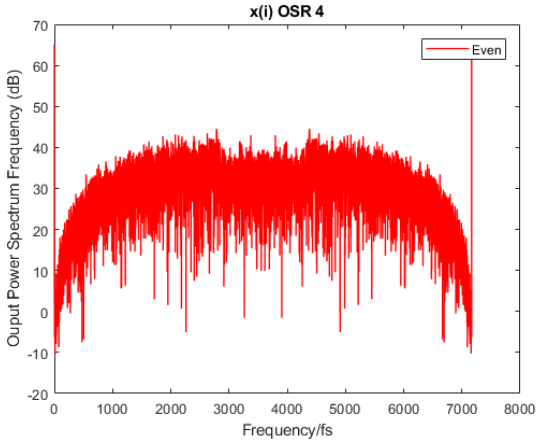


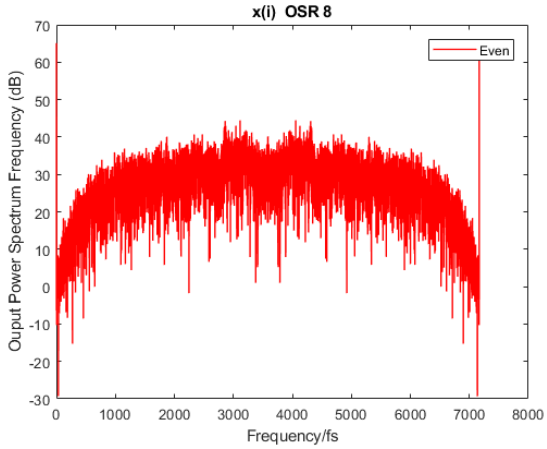


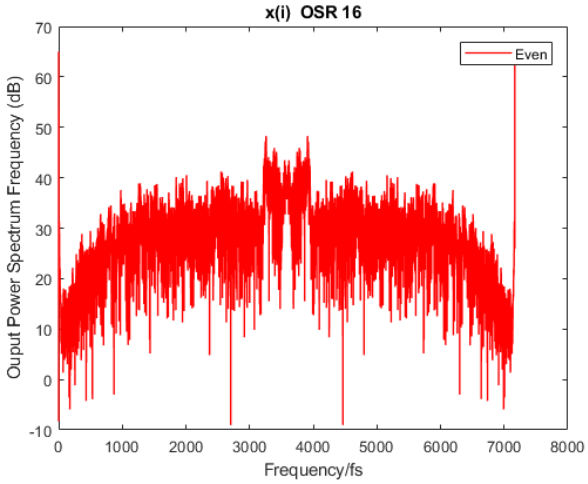


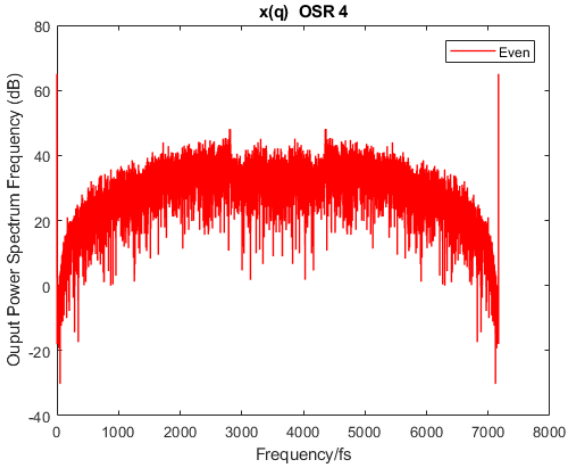


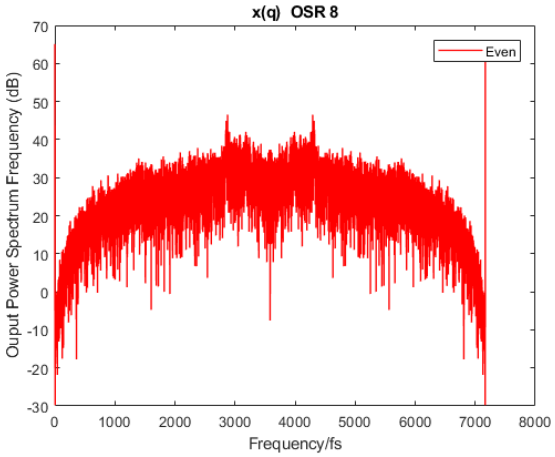
b) Frekuensi 3,5 GHz

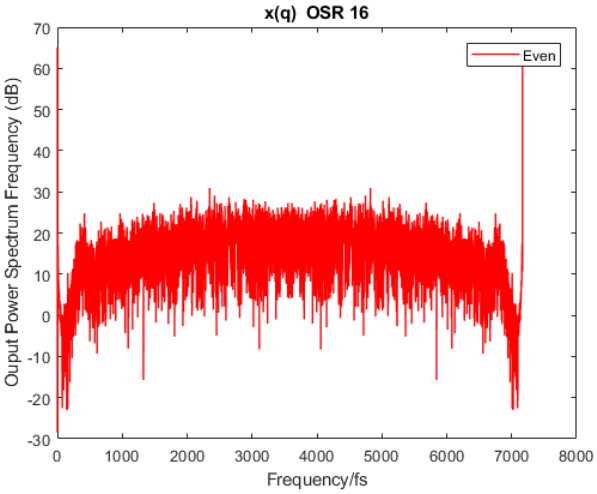






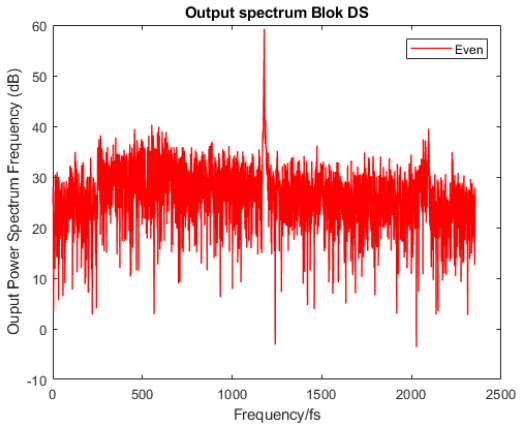




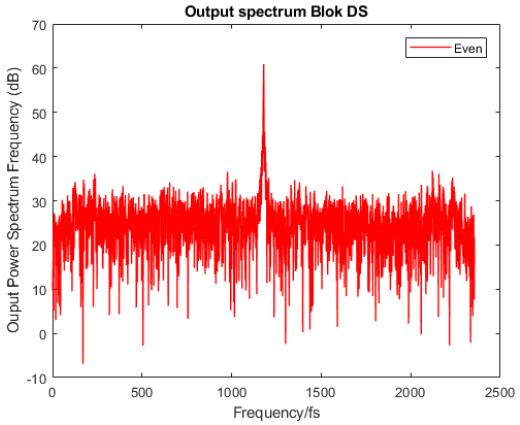


Ploting Output Spectrum Blok Delta Sigma (y_i dan y_q)

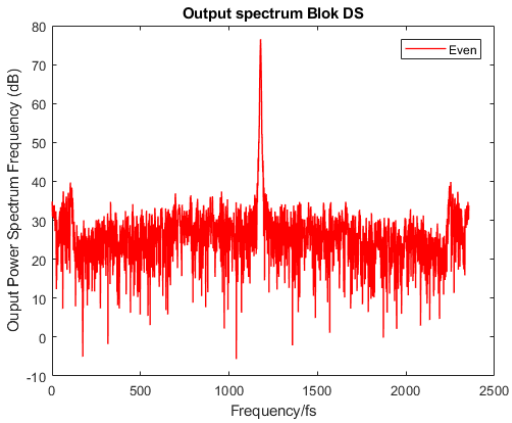
a) Frekuensi 2,3 GHz



OSR 4

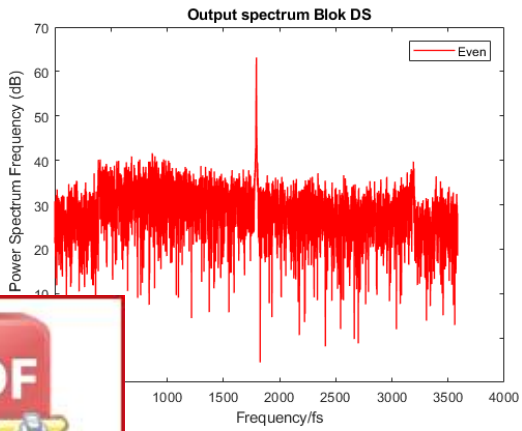


OSR 8

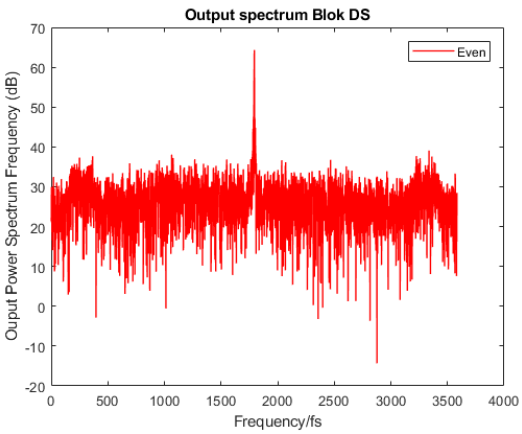


OSR 16

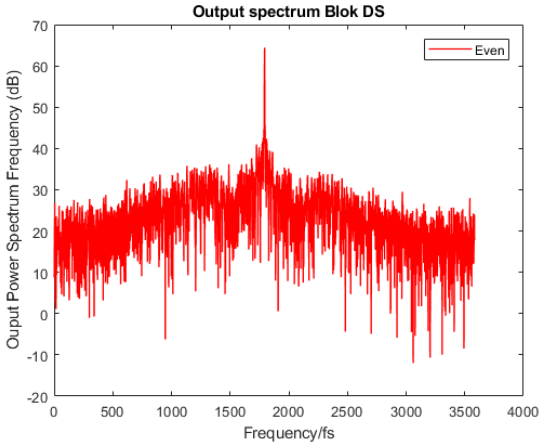
b) Frekuensi 3,5 GHz



OSR 4



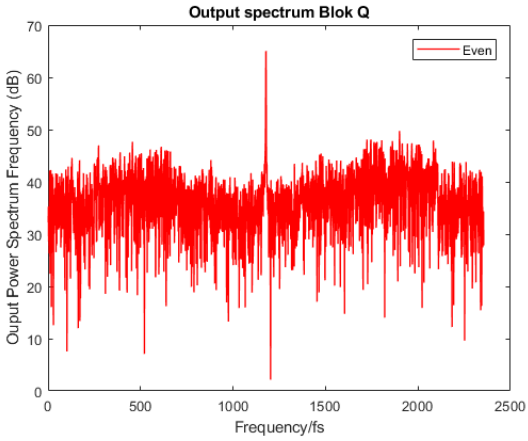
OSR 8



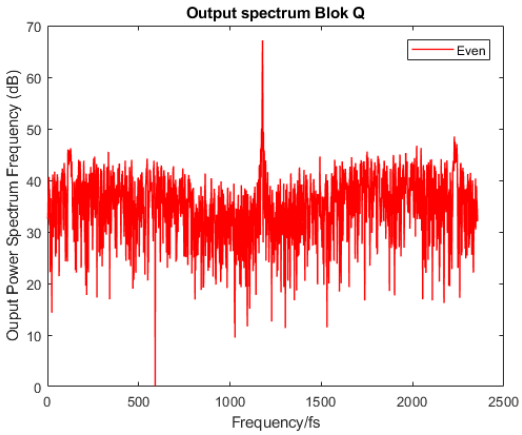
OSR 16

Ploting Output Spectrum Blok Kuantisasi (y_R, y_θ)

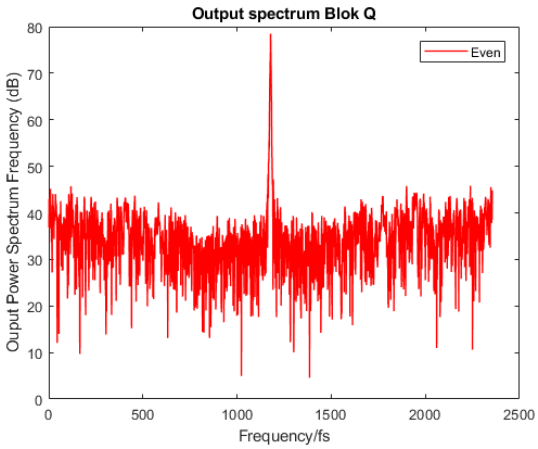
a) Frekuensi 2,3 GHz



OSR 4

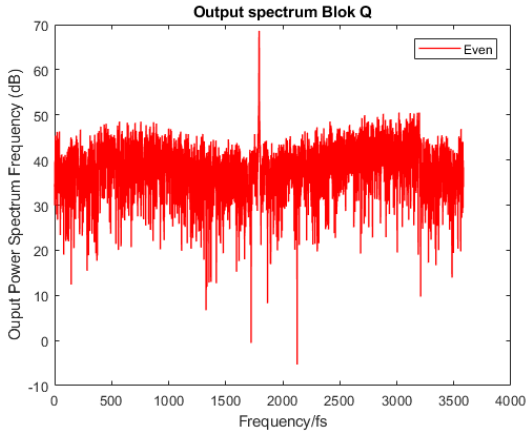


OSR 8

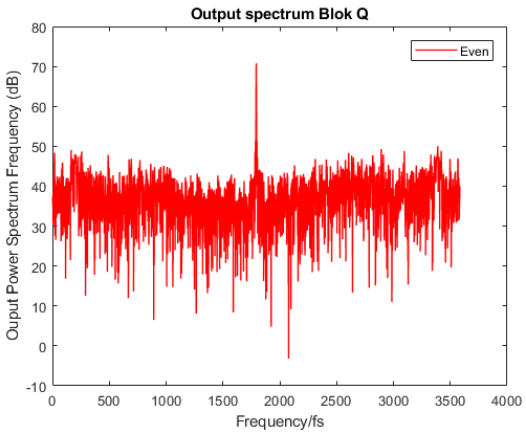


OSR 16

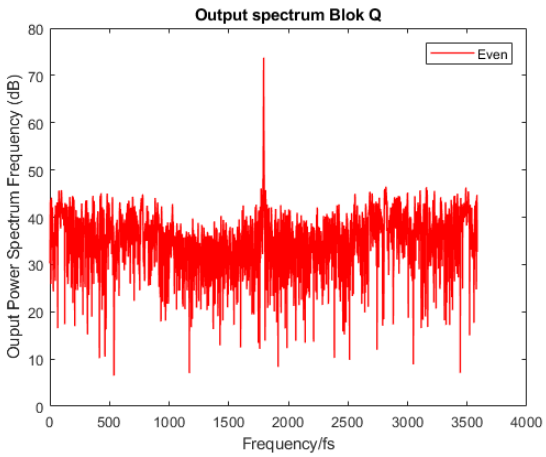
b) Frekuensi 3,5 GHz



OSR 4



OSR 8



OSR 16

Ploting Output Spectrum Feedback ΣΔ Filter ($\hat{y}_i, \hat{y}_\theta$)

a) Frekuensi 2,3 GHz