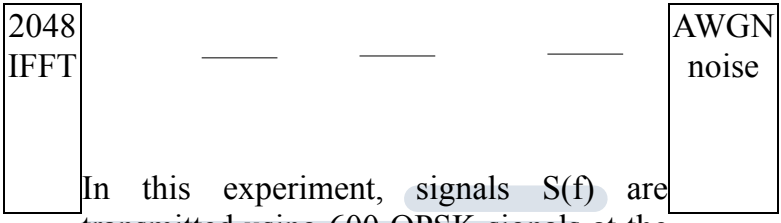
Third Assignment



In this experiment, signals S(f) are transmitted using 600 QPSK signals at the same time. The first signal 1+j is in the first quadrant, the second signal 1-j is in the 4th quadrant, the third signal -1+j is in the second quadrant, the 4th signal -1-j is in the third quadrant, and the fifth signal 1+j is in the first quadrant again. So

S(f) is sequence of QPSK signals with length 600 and

S(f)=1+j , 1-j, -1+j , -1-j , 1+j , 1-j, -1+j , -1-j ,1+j , …

with period 4. Let S(f) be the input of 2048 IFFT. (The input order is described in Appendix C.) The IFFT output is the transmitted signal s[m] (in time domain). The transmitted signal s[m] then passes the AWGN block (which is a Matlab function described in Appendix D) and the output of AWGN block r[m] is the received signal with AWGN (additive white Gaussian noise). You can choose your own SNR value for AWGN block.

Input s[m] 和 output r[m] 作比較，AWGN，m=1,2,3～60

1. Compare the input s[m] and output r[m] of AWGN block by plot s[m] and r[m] for m=1,2,3,…60. You have to plot the real part and imaginary part separately. 單獨畫出實部和虛部
2. Explain the reason why the signal and noise are both

解釋為什麼信號和雜訊都是複合的（有虛實部的部分？）

complex.

3. Find the average power of transmitted signal s[m]. Repeat the experiment 10 times and calculate the over 10 experiments. (The average power of discrete signal is explained in Appendix E.)

4. Noise signal is n[m]=r[m]-s[m]. Find he average power of noise signal n[m]. Repeat the experiment 10 times and calculate the over 10 experiments

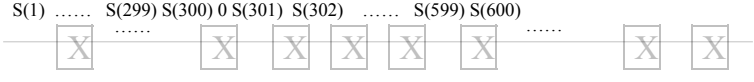
5. Compare with the SNR value used in AWGN block.

Appendix：

A. Use Matlab downloaded from University portal.

B. In Matlab, index begin from 1, instead of 0.

C. The IFFT function in Matlab is “s=ifft(X,N)”. Parameter X is the input sequence of length N, N is the size of IFFT used. As we use 2048 IFFT, N=2048. The following figure is the 600 QPSK signals in frequency domain.



Thus, the IFFT command is

s = ifft ([0 S(301:600) zeros(1,1447) S(1:300)] ,2048)

where the first element of parameter X is 0, the 2nd to 301th element of X are S(301:600) which are the last 300 elements (from index 1 to index 300) of S(f), zeros(1,1447) is a size 1*1447 with all zero elements, the last 300 elements of parameter X are the first 300 elements of S(f), S(1:300).

D. The AWGN function in Matlab is “r = awgn(X,SNR,SignalPower)”. Parameter X is the input (which is the “s” in Appendix C). Parameter SNR is the signal-to-noise ratio in in dB. Parameter SignalPower is the input signal power in dB. If the parameter is set as 'measured', Matlab will calculate the power of X automatically. So the command will look like

r = awgn(Y,10, 'measured').

E. The power of a discrete signal x[m], m=1,2,3,…,n is defined as

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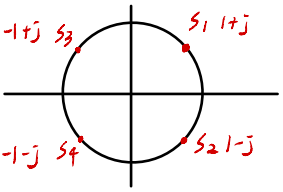
600 QPSK



$S[f] = \overset{S1}{1+j}, \overset{S2}{1-j}, \overset{S3}{-1+j}, \overset{S4}{-1-j}, \overset{S1}{1+j}, \overset{S2}{1-j}, \cdots$

週期 = 4

2048 IFFT $\longrightarrow$ $N = 2048$