APPENDIX A

MATLAB Code

A.1 Example 1: Extension of the Code Length

The MATLAB code reported below has been used to generate the figures in Example 23.1.

```
% --- Clean up the environment
clear
close all
clc

% --- Variables definition
Rc = 0.5e6;          % Code Rate (chip /s)
Fs = 8e6;            % Sampling Frequency (Hz)

% --- define PRN codes
cLoc1 = [1 -1 1 -1 -1 -1 -1 1 -1 ...
          1 -1 -1 -1 1 -1 -1 1 1 1 -1];
cLoc2 = [ 1 1 -1 1 -1 1 1 -1 -1 1 ...
          1 1 1 1 -1 -1 -1 1 1 -1 1 ...
          1 1 -1 1 -1 1 -1 -1 -1 -1 ];

% cLoc = cLoc1;
cLoc = cLoc2;

L = length (cLoc); % Code Length (chip)
N = floor (Fs*L/Rc);       % Code Length (samples)

% --- Sample the local code
k = 0:N-1;
cLocSampled = cLoc (floor (k*Rc/Fs)+1); % cLoc code sampled
at Fs

% --- Generate the incoming code with 3 periods of cLoc,
sample and shift
cIn = [cLoc cLoc cLoc];
k = 0:3*N-1;
cInSampled = cIn (floor (k*Rc/Fs) + 1); % cIn code sampled
at Fs
```

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```
% --- Samples of the incoming code with a code-phase shift
Delay = 4*Fs/Rc;          % code Delay (samples)
cInSampledShift = circshift (cInSampled, [0 Delay]);

% --- Add AWGN noise
sigmaAWGN = 1;
% sigmaAWGN = 4;
% sigmaAWGN = 8;

cInSampledNoise = cInSampledShift + sigmaAWGN * randn (1,
3*N);

% --- Correlate the two sequences of samples
Corr = zeros (1, N);   % initialize the variable
for index = 0:N-1
   % --- correlate the codes
   Corr (index+1) = cInSampledNoise (1+index:N+index) *
   cLocSampled (1:N)';
end

% --- Plot correlation functions
xAxis = [0:(N-1)] ./Fs .* Rc;          % Prepare x-axis (chip)

figure,
plot (xAxis, Corr, '.-k'),
grid on
xlabel ('Delay (chip)')
ylabel ('Correlation')
title ('PRN code correlation')
axis tight
```

A.2 Example 2: Extension of Integration Time

The Matlab code reported below has been used to generate the figures in Example 23.2.

```
% --- clean up the environment
clear
close all
clc

% --- Variables definition
Rc = 0.5e6;             % Code Rate (chip/s)
Fs = 8e6;               % Sampling Frequency (Hz)

% --- define PRN codes
cLc = [1 -1 1 -1 -1 -1 -1 1 -1 ...
         1 -1 -1 -1 1 -1 -1 1 1 1 -1];
```

```
L = length (cLc);            % Code Length (chip)
N = floor (Fs*L/Rc);         % Code Length (samples)

% --- Sample the local code
k = 0:N-1;
cLocSampled = cLc (floor (k*Rc/Fs)+1); % cLoc code sampled
at Fs
% --- Number of sums for high sensitivity
Nsums = 10;
cLocSampled = repmat (cLocSampled, [1 Nsums]);

% --- Generate the incoming code with M =20 periods of cLoc,
sample, and shift
M = 20;
cIn = repmat (cLc, [1 M]);
k = 0:M*N -1;
cInSampled = cIn (floor (k*Rc/Fs)+1);   % cIn code sampled @
Fs

% --- Samples of the incoming code with a code-phase
shift
Delay = 4*Fs/Rc;          % Code Delay (samples)
cInSampledShift = circshift (cInSampled, [0 Delay]);

% --- Add AWGN noise
sigmaAWGN = 1;
% sigmaAWGN = 12.5;
cInSampledNoise = cInSampledShift + sigmaAWGN * randn (1,
M*N);
%-------------------------------------------------------------------------

% --- Correlate the two sequences of samples
CorrFull = zeros (1, Nsums*N);   % initialize the variable
for index = 0:Nsums *N -1
   % --- correlate the codes
   CorrFull (index+1) = cInSampledNoise (1+index:2* N+
   index) * cLocSampled (1:2* N)';
end
% --- sum the correlation results
Corr = sum (reshape (CorrFull, N, Nsums)');

% --- Plot correlation functions
xAxis = [0:(N-1)] ./Fs .* Rc;         % Prepare x-axis (chip)

figure
plot (xAxis, Corr, '.-k')
grid on
xlabel ('Delay  (chip)')
ylabel ('Correlation')
title ('Code cross-correlation ')
axis tight
```