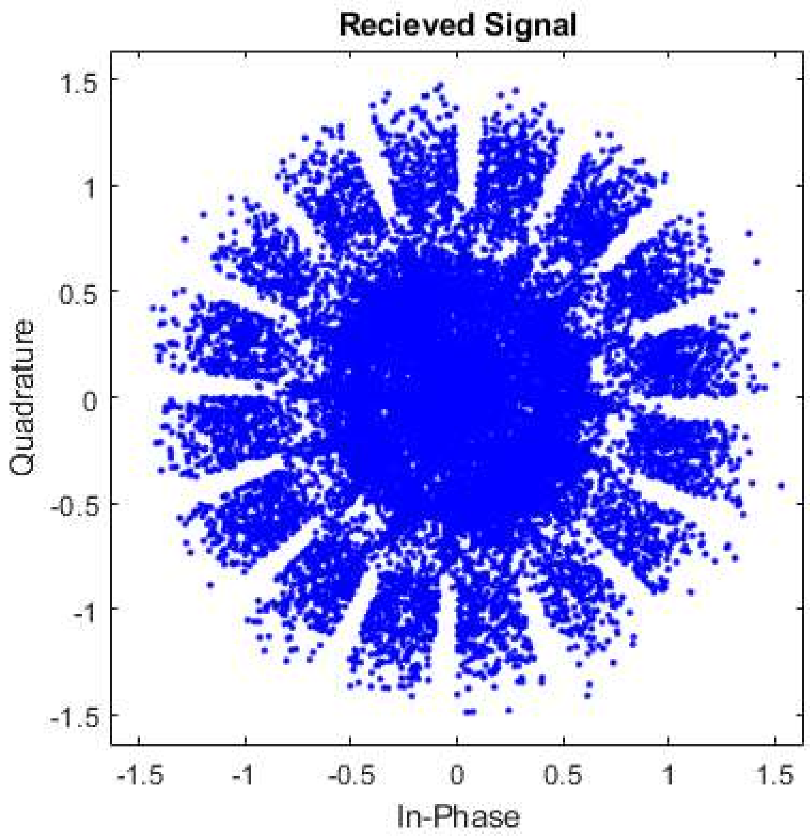
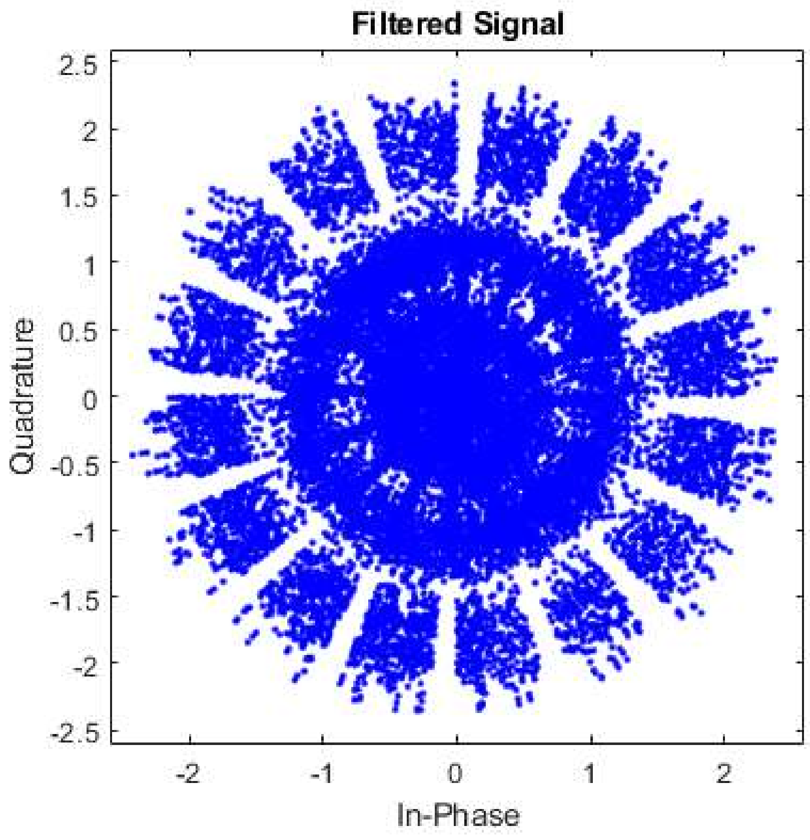
Contents

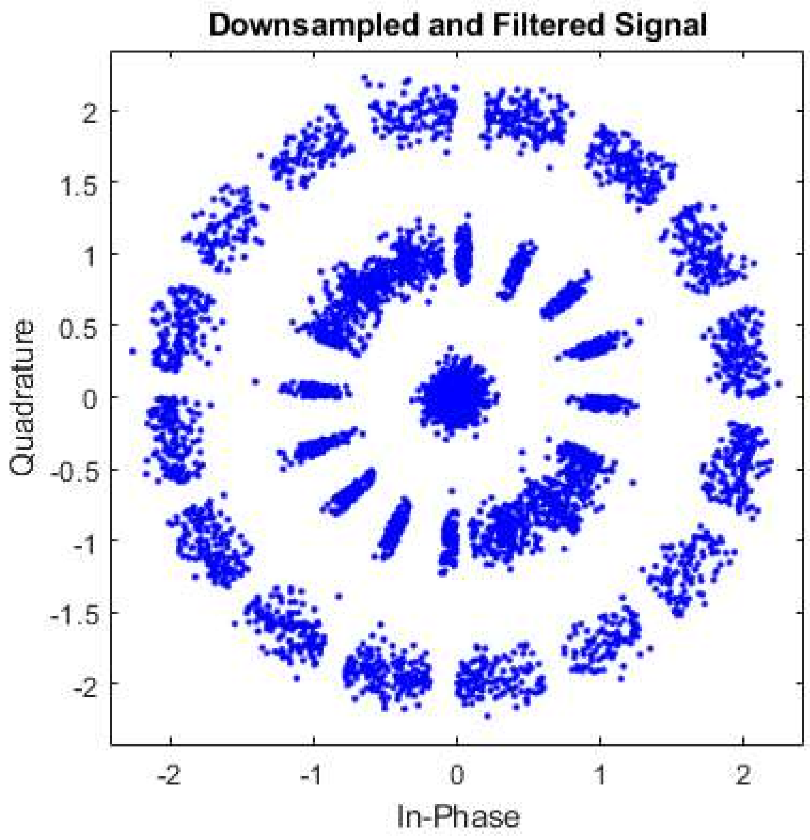
```
%CDMA Decoding
%Gian Angelo Tria
%ECE 408: Wireless Communications
clear;
clear all;
clc;
```

Filter and Donwnsample

```
load('Rcvd_Tria .mat');

%Root Raise Cosine Filter
%Given
B_RCOS = [.0038;.0052;-.0044;-.0121;-.0023;.0143;.0044;-.0385;-.0563;...
            .0363;.2554;.4968;.6025;.4968;.2554;.0363;-.0563;-.0385;...
            .0044;.0143;-.0023;-.0121;-.0044;.0052;.0038];
filtered = filter(B_RCOS,1,Rcvd); %%Root Raised Cosine filter used to
%Downsampling
downsampled = downsample(filtered,4);

scatterplot(Rcvd)
title('Recieved Signal')
scatterplot(filtered)
title('Filtered Signal')
scatterplot(downsampled)
title('Downsampled and Filtered Signal')
```


Recieved Signal
Quadrature
In-Phase
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5


Filtered Signal
Quadrature
In-Phase
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-2
-1
0
1
2



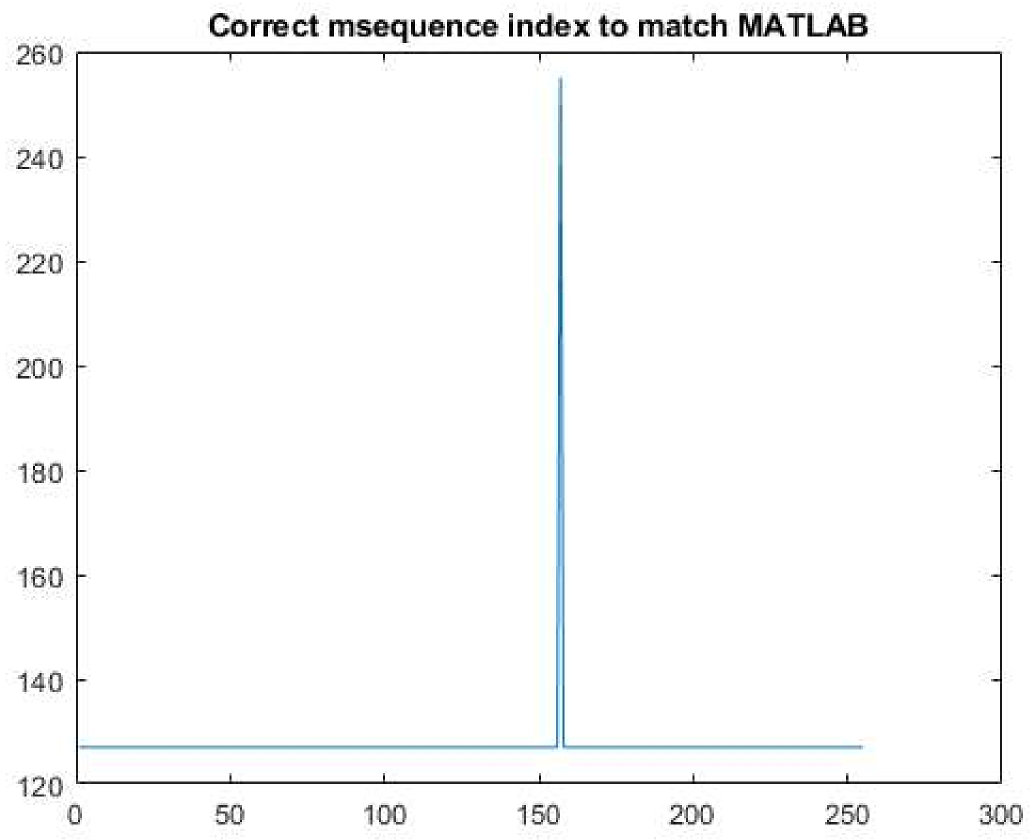
PN Sequence Generation

```
% PN Sequence Galois (same sequence)
length_pn=255; %length of 1 frame
m = zeros(1,255);%preallocating for for loop
a = [0 0 0 0 0 0 0 1]; %initial condition
for i = 1:length_pn
x_1 = mod(a(2)+a(1),2);
x_6 = mod(a(7)+a(1),2);
x_7 = mod(a(8)+a(1),2);
a = circshift(a,-1);  %Shifts registers first then applies changes from XOR
a(1)  = x_1;
a(6)  = x_6;
a(7)  = x_7;
m(i)= a(1);
end
m_flip = flip(m); %Flip m was the same sequence as the PN from Matlab
```

Testing PN Using Matlab's example

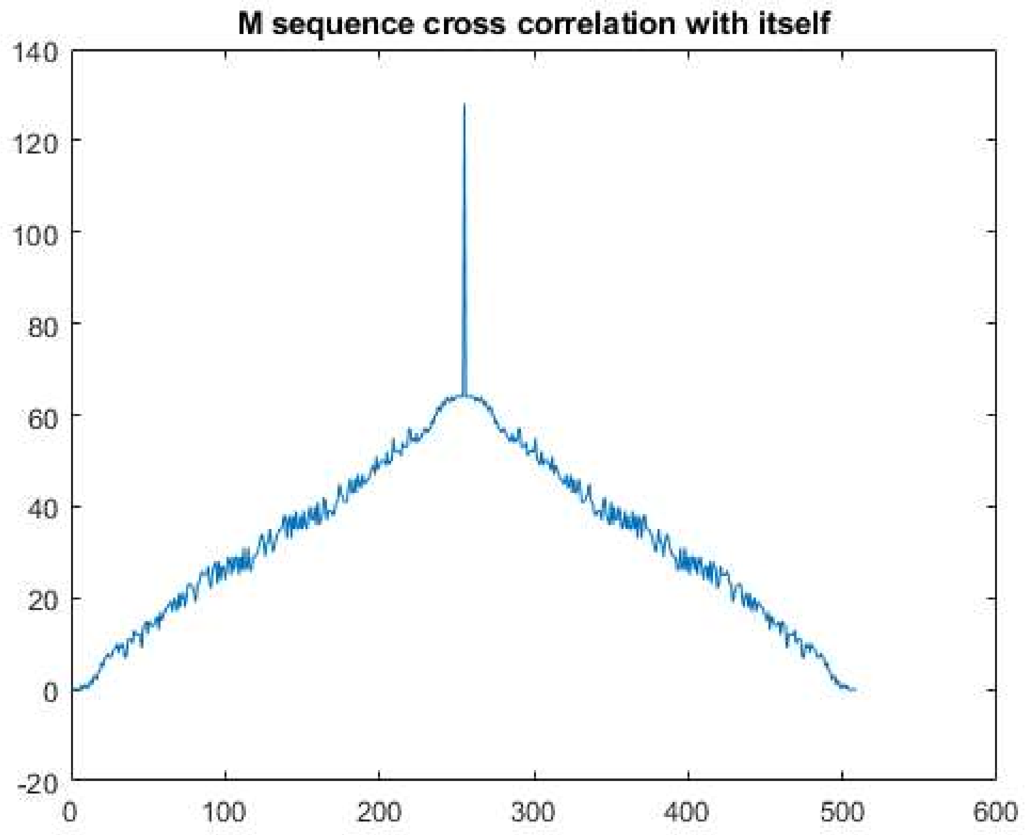
```
PN = [8 7 6 1 0];
PNGEN = comm.PNSequence('Polynomial', PN, 'InitialConditions', 1, ...
    'SamplesPerFrame', 2^8-1, 'Mask', de2bi(1,8));
PNSEQ = PNGEN();

%Checking which index to shift to to be the same
m_flip_check = m_flip;
for i = 1:length(m_flip_check)
```

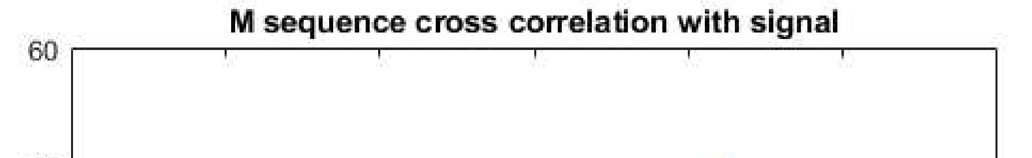
```
    check(i) = sum(m_flip_check == transpose(PNSEQ));
    m_flip_check = circshift(m_flip_check,1);
end
verify = max(check)==255;
figure
plot(check)
title('Correct msequence index to match MATLAB')

%Index 157 is the correct msequence starting point
m_flip_shift = circshift(m_flip,-156);
verified = m_flip_shift == transpose(PNSEQ);
```

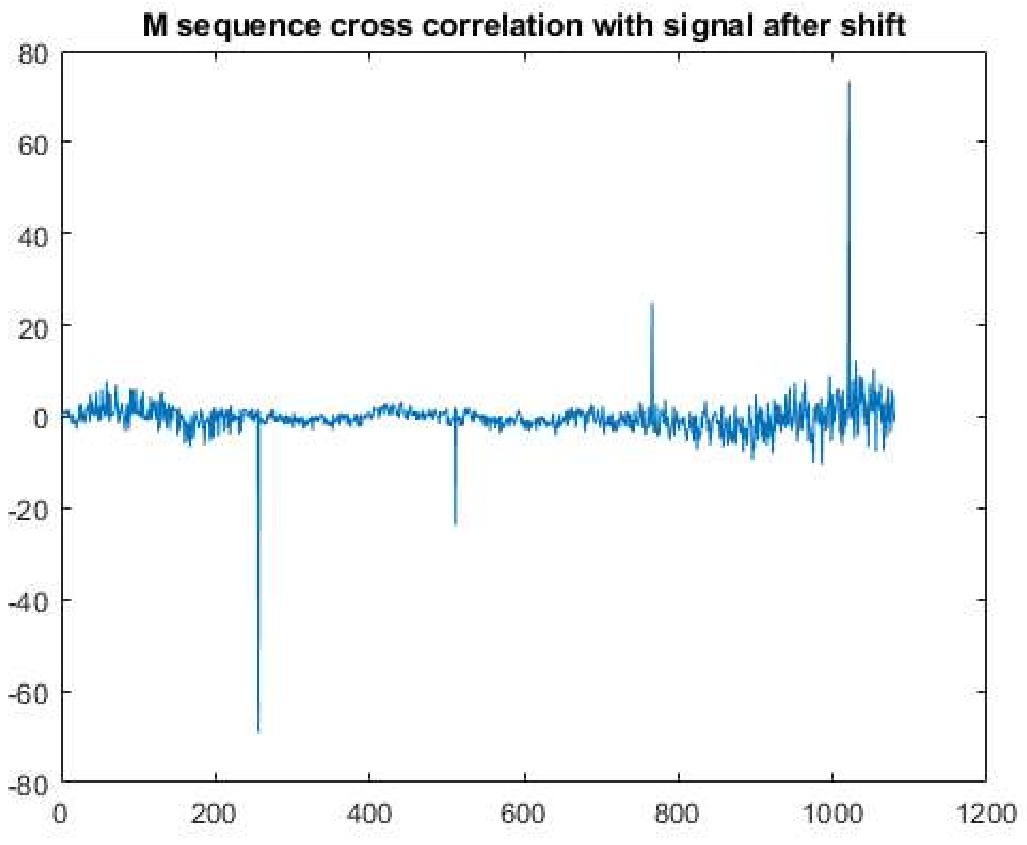


Finding Starting Index

```
figure
plot(xcorr(m_flip_shift,m_flip_shift));
title('M sequence cross correlation with itself')
correlation = xcorr(m_flip_shift,real(downsampled));
figure
plot(correlation(1:1080));
title('M sequence cross correlation with signal')
%Impulse appears at index 14
m_final = circshift(m_flip_shift,-86);
correlation_2 = xcorr(m_final,real(downsampled));
figure
plot(correlation_2(1:1080));
title('M sequence cross correlation with signal after shift')
%checking if impulses appear at mod 256
```

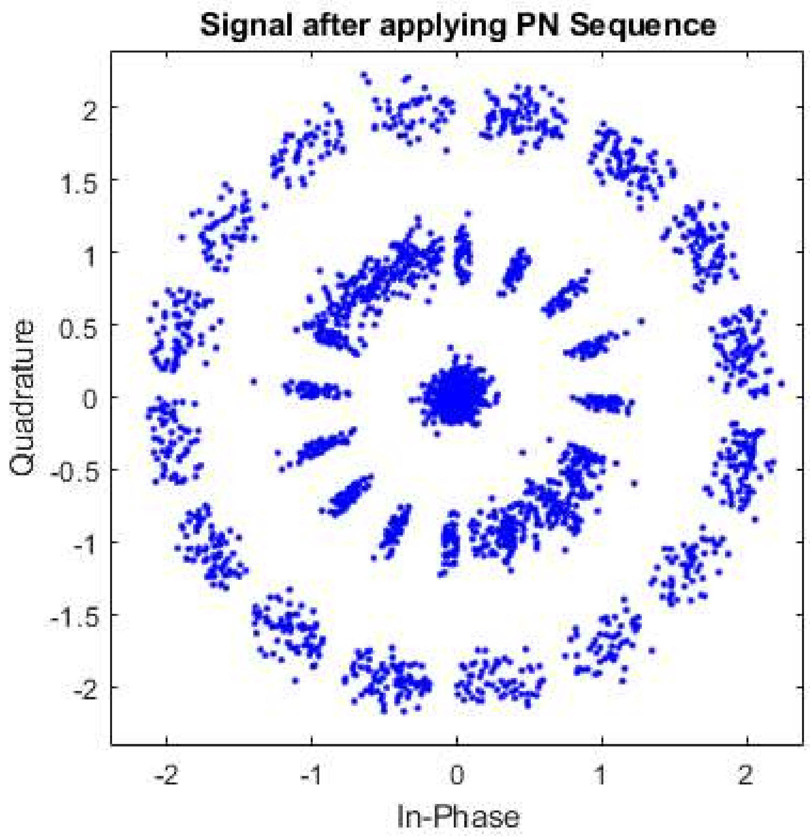

M sequence cross correlation with itself
140
120
100
80
60
40
20
0
-20
0
100
200
300
400
500
600


M sequence cross correlation with signal
60
40
20
0
-20
-40
-60
0
200
400
600
800
1000
1200



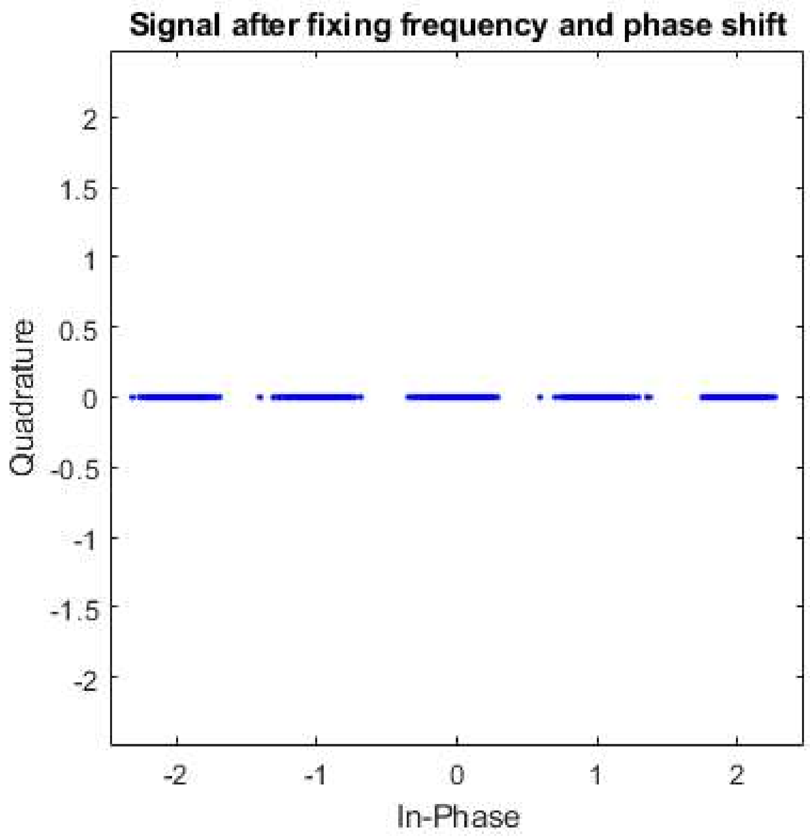
Applying PN Sequencce

```
num_frame = length(downsampled)/length_pn;
x=1;
post_pn = repmat(m_final,1,num_frame).*downsampled; %repeating m to be size of downsampled
scatterplot(post_pn);
title('Signal after applying PN Sequence')
```



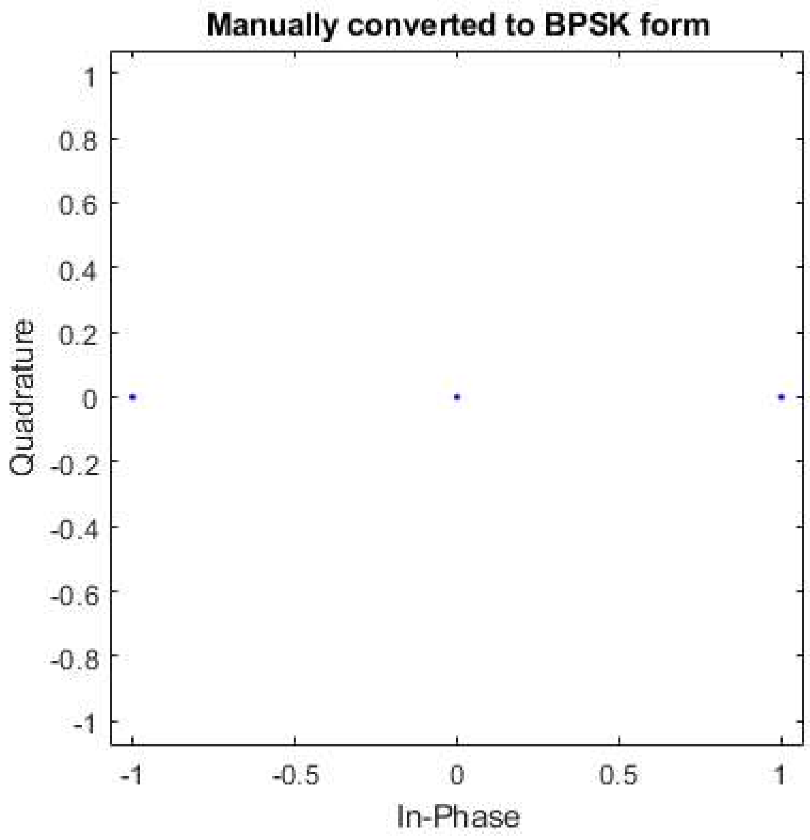
Fixing Frequency and Phase Shift

```
sign = ((real(post_pn)>0)-.5).*2;%Assuming that the shift is not greater than pi
fixed = sign.*(abs(post_pn));
scatterplot(fixed)
title('Signal after fixing frequency and phase shift')
```



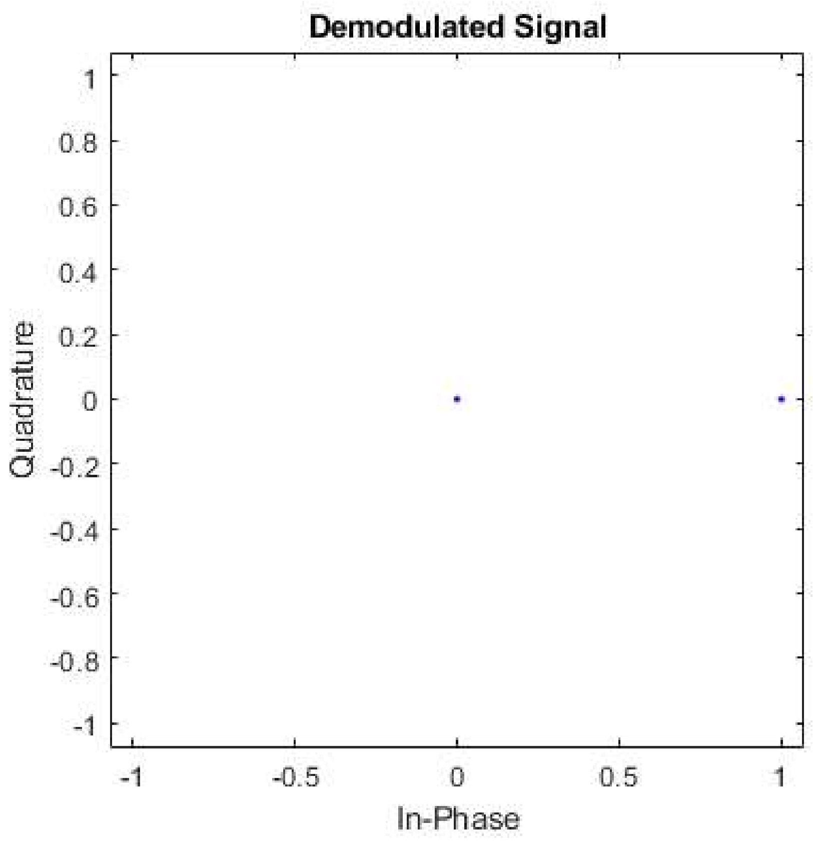
Manual BPSK

```
o_negative = -1*(fixed < -.5); %Fixed must be converted to values -1,0,1 for Walsh
o_positive = fixed >.5;
BPSK_sig = o_negative+o_positive;
scatterplot(BPSK_sig)
title('Manually converted to BPSK form')
```



Walsh Channel Orthogonal Spreading

```
N = 8;  % Length of Walsh (Hadamard) functions
hadamardMatrix = hadamard(N);

resized = reshape(BPSK_sig,[length(BPSK_sig)/8 8]); %resizing to multiply by hadamard
unwalsh = resized*hadamardMatrix;

o_negative = -1*(unwalsh(:,6) < 0); %each column is a channel, want channel 5 so index 6
o_positive = unwalsh(:,6) >= 0;
demod = o_negative+o_positive; %Changing into a form that can be BPSKdemod
out = BPSKdemod(demod);
scatterplot(out)
title('Demodulated Signal')
```



Characters

```
out_2 = reshape(transpose(out(1:760)),[8 95]); %reshaping to separate bytes
out_2 = transpose(out_2);
for i = 1:95
c(i) = char(bi2de(out_2(i,:),'left-msb')); %not sure if left-msb or right-msb
end
for i = 1:95
c_2(i) = char(bi2de(out_2(i,:),'right-msb'));
end
disp(c)
disp(c_2)
```

```
  * D @HRB  ’ S "  $   J¤Š @R”          @       ˆ     À   ÀÀ                „ !, @   ¬‘,   "  '‰
,
@€T $ "   JB( I Ê D$ˆ€(R%Qˆ J)      @    +   @     €          @!@„A€5‰A  D  ä‘A
```

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