Discrete Fourier transform of the DDS output sequence

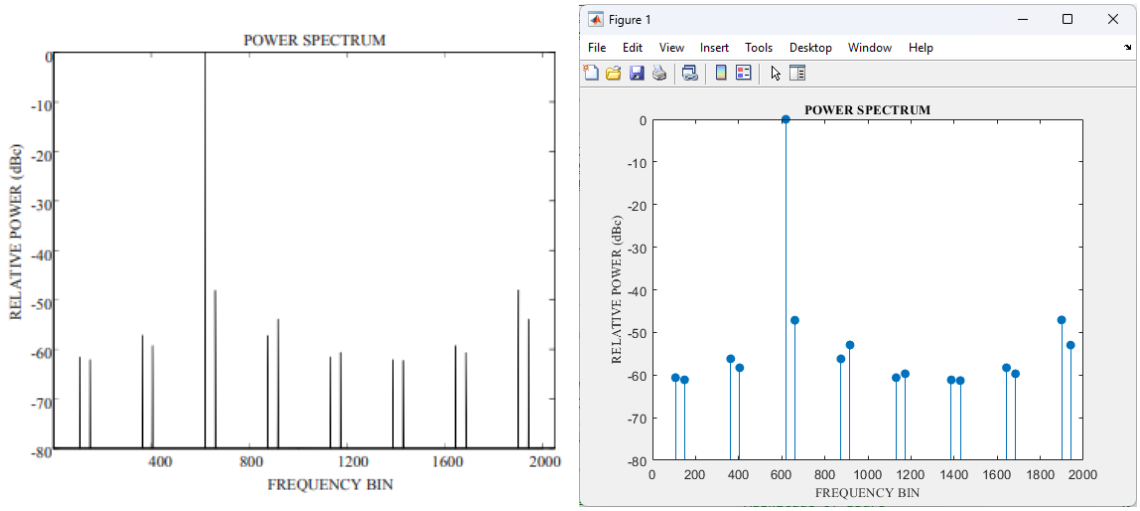
MATLAB implementation

```
% ========================================================================= %
% This program was built by Sirapop Saengthongkam to study
% 1. Behavior of Spur
% 2. Spur locations for quadrature DDS (Complex in-input to Discrete
% Fourier Transform (DFT)) [Bin]
% 3. Power Spectrum of Carrier-to-Spur Relative Power [dBc].
% ========================================================================= %
clear, clc, close all;

% ======================== Initial Conditions ============================= %
j = 12;
k = 8;
dP = 619;
Pe = 4096;
N = 2^k;
M = (2^(j-k))/gcd(dP, 2^(j-k));
Y = M-1;
% ========================================================================= %

% ====================== Position of Spurs in bin ========================= %
fprintf("Number of Spurs are %d\n", Y);
r = [0:1:Y];
Fr = mod((dP/gcd(dP, 2^j)) + r*(N*dP/gcd(dP, 2^j)), Pe);

% Fourier Series De-Aliasing of spurs position
for n = 1:M
    if (Fr(n) > (Pe/2))
        Fr_new = Pe - Fr(n);
        Fr(n) = Fr_new;
    else
        Fr(n) = Fr(n);
    end
end

% Show the Fourier bin position of Carrier and Spurs
fprintf("Carrier bin[Fr(0)] = %d \n", Fr(1));
for i = 2:M
    fprintf("Spur#%d bin[Fr(%d)] = %d \n", i-1, i-1, Fr(i));
end
% ========================================================================= %

% ======================== Magnitude of Spurs ============================= %
SP = [1:M];
SP(1) = (sin(pi/N)^2)*((pi/(M*N))^2)/(((pi/N)^2)*(sin(pi/(M*N))^2));
for r = 1:Y
    SP(r+1) = 10*log10((sinc(1/N)^2 * sinc(N*r/(N*M) + 1/(N*M))^2) / ...
        (sinc(1/(N*M))^2 * sinc(r + 1/N)^2));
end
% ========================================================================= %
```

```
% ==================== Relative Power to Carrier ======================== %
for r = 1:M
    Crr2Spr_dB(r) = SP(1) - SP(r);
end
% ======================================================================== %

% ============================ Plotting ================================== %
Plot_data = stem(Fr, Crr2Spr_dB, "filled");
Plot_data.BaseValue = -80;
ylim([-80, 0])
title("POWER SPECTRUM", 'fontsize', 10, 'fontname', 'Times New Roman')
xlabel("FREQUENCY BIN", 'fontsize', 10, 'fontname', 'Times New Roman')
ylabel("RELATIVE POWER (dBc)", 'fontsize', 10, 'fontname', ...
    'Times New Roman')
% ======================================================================== %
```

Results #1:

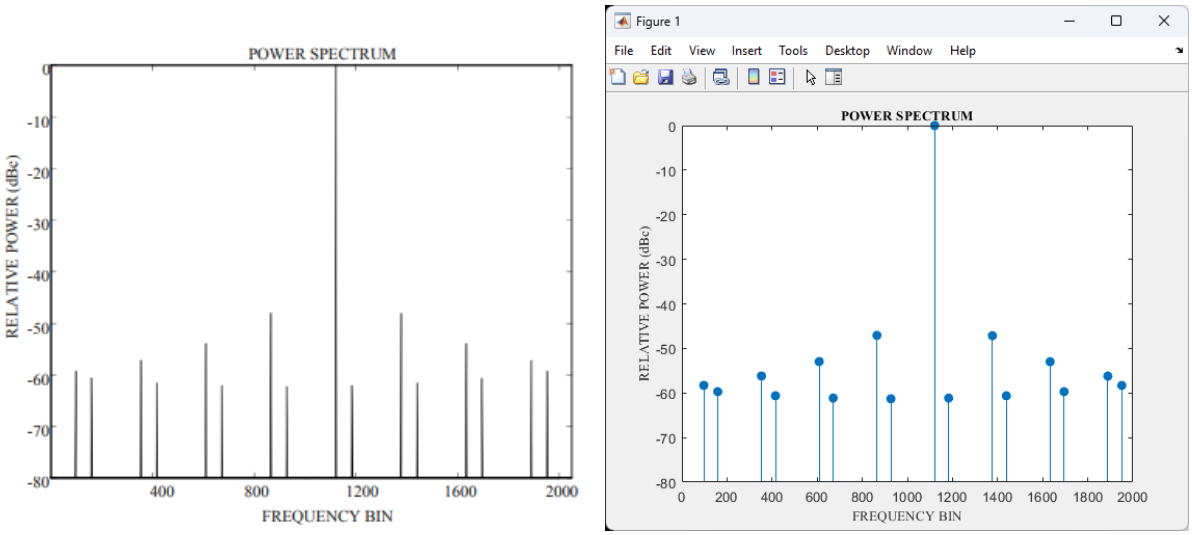
```
Number of Spurs are 15
Carrier bin[Fr(0)] = 619
Spur#1 bin[Fr(1)] = 661
Spur#2 bin[Fr(2)] = 1941
Spur#3 bin[Fr(3)] = 875
Spur#4 bin[Fr(4)] = 405
Spur#5 bin[Fr(5)] = 1685
Spur#6 bin[Fr(6)] = 1131
Spur#7 bin[Fr(7)] = 149
Spur#8 bin[Fr(8)] = 1429
Spur#9 bin[Fr(9)] = 1387
Spur#10 bin[Fr(10)] = 107
Spur#11 bin[Fr(11)] = 1173
Spur#12 bin[Fr(12)] = 1643
Spur#13 bin[Fr(13)] = 363
Spur#14 bin[Fr(14)] = 917
Spur#15 bin[Fr(15)] = 1899
```



รูปที่ 1 Discrete Fourier transform of the DDS output sequence for j = 12, k = 8 and $\Delta P = 619$.

Results #2:

```
Number of Spurs are 15
Carrier bin[Fr(0)] = 1121
Spur#1 bin[Fr(1)] = 1377
Spur#2 bin[Fr(2)] = 1633
Spur#3 bin[Fr(3)] = 1889
Spur#4 bin[Fr(4)] = 1951
Spur#5 bin[Fr(5)] = 1695
Spur#6 bin[Fr(6)] = 1439
Spur#7 bin[Fr(7)] = 1183
Spur#8 bin[Fr(8)] = 927
Spur#9 bin[Fr(9)] = 671
Spur#10 bin[Fr(10)] = 415
Spur#11 bin[Fr(11)] = 159
Spur#12 bin[Fr(12)] = 97
Spur#13 bin[Fr(13)] = 353
Spur#14 bin[Fr(14)] = 609
Spur#15 bin[Fr(15)] = 865
```



รูปที่ 2 Discrete Fourier transform of the DDS output sequence for j = 12, k = 8 and $\Delta P = 1121$.