Credit Hours System

ELCN406

Communications-3

Fall 2022

Cairo University

Faculty of Engineering

Project

CDMA with DSSS

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Submitted to: **Dr. Samy Soliman**

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Project Description

The aim of our project is to simulate the transmission of N mobile stations of different users where here in the project the N= 4 users, the transmission schema is QPSK-DSSS.

QPSK will be composed of 2 arrays in phase component and quad phase component.

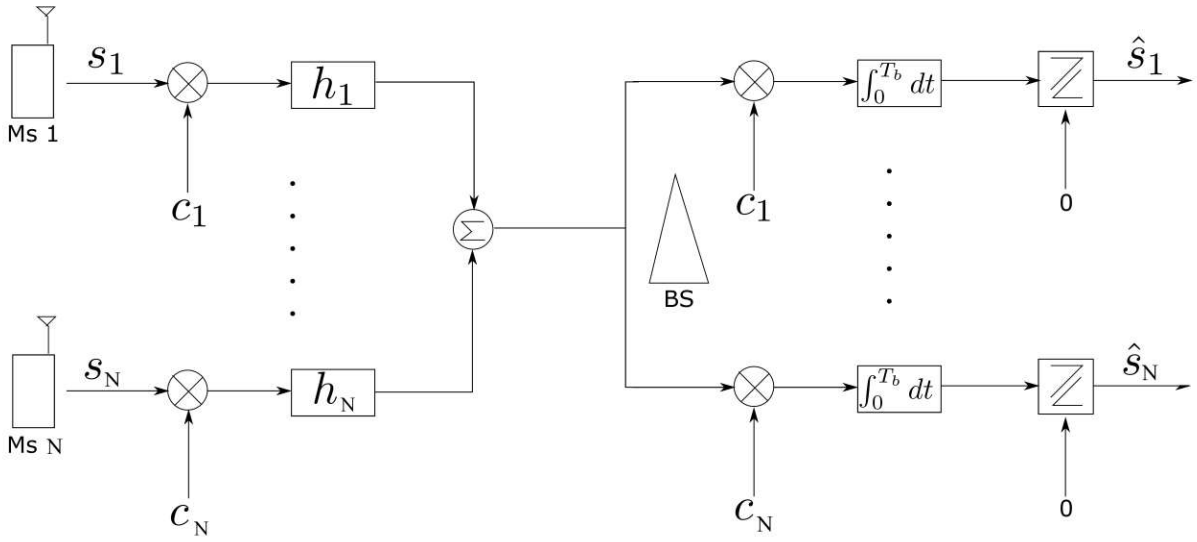


Figure 1: System Model

The steps will be as follows:

a) Number of mobile users (MS) = 4 users, each composed of randomly generated K symbols where K = 5 symbols.
b) Generate the maximal length PN Sequence for each user.
c) Multiply each component with the spreading code.
d) The output will be convolved with the channel impulse response.
e) All the output of users will be summed up and received to the Base Station (i.e., received = user1 + user2 + user3).
f) Output of the Base Station is multiplied by C1 -> CN then get the average.
g) The output of correlator is then compared to the threshold to decide if it's a 1 or -1.

Generator Polynomial

From the Commsrc MATLAB function, that generates the PN sequence. Where the matrix is [m, number of feedbacks, 0]

Generating a sequence of the maximum possible length for r of the generator polynomial to set Generator polynomial (it is a parameter that should be set in the commsrc.pn function to get the required shift registers with the feedback required to get the maximum length).

r	Generator Polynomial
2	[2 1 0]
3	[3 2 0]
4	[4 3 0]
5	[5 3 0]
6	[6 5 0]
7	[7 6 0]
8	[8 6 5 4 0]
9	[9 5 0]
10	[10 7 0]

Figure 2: Generator Polynomial

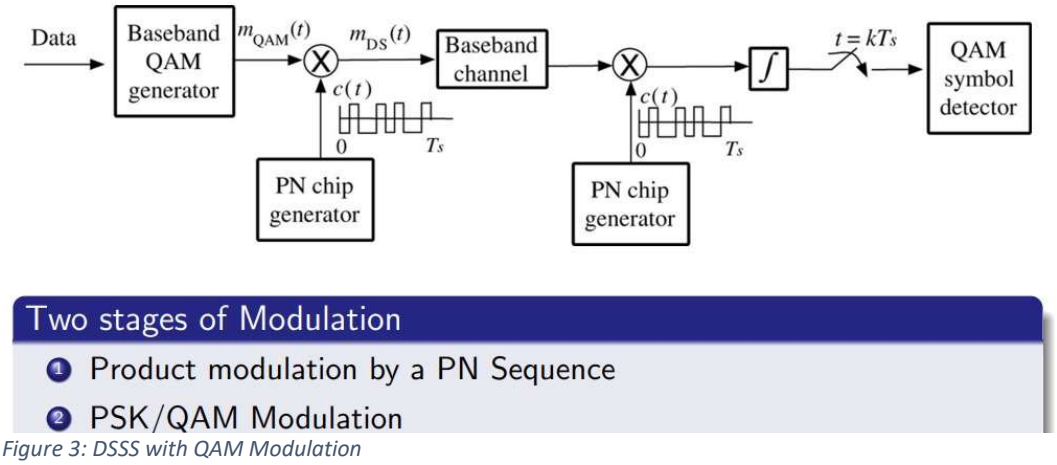


Figure 3: DSSS with QAM Modulation

Simulation and Results

1. PN Spreading Sequence of Length 7

Channel Case (1):

✓ Before de-spreading

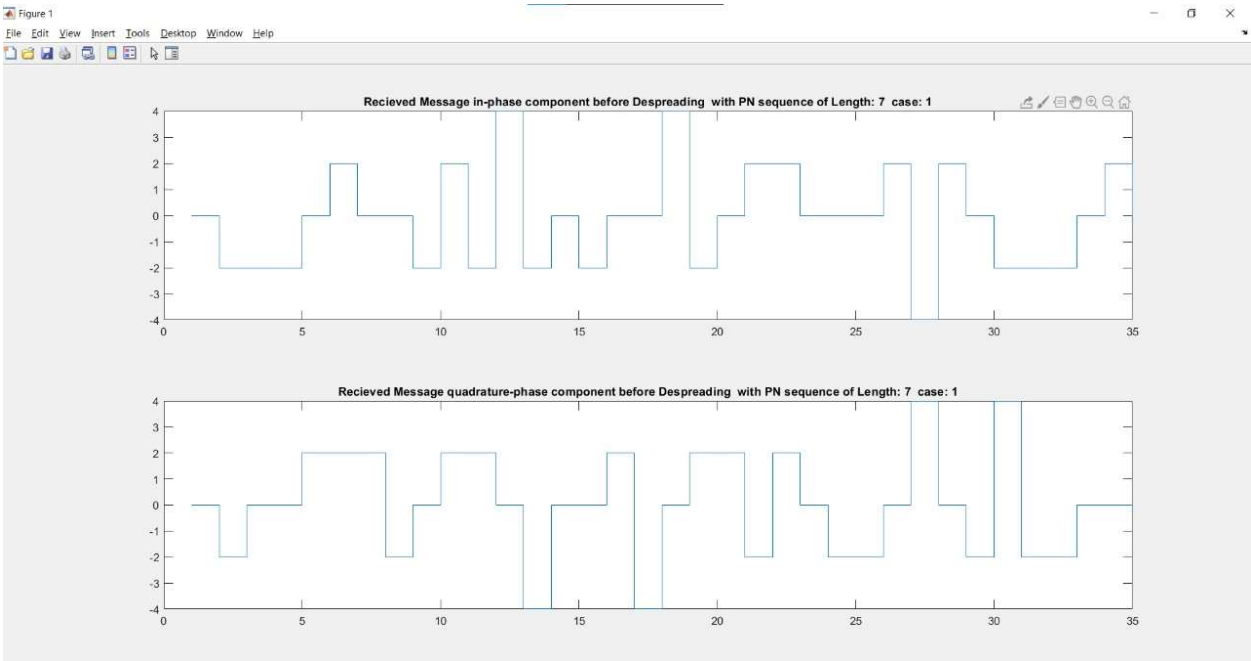


Figure 4: Received message in-phase component before de-spreading with PN sequence of length 7 1st case

✓ After de-spreading

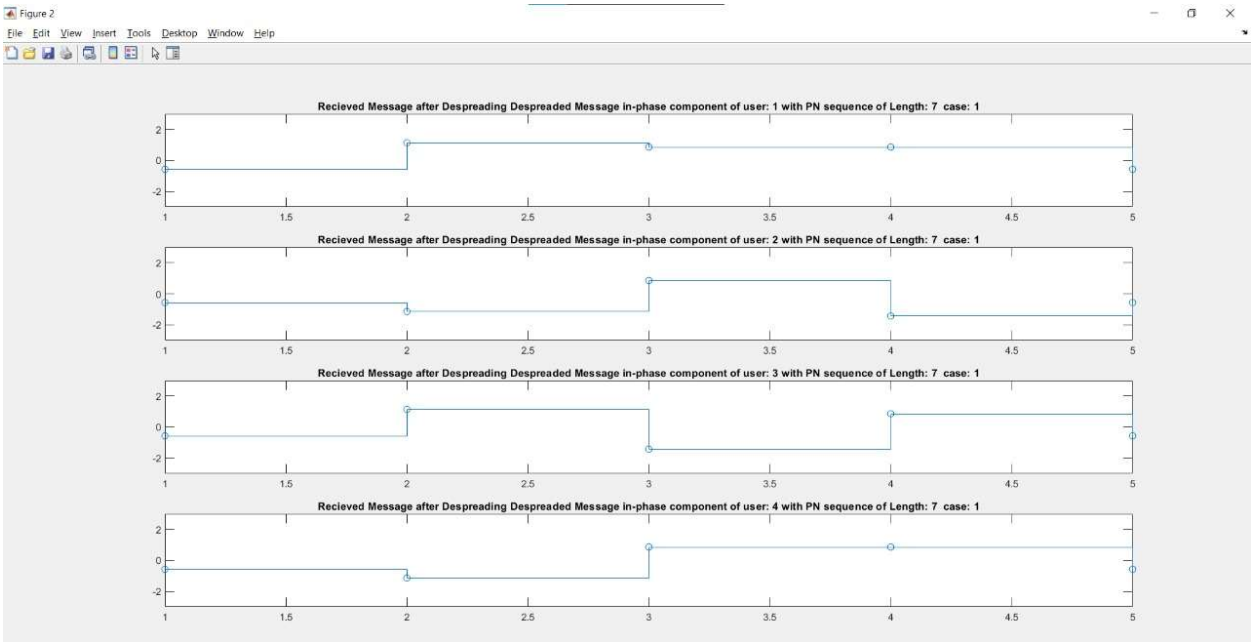


Figure 5: Received message in-phase component after de-spreading with PN sequence of length 7 1st case

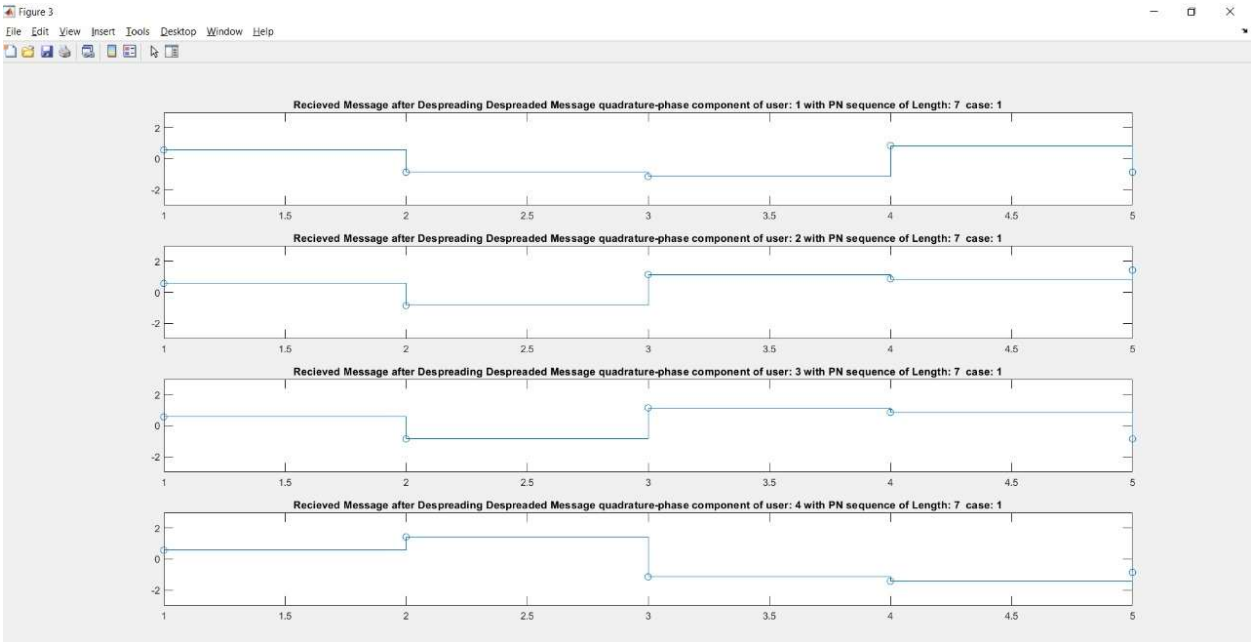


Figure 6: Received message quadrature component after de-spreading with PN sequence of length 7 1st case

- Estimated transmitted information

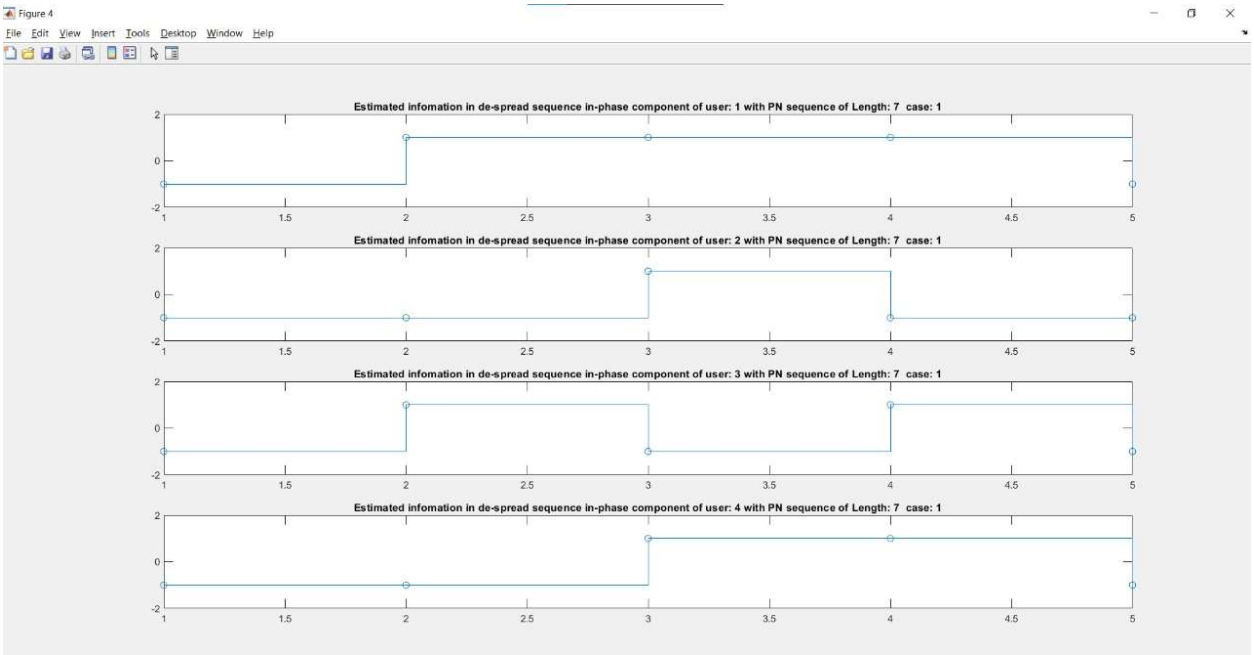


Figure 7: Estimated information in-phase component with PN sequence of length 7 1st case

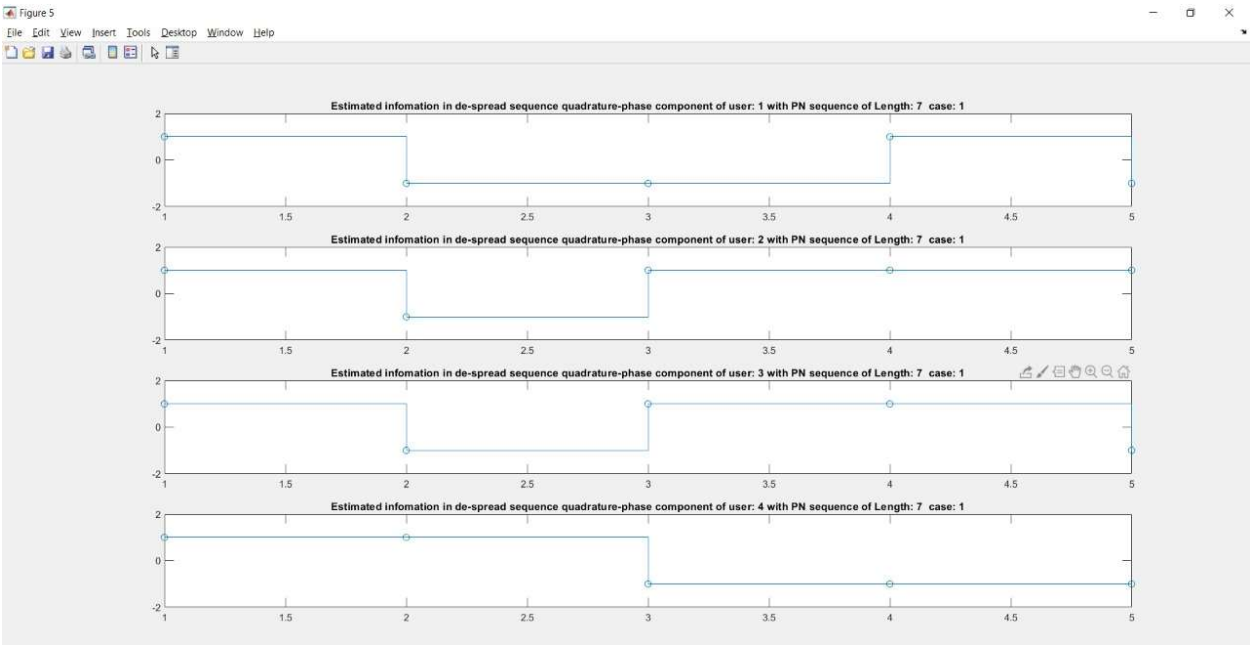
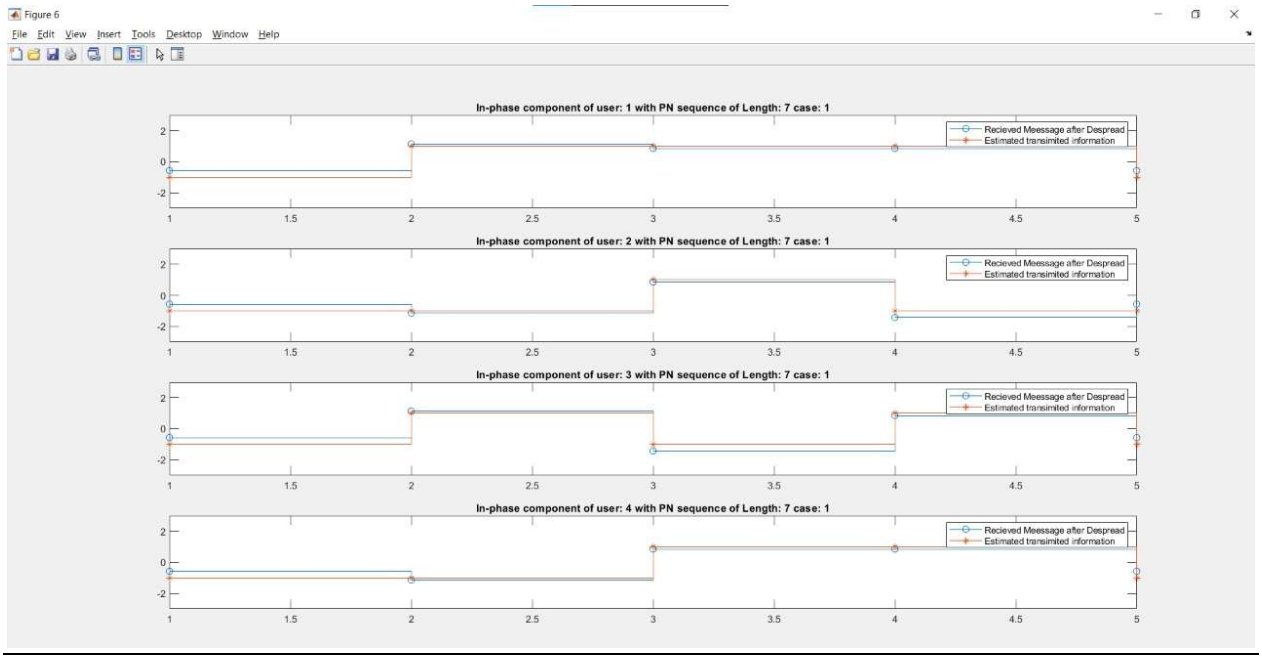
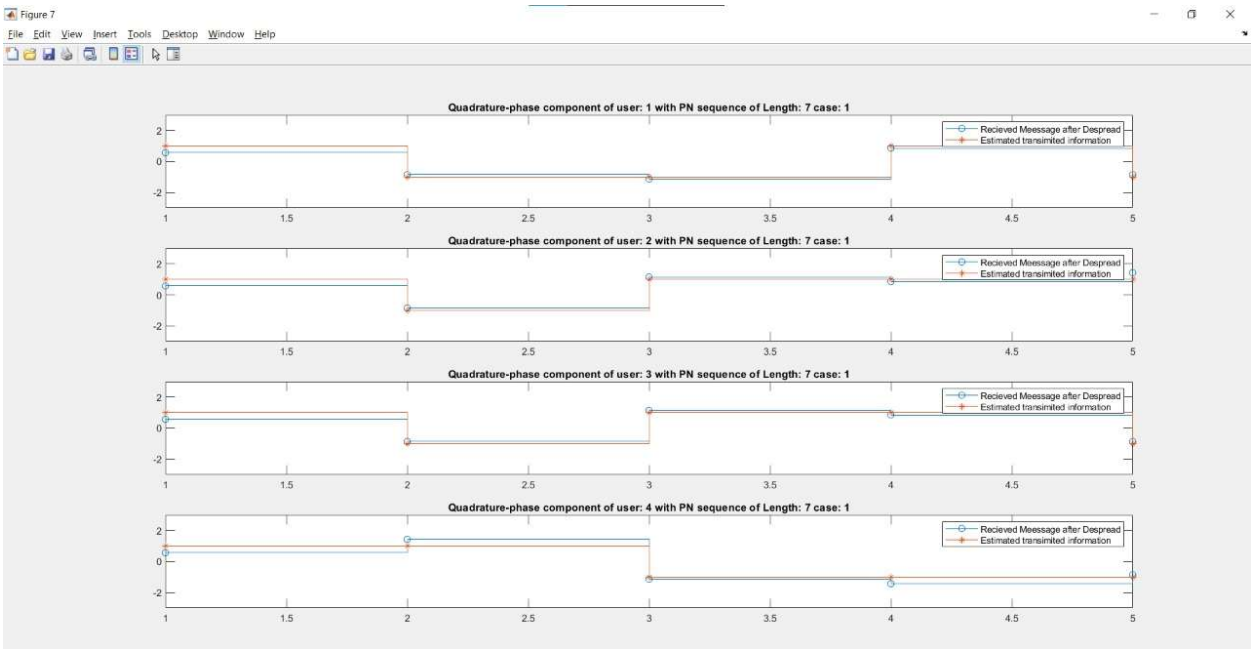


Figure 8: Estimated information quadrature component with PN sequence of length 7 1st case

- Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: Since the impulse response equals 1, no errors occurred so if we make a decision at the threshold all of them will be correct as we see from the graph.

Channel Case (2):

- ✓ Before de-spreading

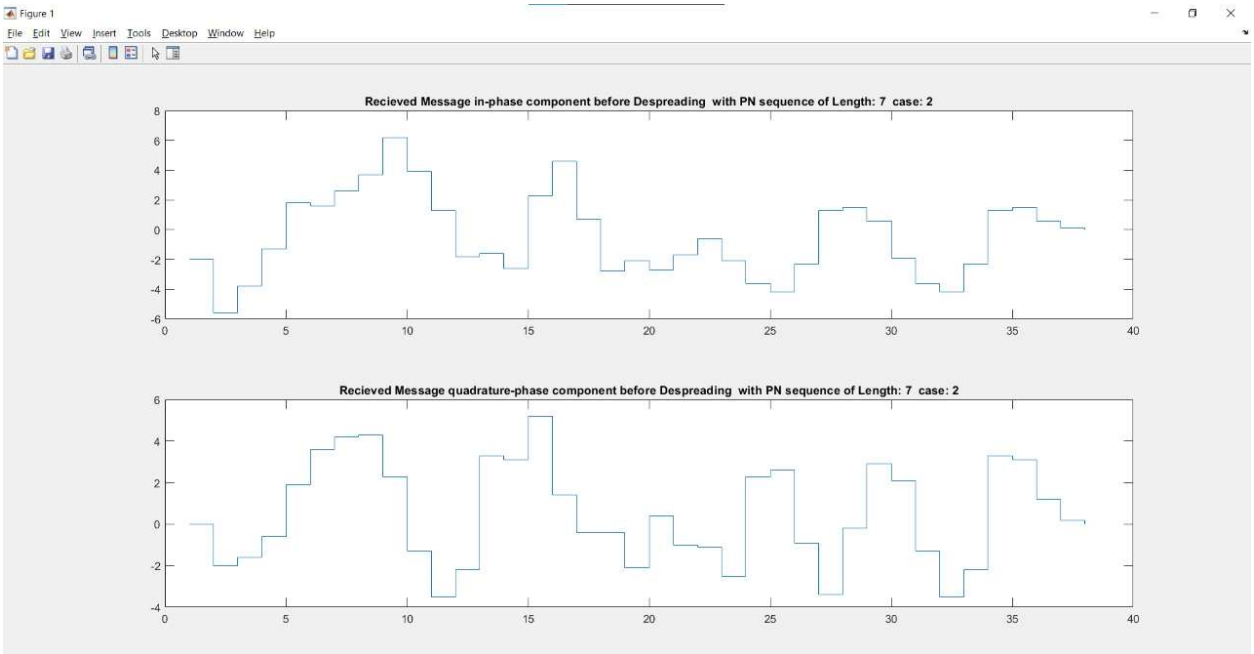


Figure 9: Received message in-phase component before de-spreading with PN sequence of length 7 2nd case

✓ After de-spreading

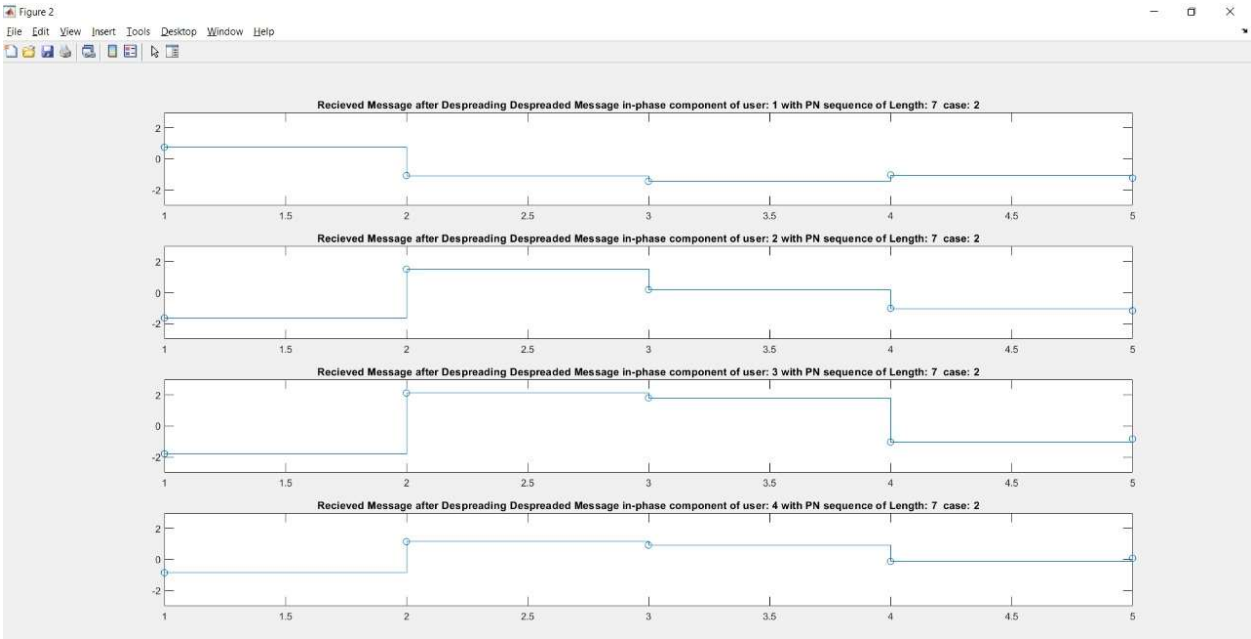


Figure 10: Received message in-phase component after de-spreading with PN sequence of length 7 2nd case

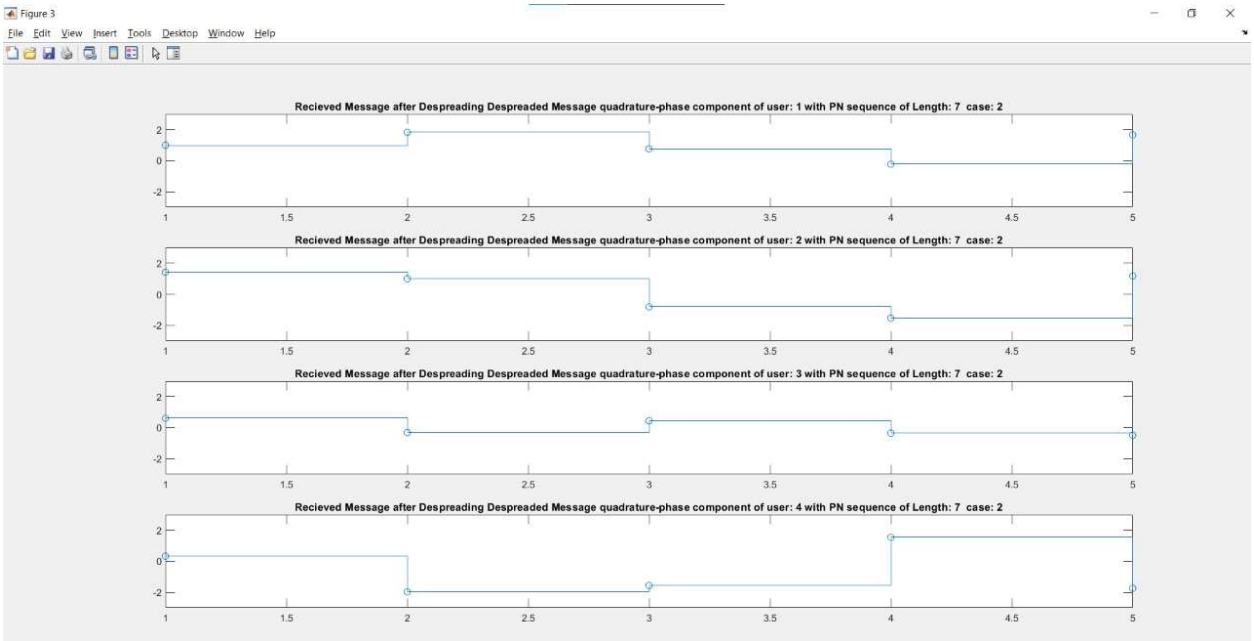


Figure 11: Received message quadrature component after de-spreading with PN sequence of length 7 2nd case

✓ Estimated transmitted information

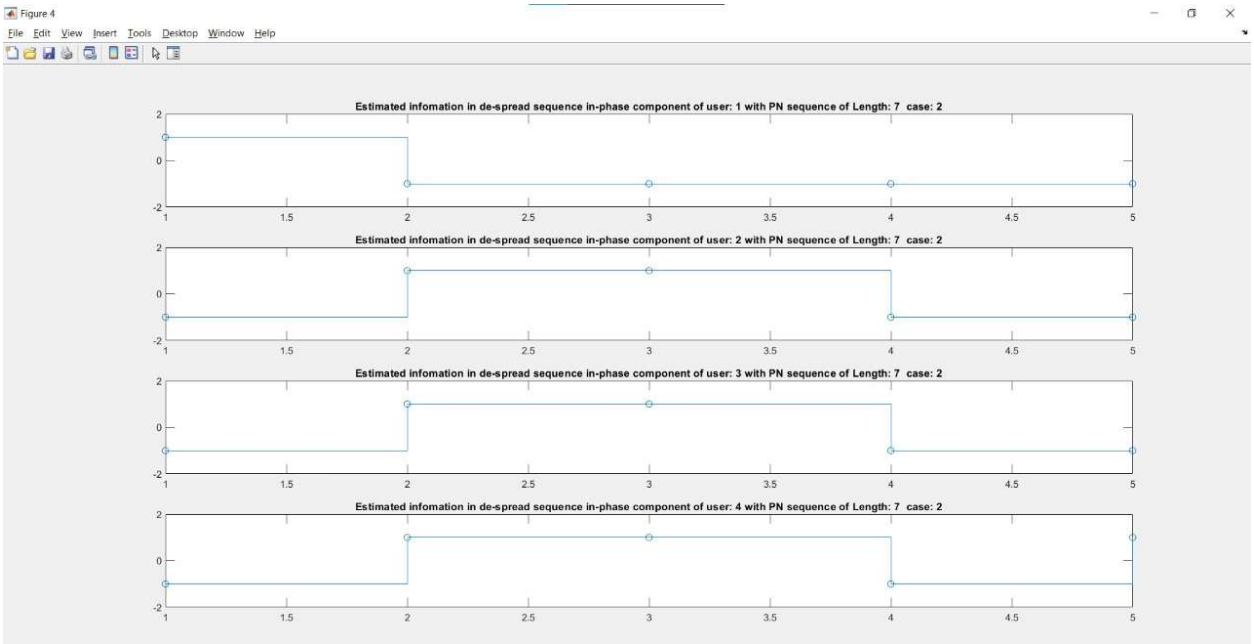


Figure 12: Estimated information in-phase component with PN sequence of length 7 2nd case

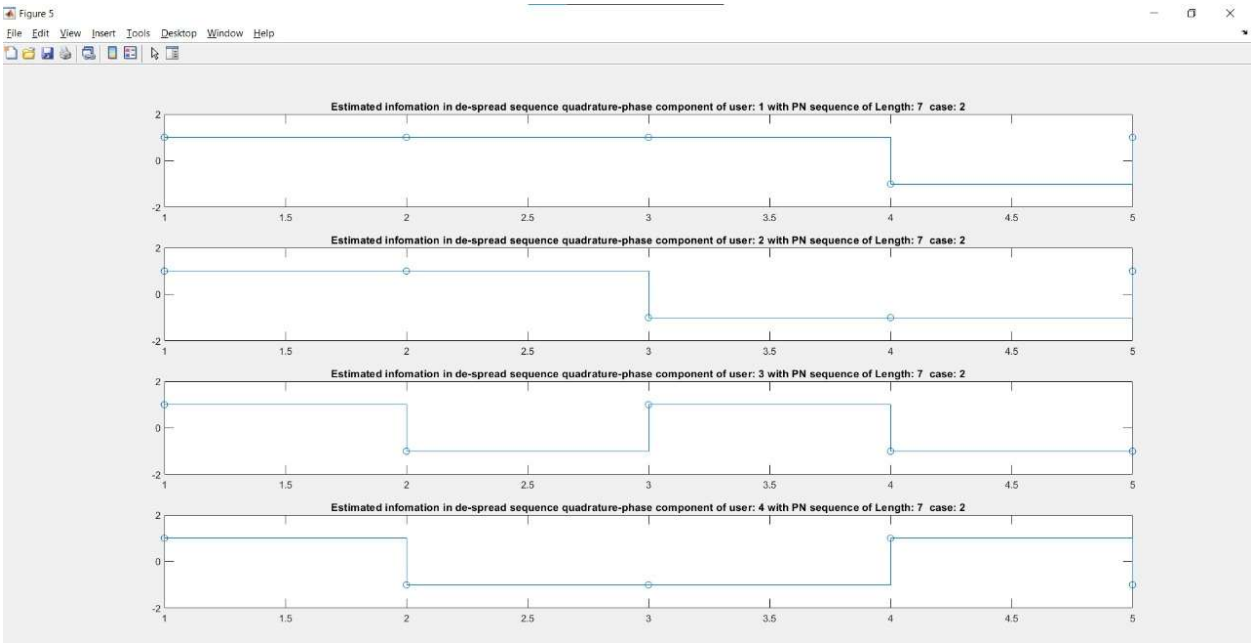
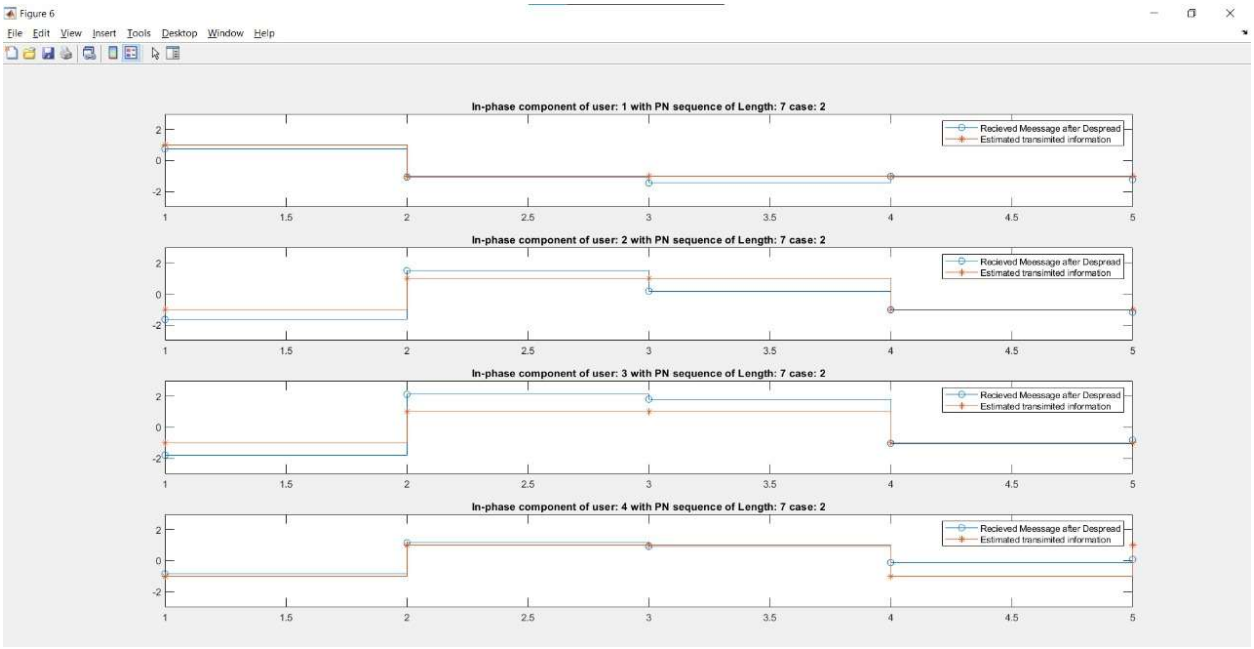
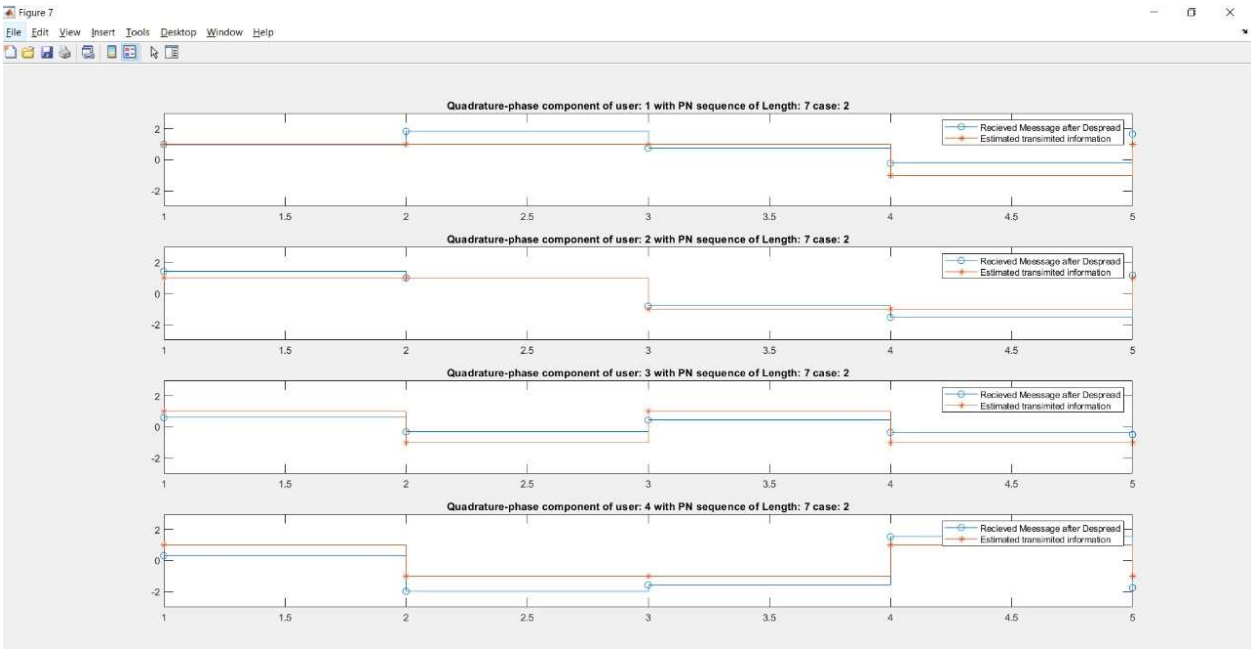


Figure 13: Estimated information quadrature component with PN sequence of length 7 2nd case

- ✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: When we changed the impulse response to [1 0.8 0.3 0.05], errors appeared as we see from the received message after despread and the estimated transmitted information as the impulse of channel that represent the noise appeared or the delay.

Channel Case (3):

- ✓ Before de-spreading

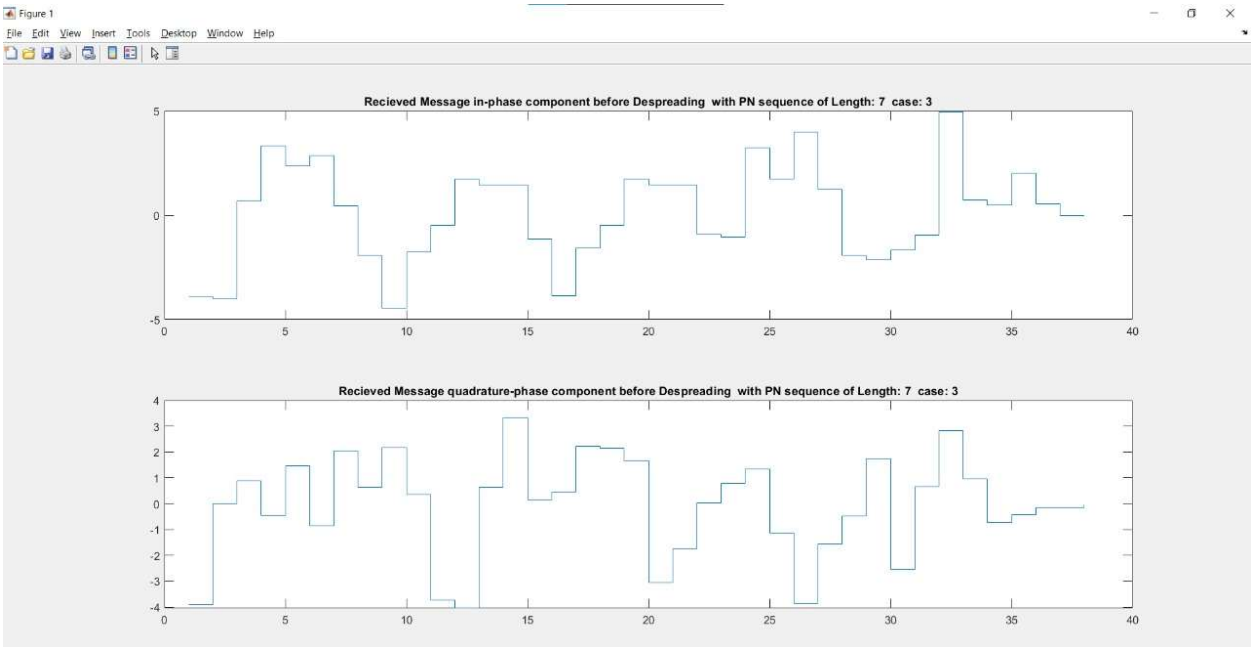


Figure 14: Received message in-phase component before de-spreading with PN sequence of length 7 3rd case

✓ After de-spreading

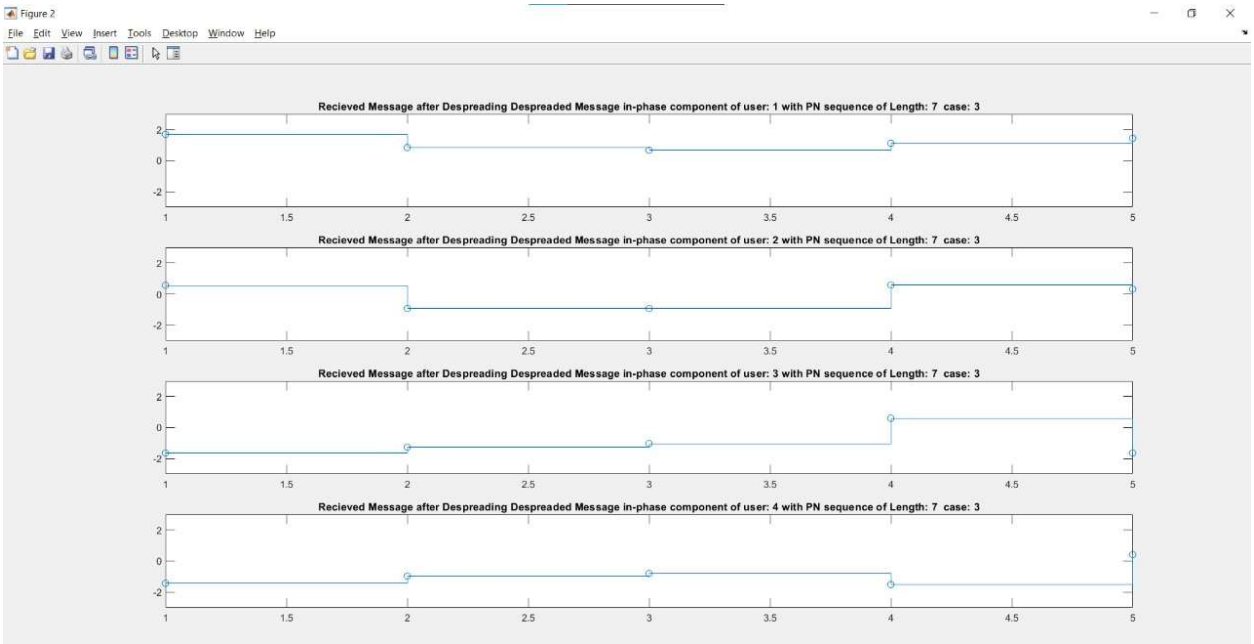


Figure 15: Received message in-phase component after de-spreading with PN sequence of length 7 3rd case

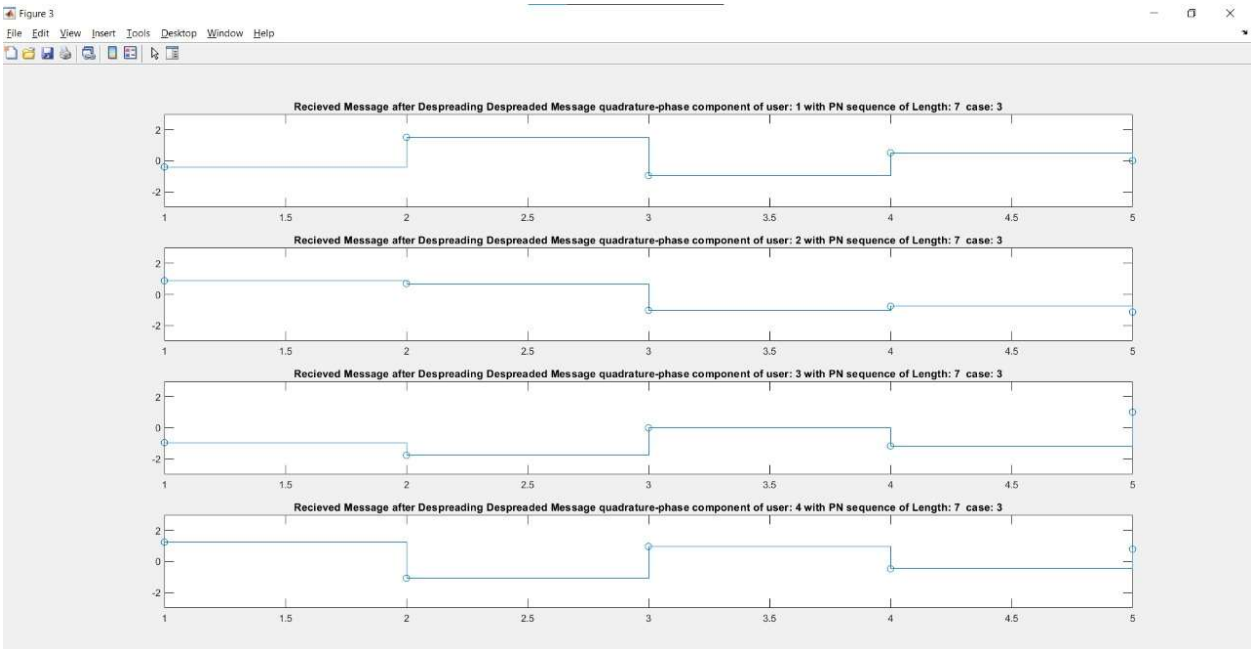


Figure 16: Received message quadrature component after de-spreading with PN sequence of length 7 3rd case

✓ Estimated transmitted information

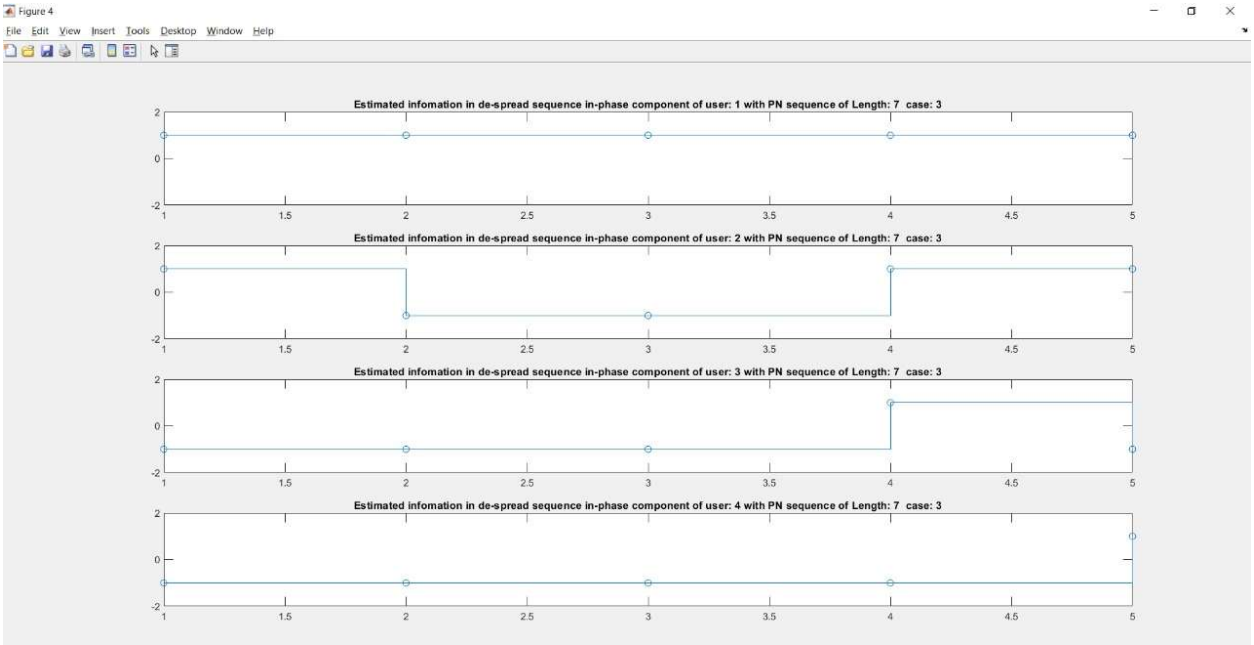


Figure 17: Estimated information in-phase component with PN sequence of length 7 3rd case

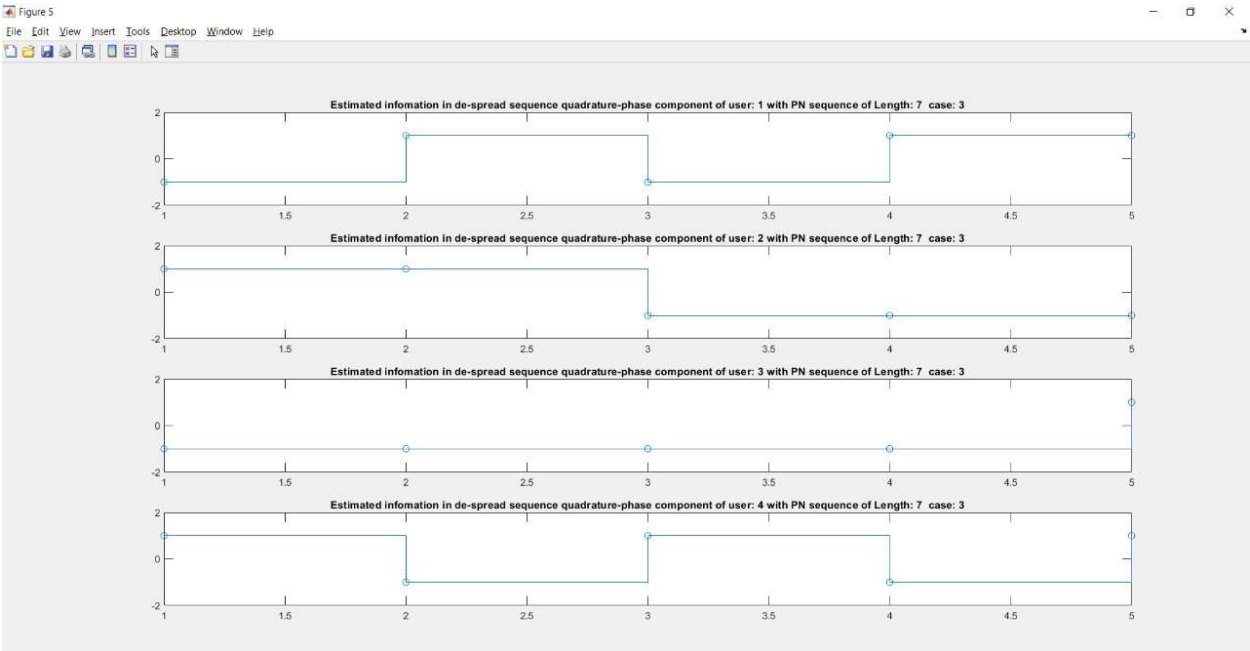
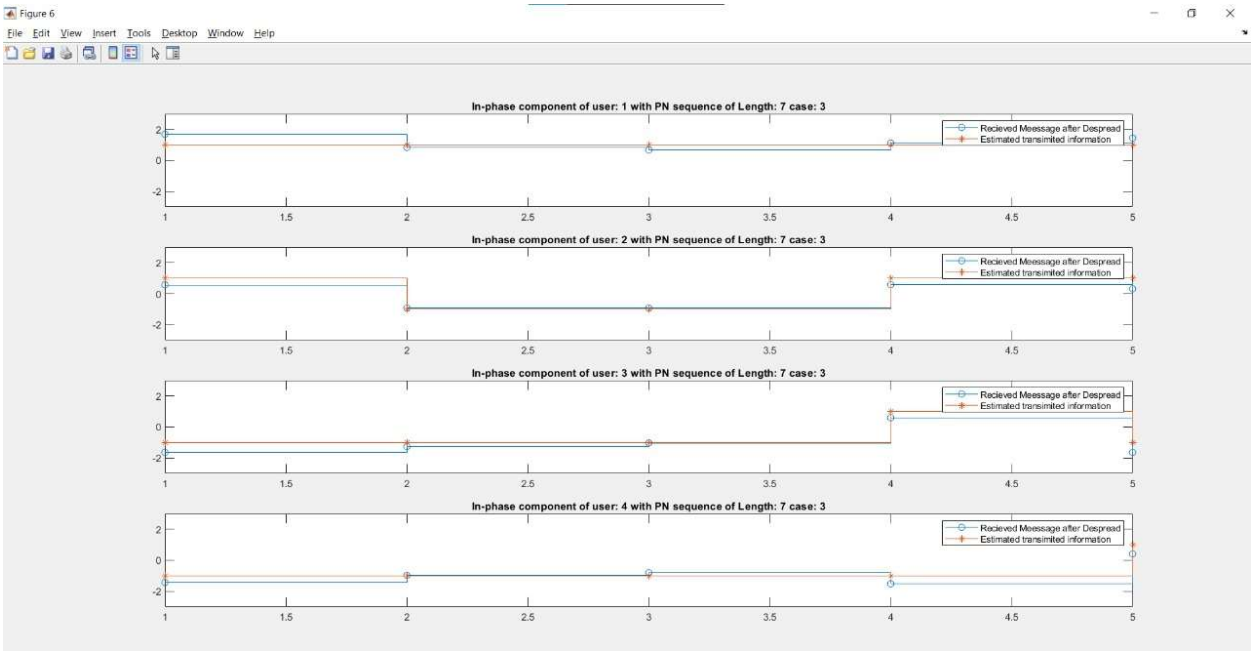
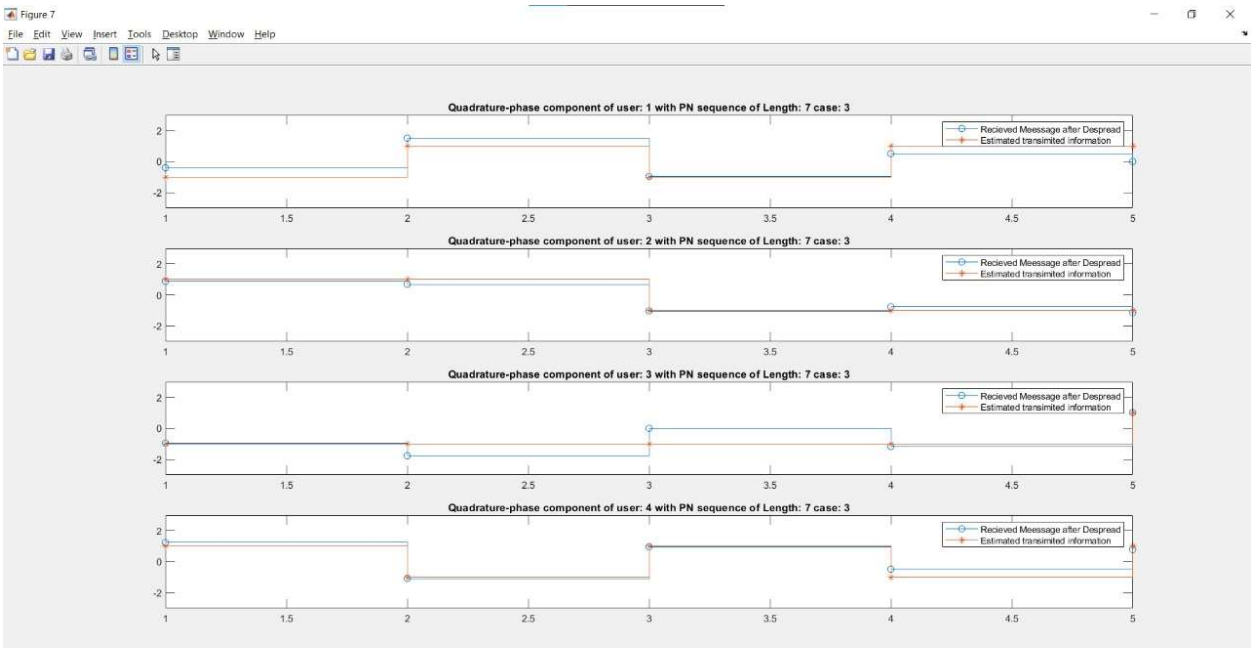


Figure 18: Estimated information quadrature component with PN sequence of length 7 3rd case

- ✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: When we changed the impulse response other than case 2 in addition that last row has 3 elements not 4 so we padded it with 0 from the right as we in convolution, we multiply by -T so that we get it in left in convolution, errors appeared as we see from the received message after despread and the estimated transmitted information as the impulse of channel that represent the noise appeared or the delay.

2. PN Spreading Sequence of Length 15

Channel Case (1):

✓ Before de-spreading

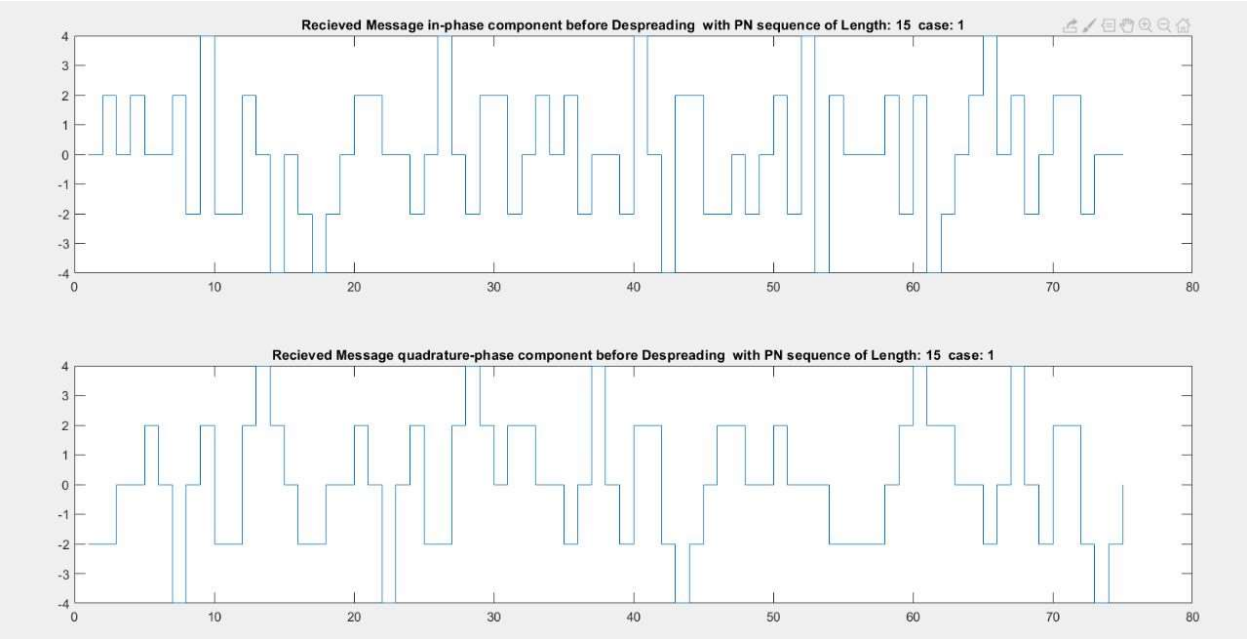


Figure 19: Received message in-phase component before de-spreading with PN sequence of length 15 1st case

✓ After de-spreading

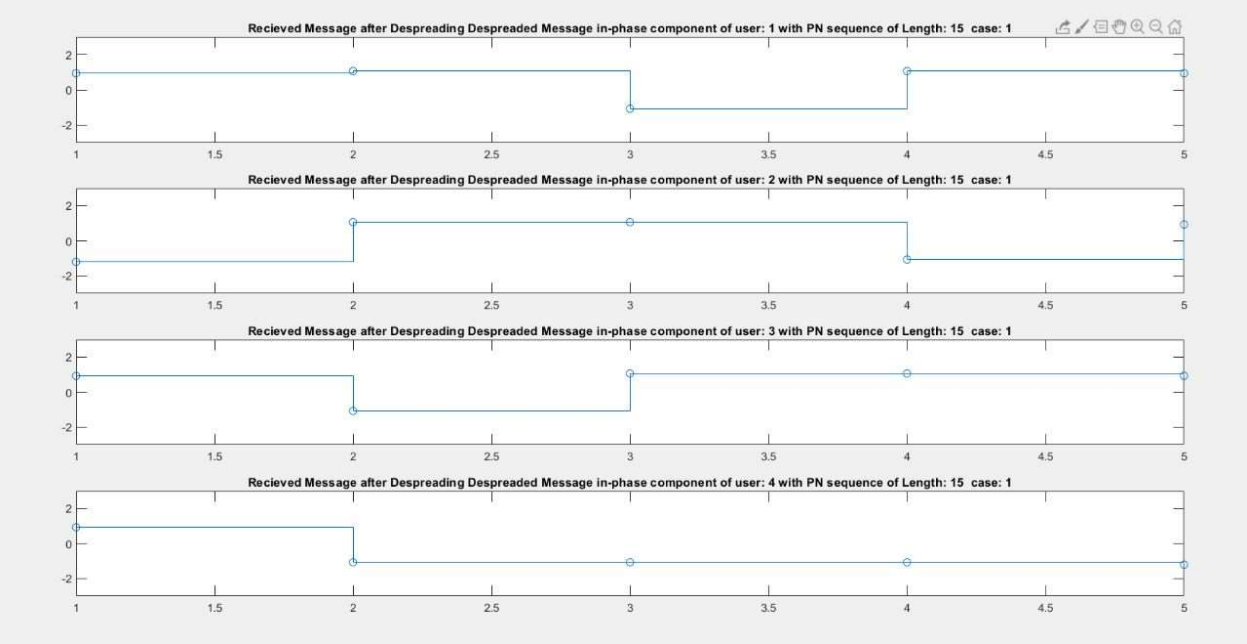


Figure 20: Received message in-phase component after de-spreading with PN sequence of length 15 1st case

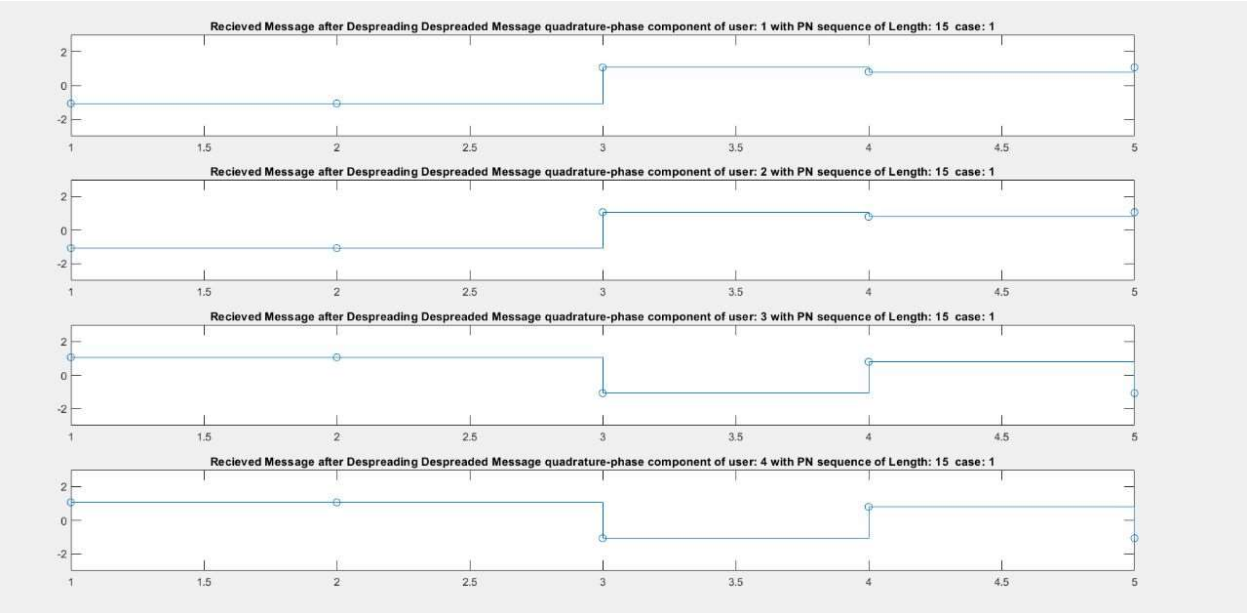


Figure 21: Received message quadrature component after de-spreading with PN sequence of length 15 1st case

- Estimated transmitted information

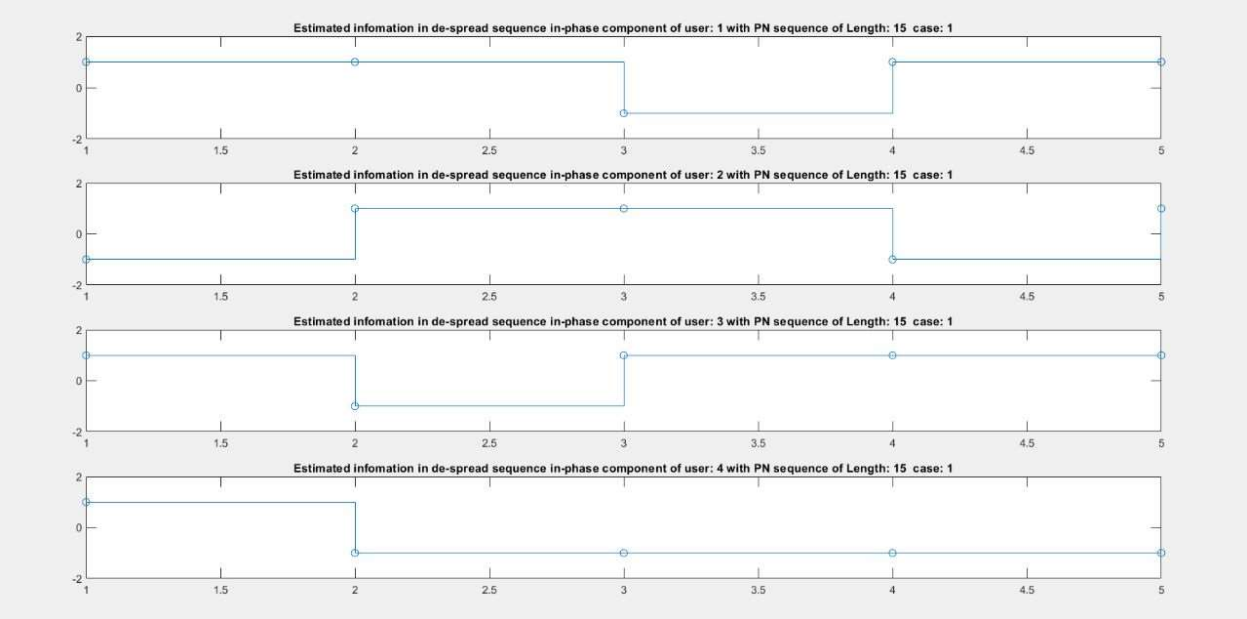


Figure 22: Estimated information in-phase component with PN sequence of length 15 1st case

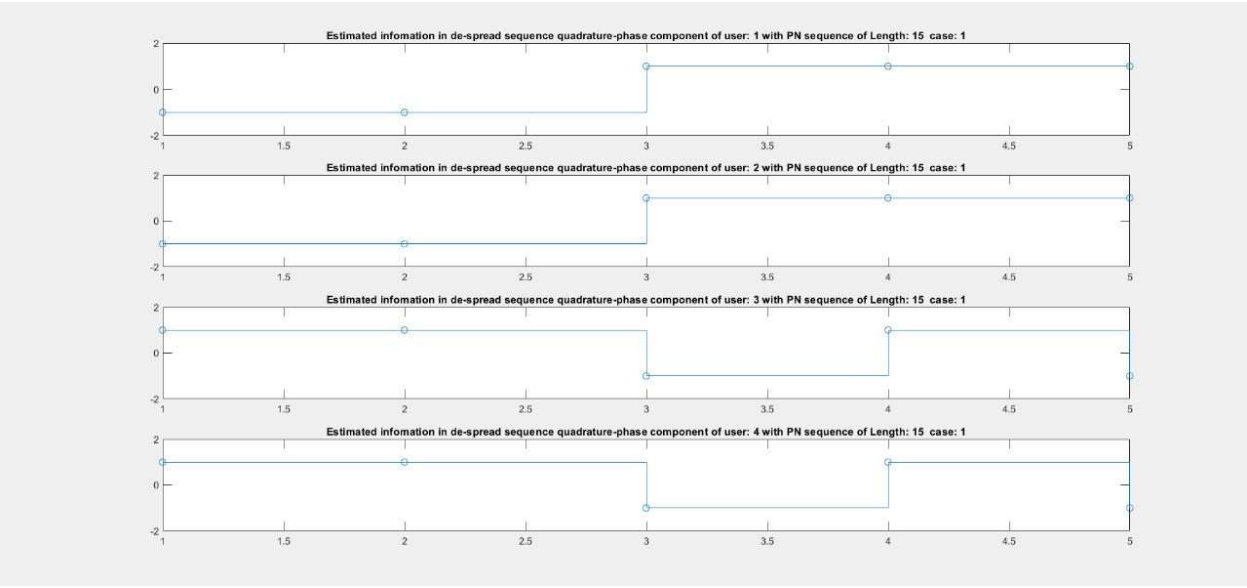
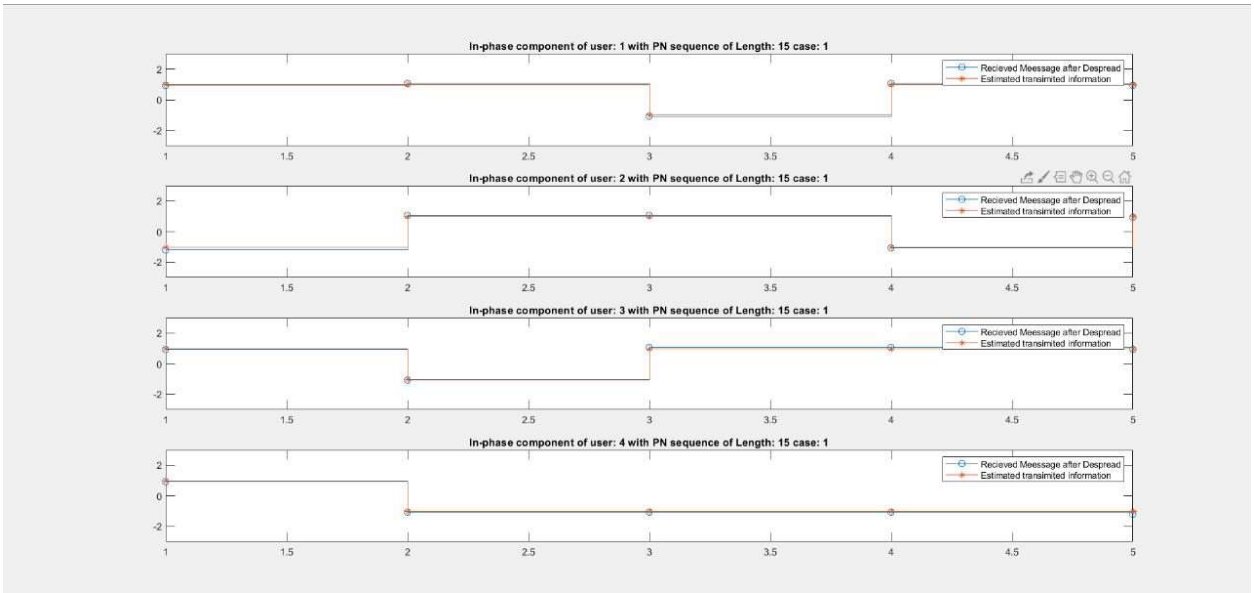
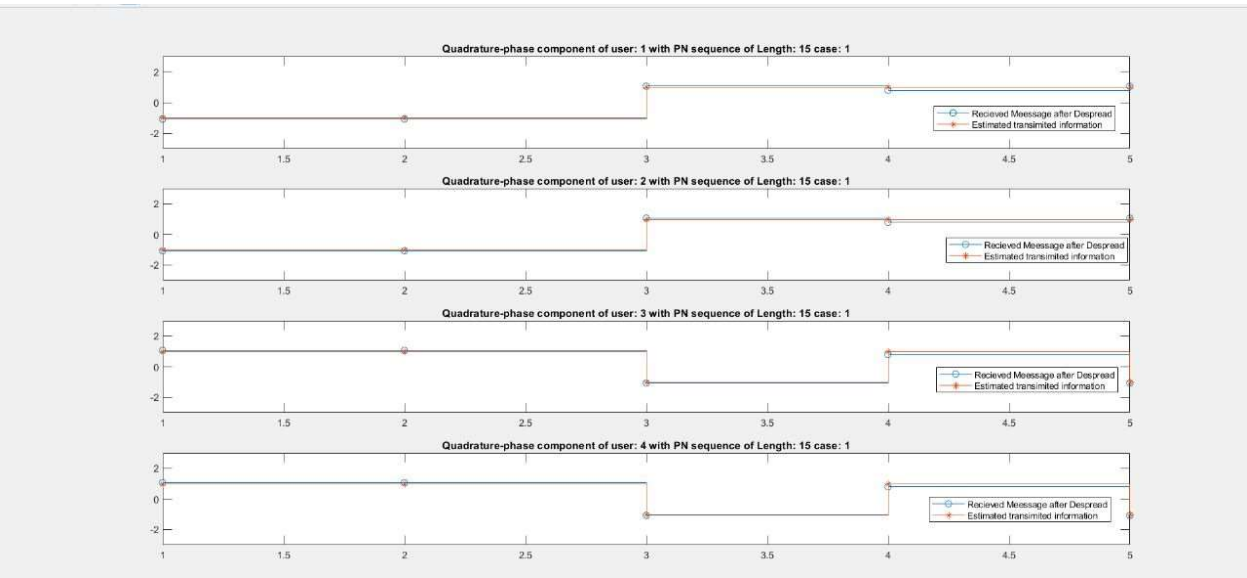


Figure 23: Estimated information quadrature component with PN sequence of length 15 1st case

- Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: As we increased the PN sequence and the impulse response is ideal, no multipath components or delay spread exists.

Channel Case (2):

✓ Before de-spreading

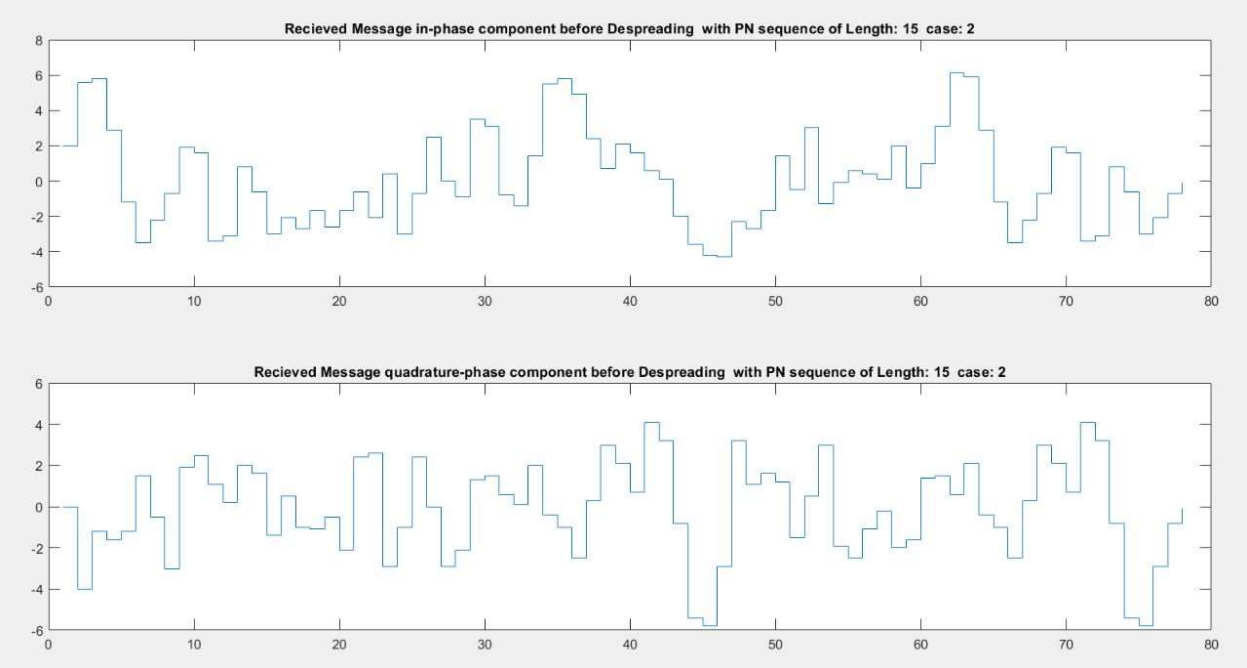


Figure 24: Received message in-phase component before de-spreading with PN sequence of length 15 2nd case

✓ After de-spreading

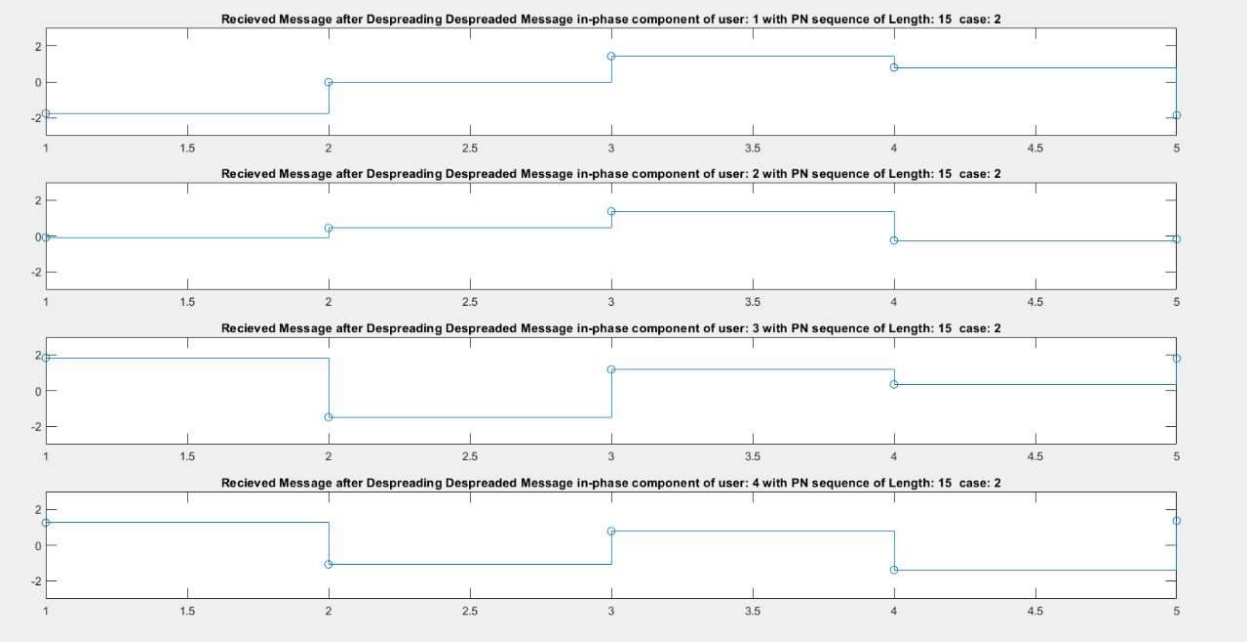


Figure 25: Received message in-phase component after de-spreading with PN sequence of length 15 2nd case

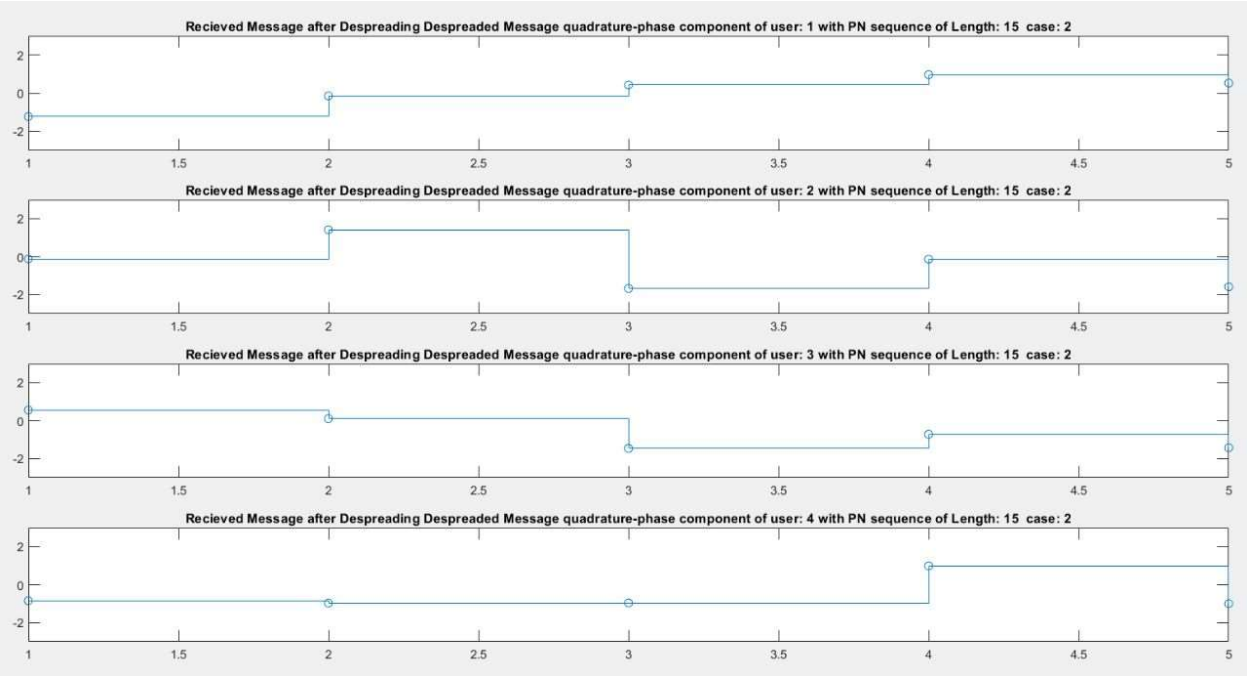


Figure 26: Received message quadrature component after de-spreading with PN sequence of length 15 2nd case

✓ Estimated transmitted information

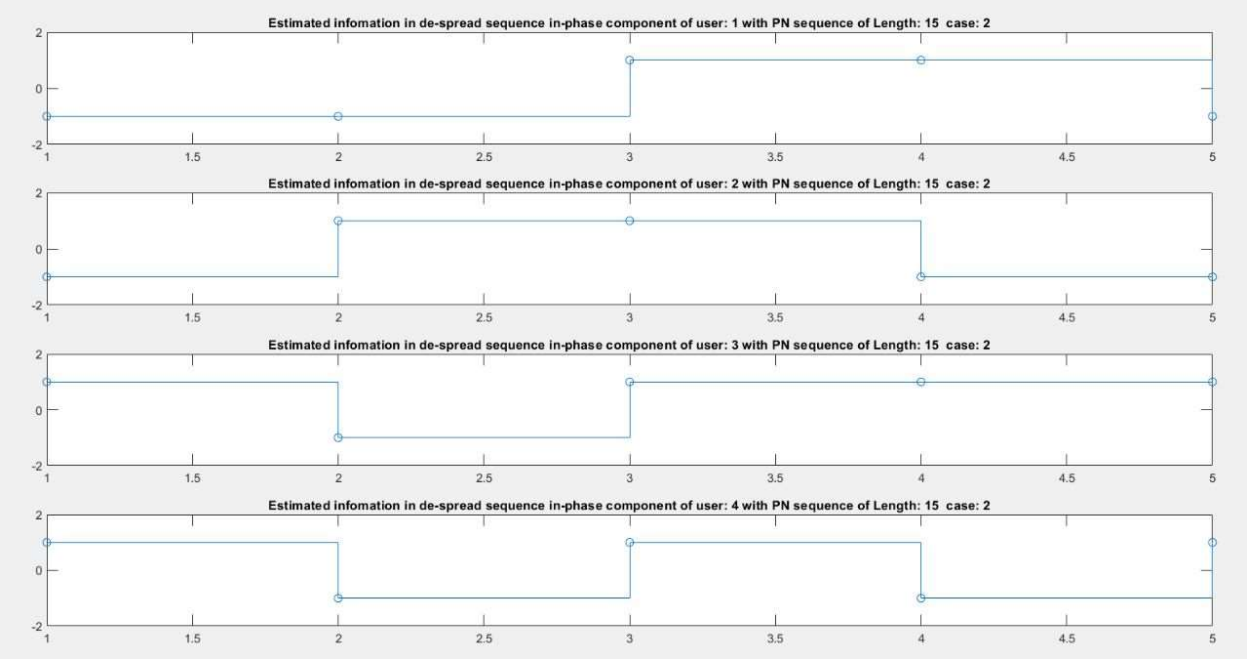


Figure 27: Estimated information quadrature component with PN sequence of length 15 2nd case

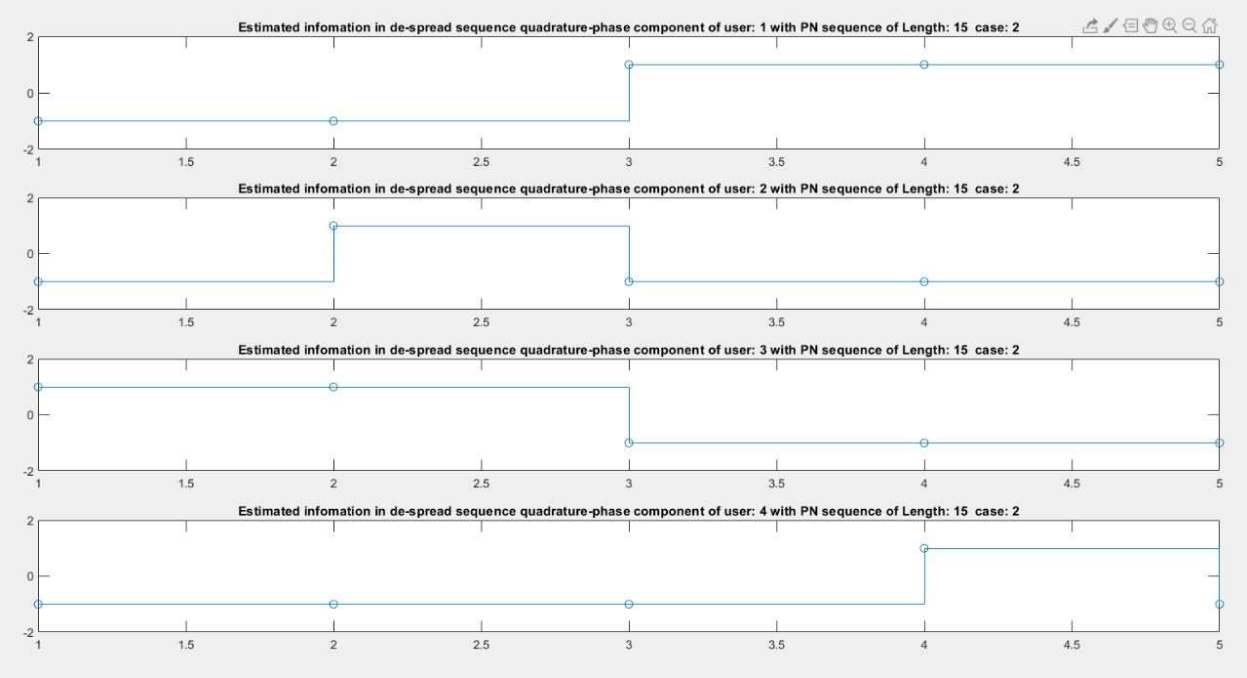
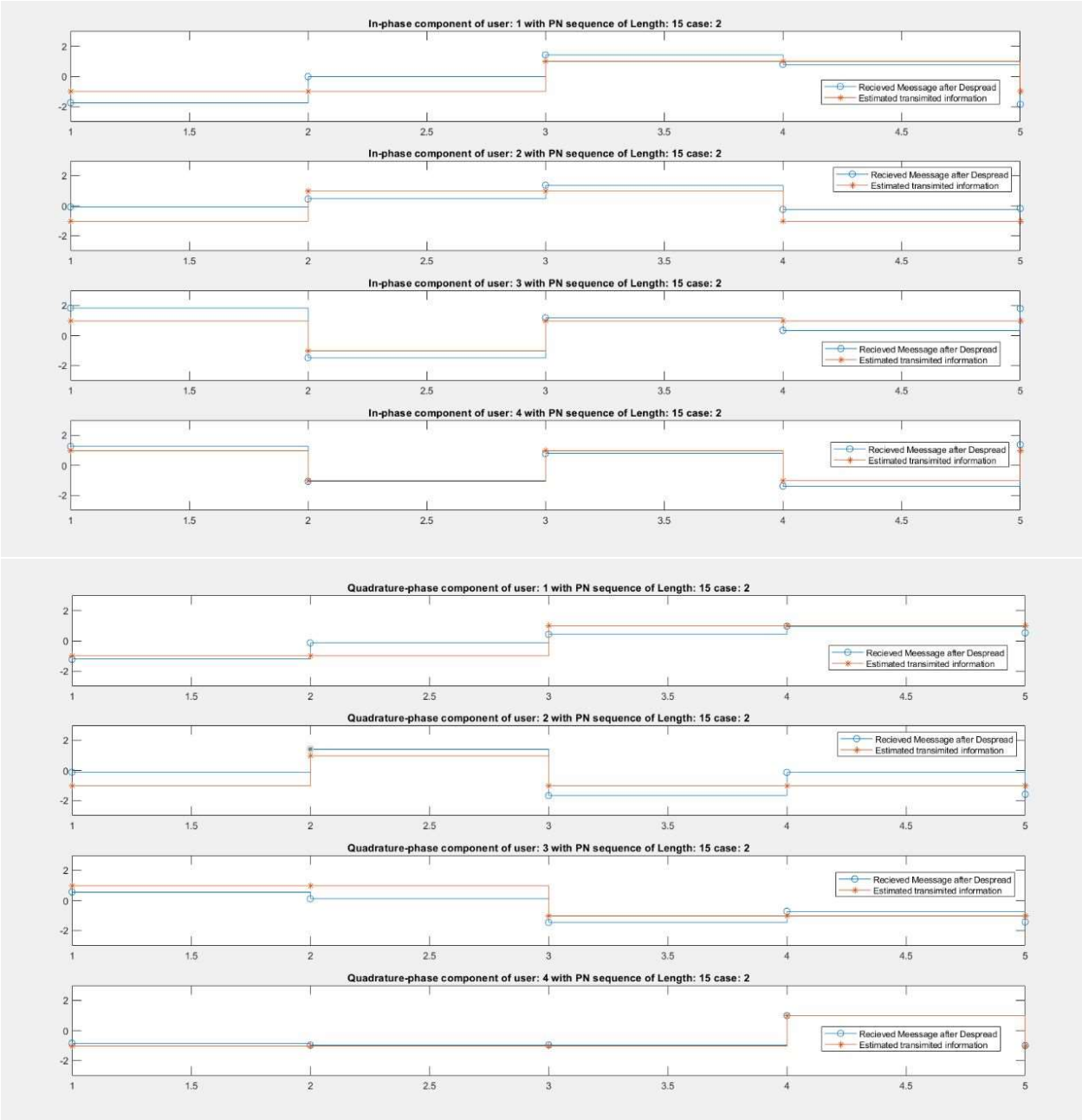


Figure 28: Estimated information quadrature component with PN sequence of length 15 2nd case

✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph



Comment: As we increased the PN sequence and the impulse response is not ideal, a multipath components or delay spread exists.

Channel Case (3):

✓ Before de-spreading

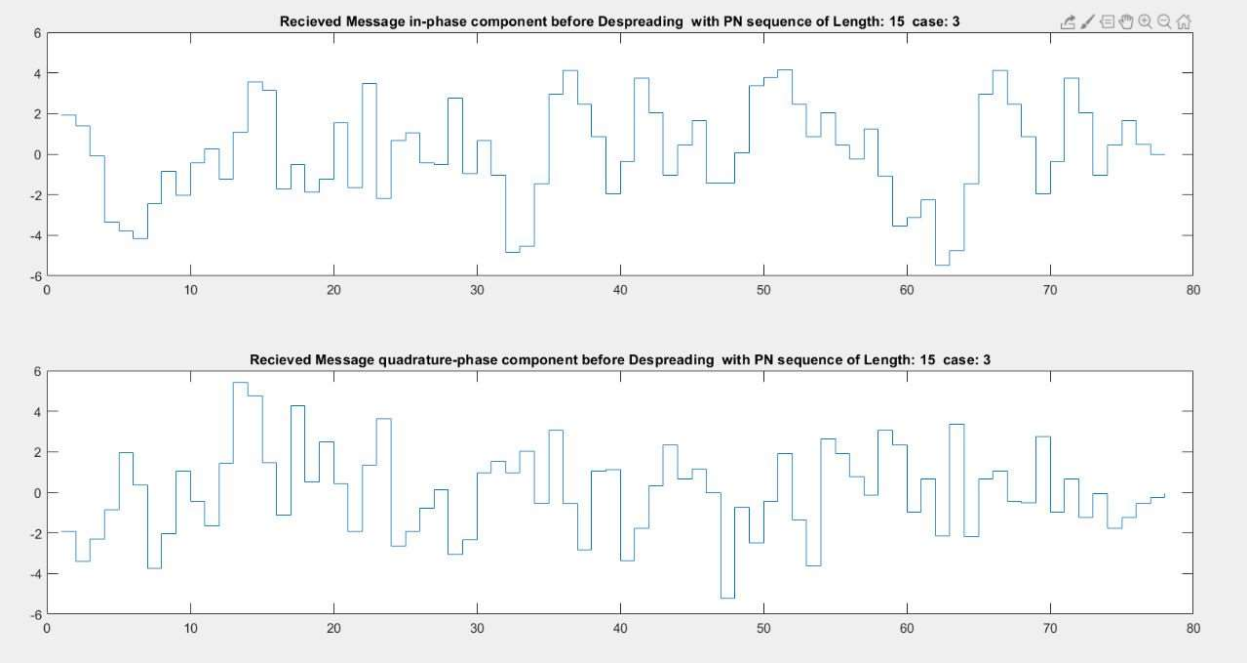


Figure 29: Received message in-phase component before de-spreading with PN sequence of length 15 3rd case

✓ After de-spreading

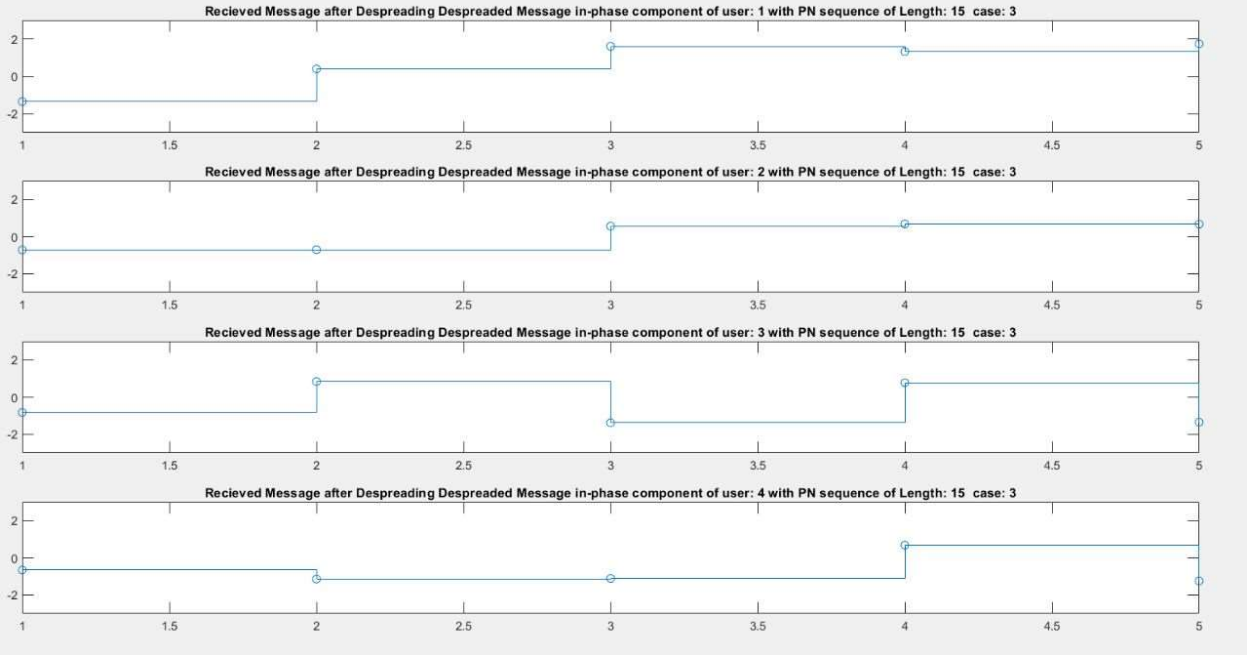


Figure 30: Received message in-phase component after de-spreading with PN sequence of length 15 3rd case

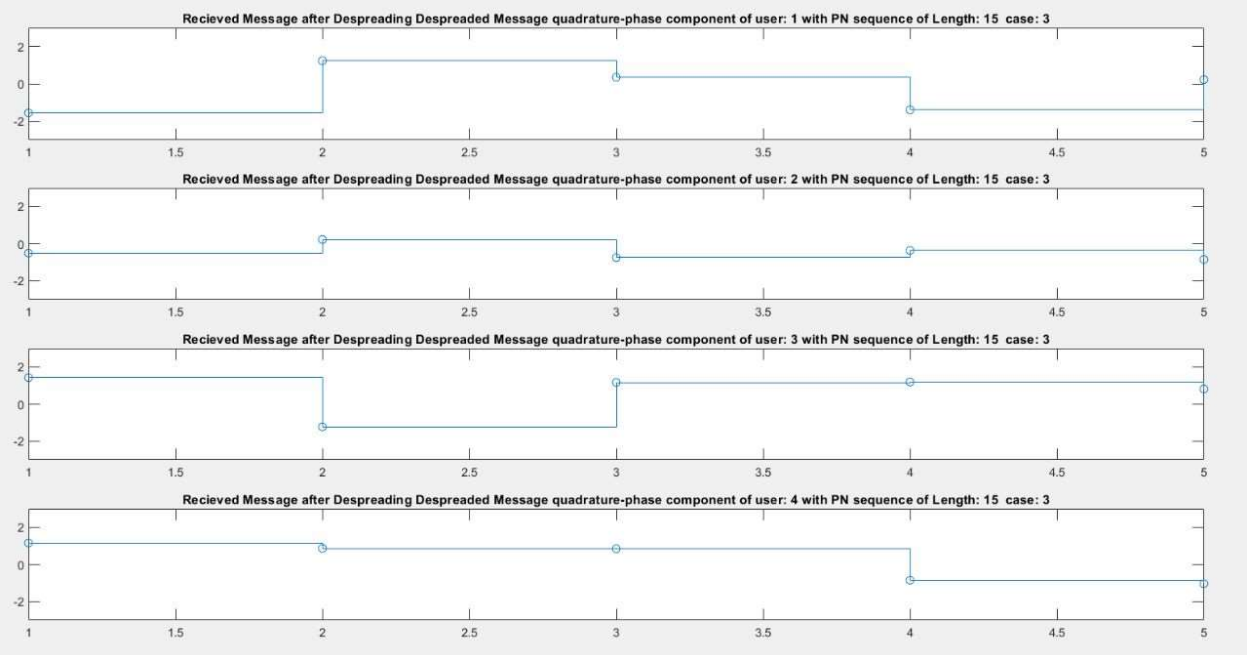


Figure 31: Received message quadrature component after de-spreading with PN sequence of length 15 3rd case

✓ Estimated transmitted information

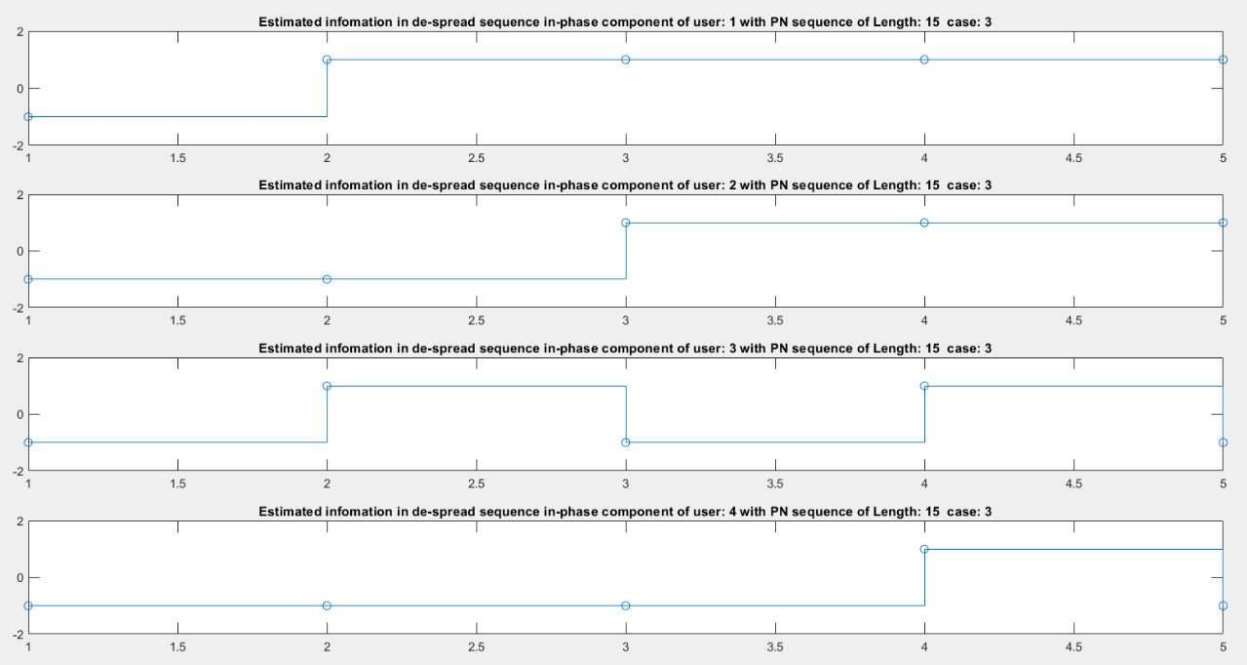


Figure 32: Estimated information in-phase component with PN sequence of length 15 3rd case

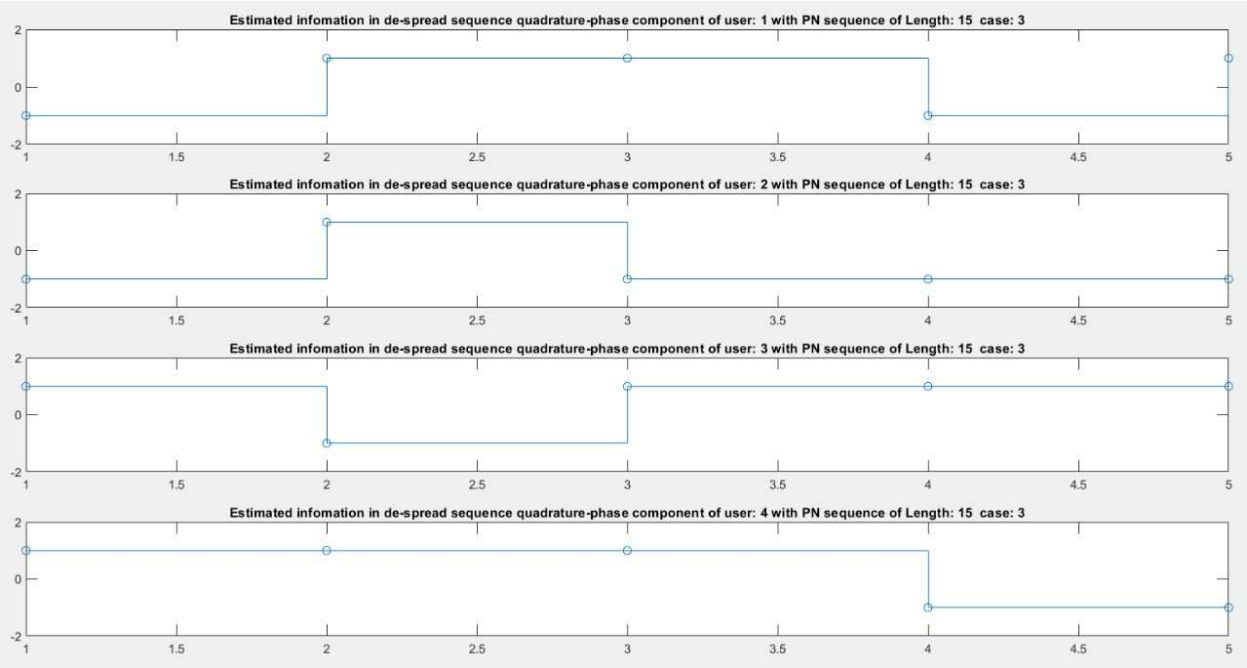
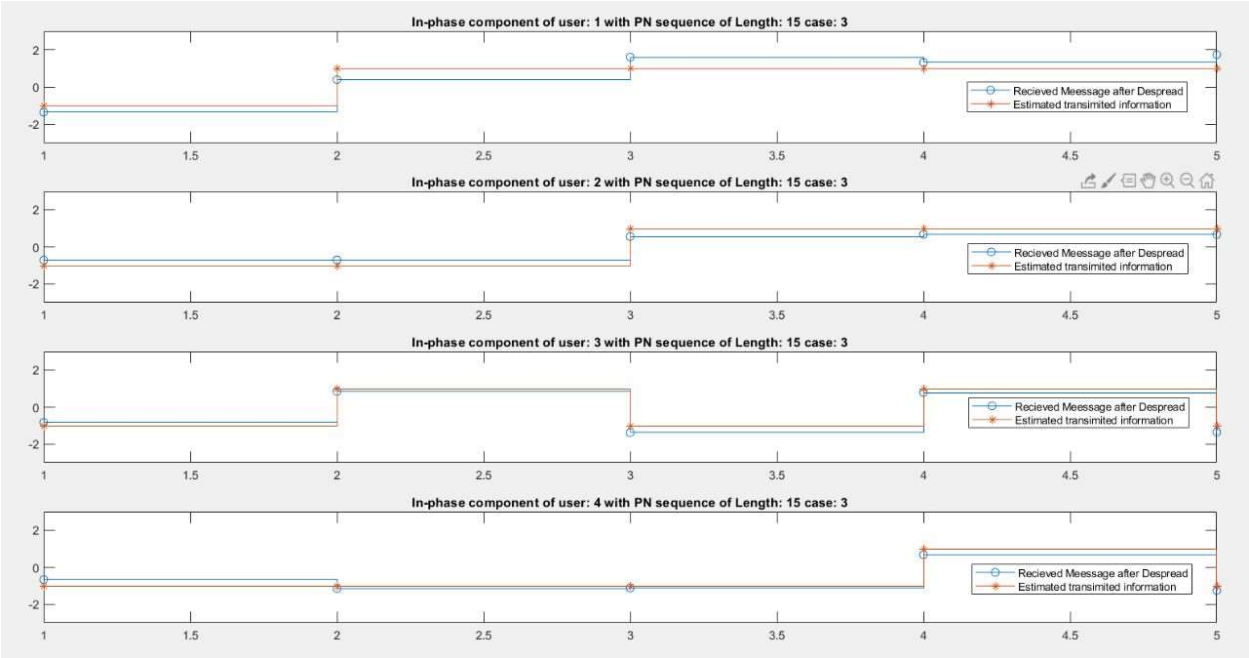
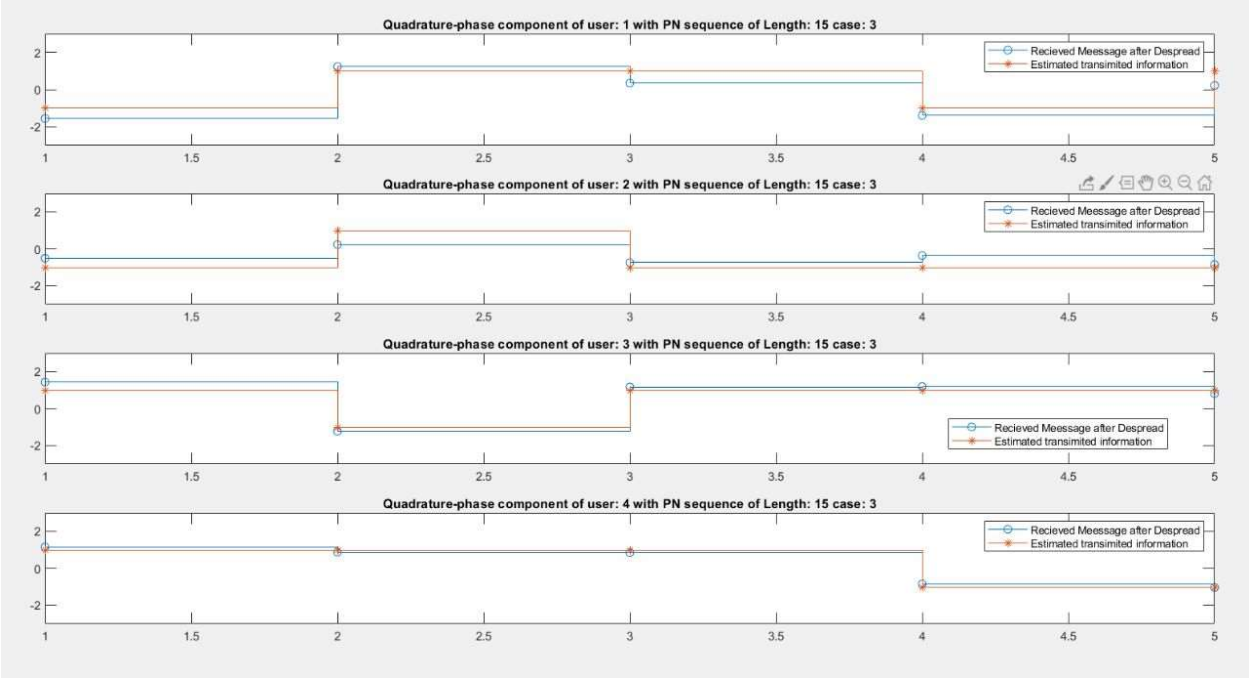


Figure 33: Estimated information quadrature component with PN sequence of length 15 3rd case

✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: As we increased the PN sequence and the impulse response is not ideal, multipath components or delay spread exists different than case 2 as the impulse response are not having the same values.

3. PN Spreading Sequence of Length 63

Channel Case (1):

✓ Before de-spreading

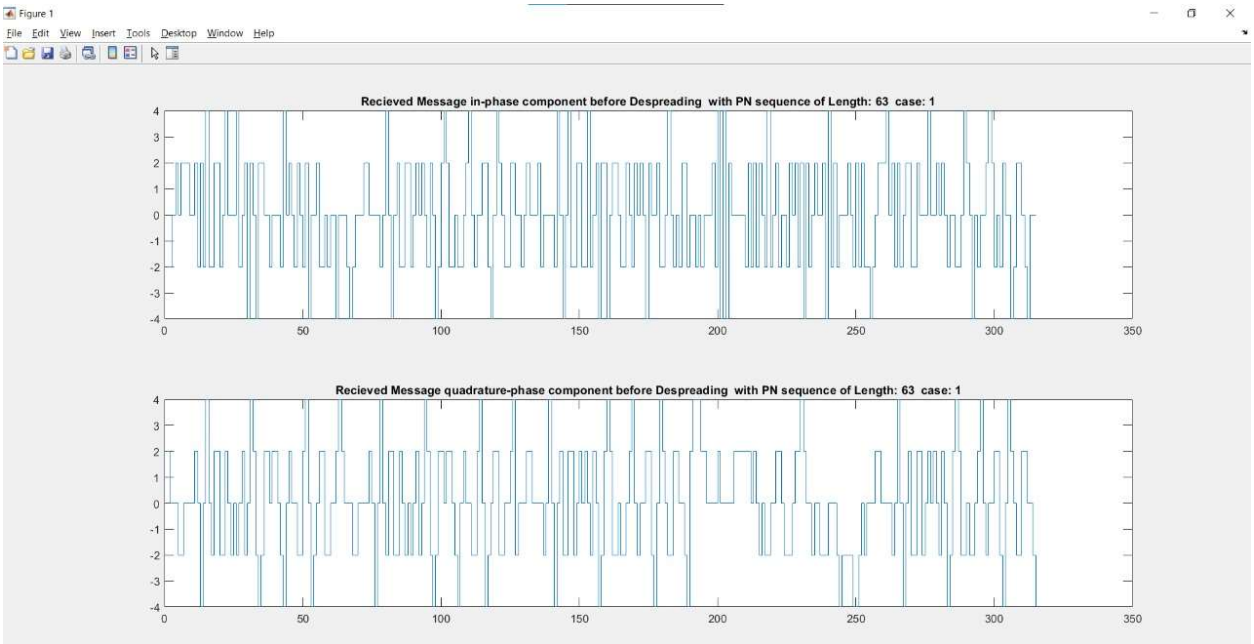


Figure 34: Received message in-phase component before de-spreading with PN sequence of length 63 1st case

✓ After de-spreading

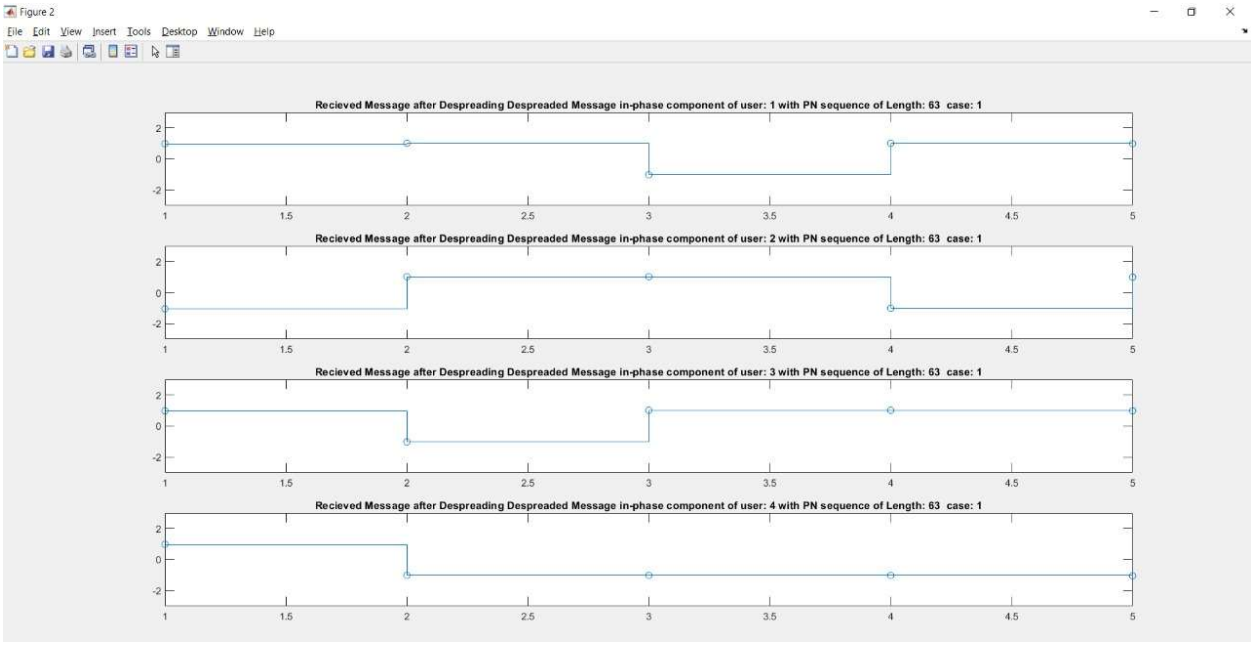


Figure 35: Received message in-phase component after de-spreading with PN sequence of length 63 1st case

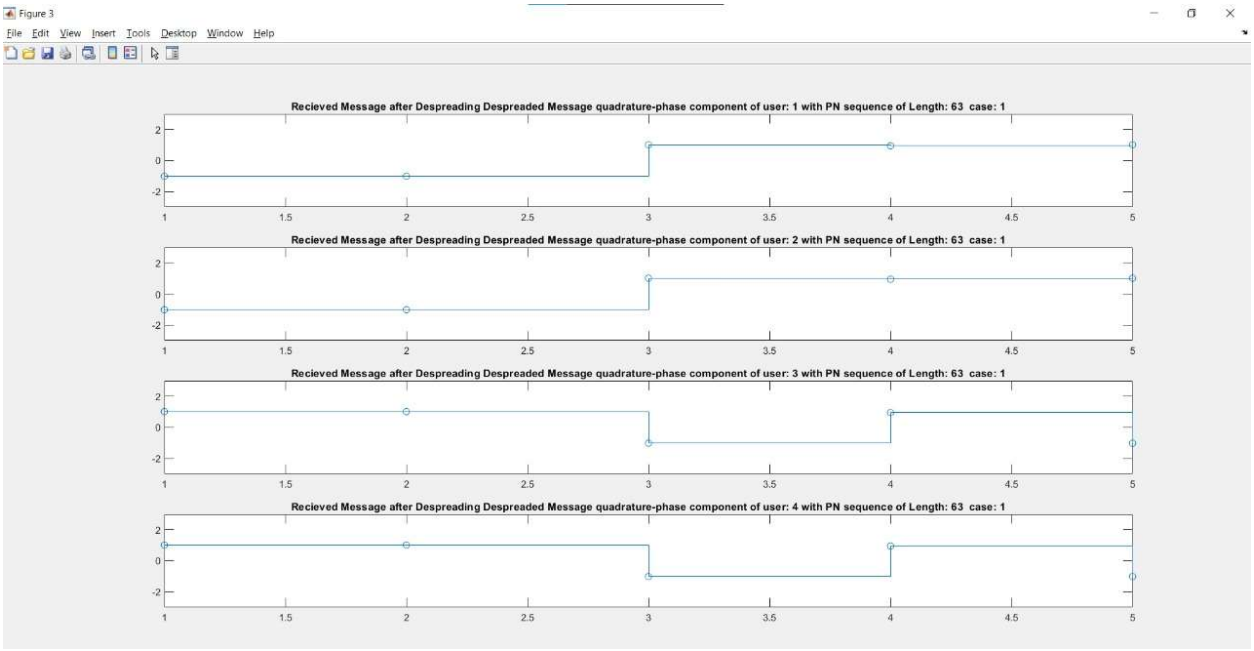


Figure 36: Received message quadrature component after de-spreading with PN sequence of length 63 1st case

- Estimated transmitted information

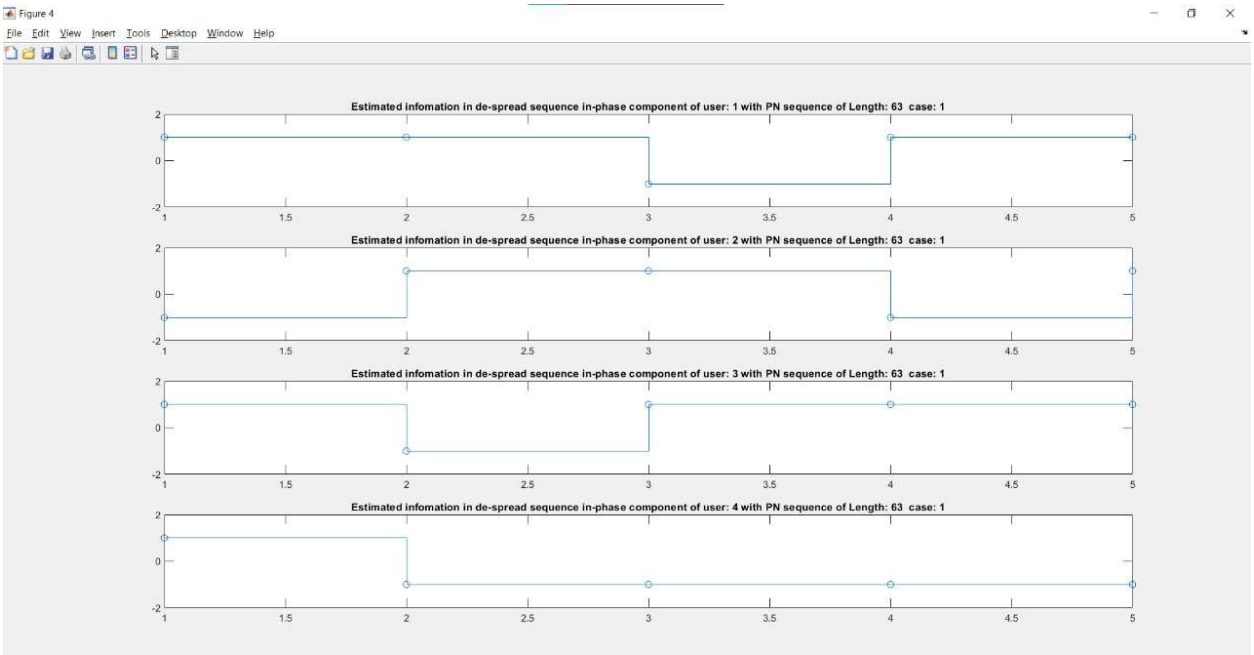


Figure 37: Estimated information in-phase component with PN sequence of length 63 1st case

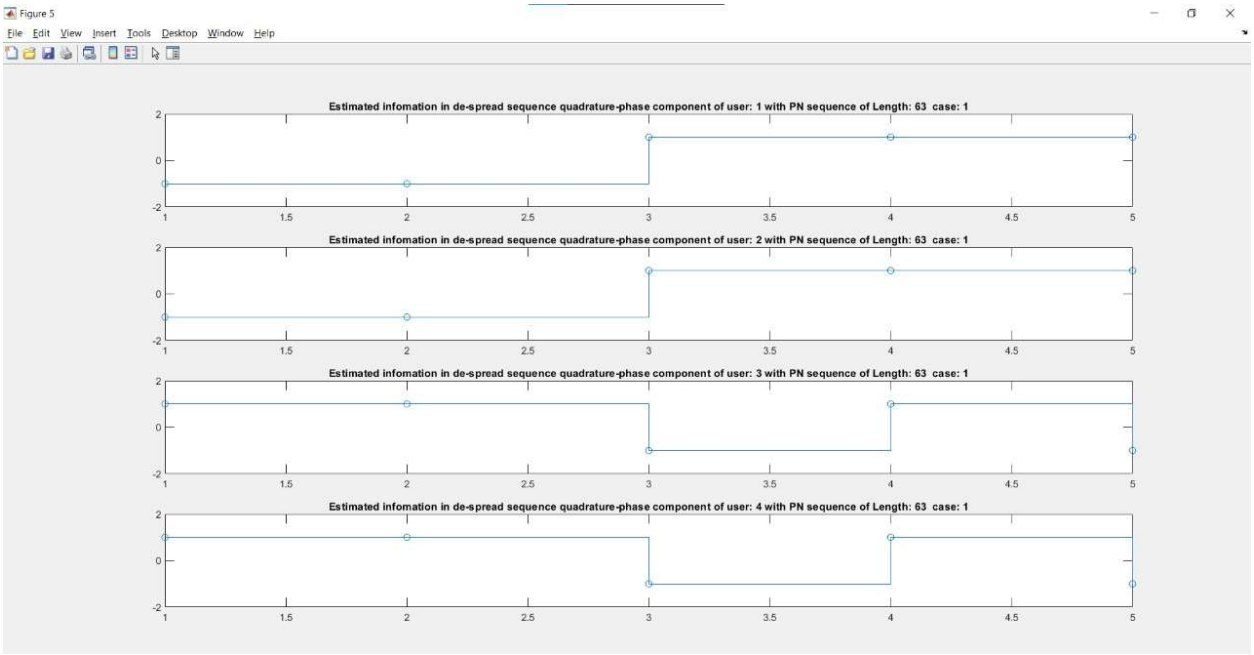
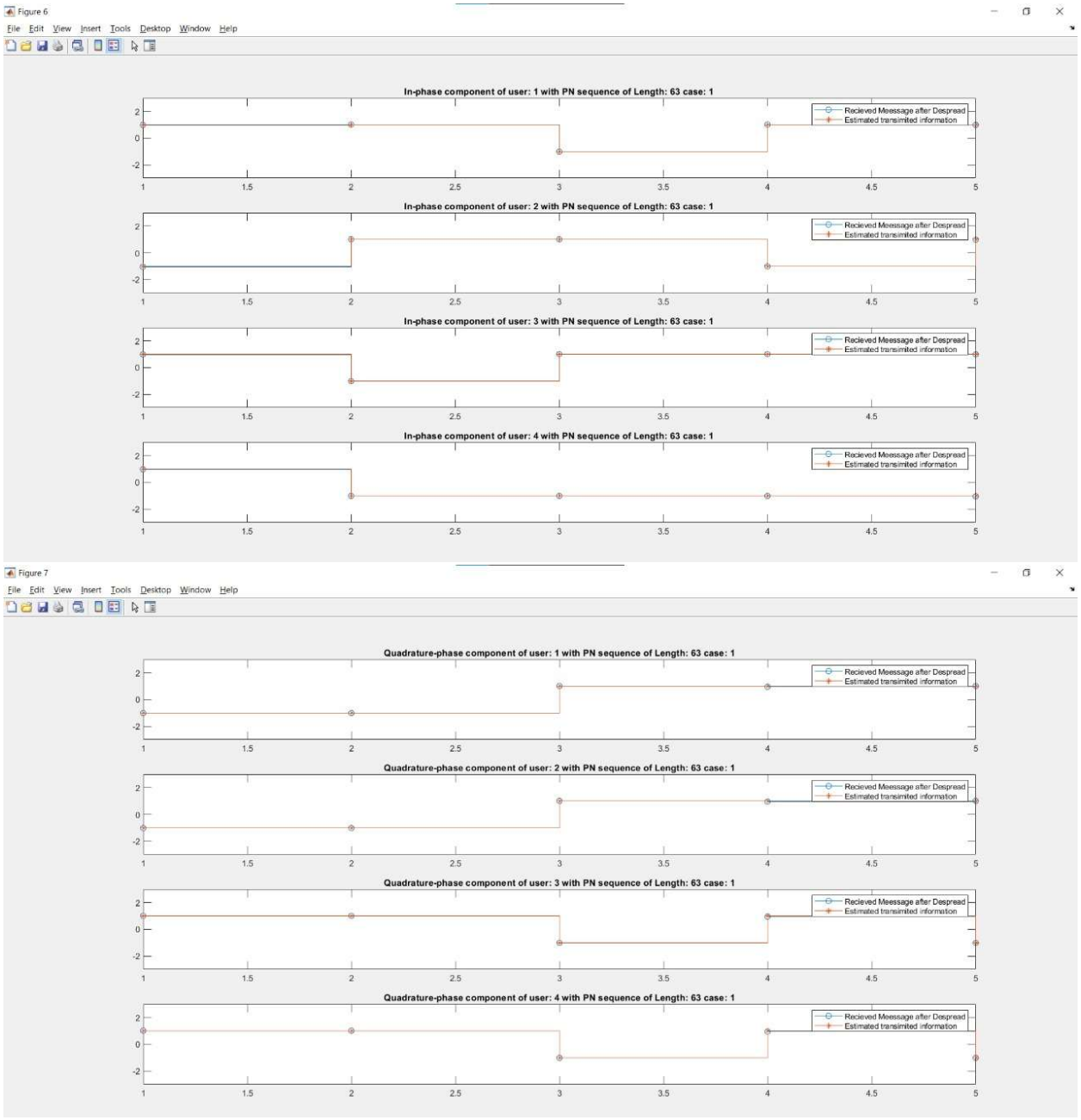


Figure 38: Estimated information quadrature component with PN sequence of length 63 1st case

- Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph



Comment: This case should be the best among all as the impulse response is ideal and we have maximum PN sequence among the other (15,7) so that it was expected to be the perfect case and that's very obvious from the graph as they are identical.

Channel Case (2):

- ✓ Before de-spreading

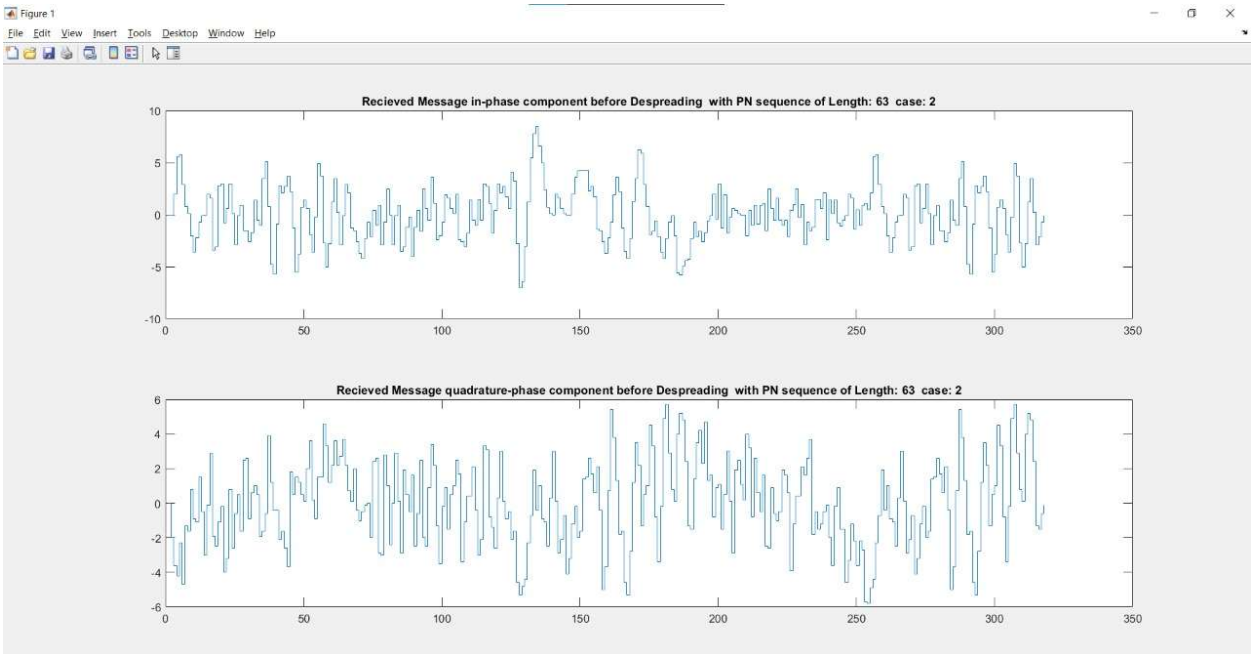


Figure 39: Received message in-phase component before de-spreading with PN sequence of length 63 2nd case

✓ After de-spreading

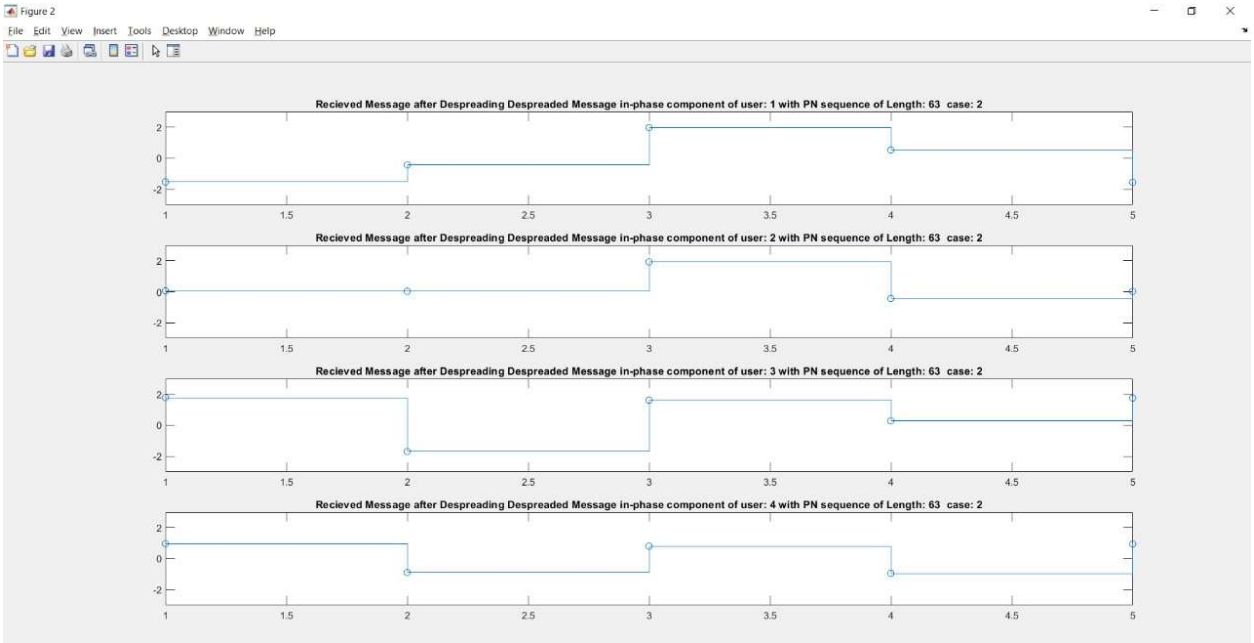


Figure 40: Received message in-phase component after de-spreading with PN sequence of length 63 2nd case

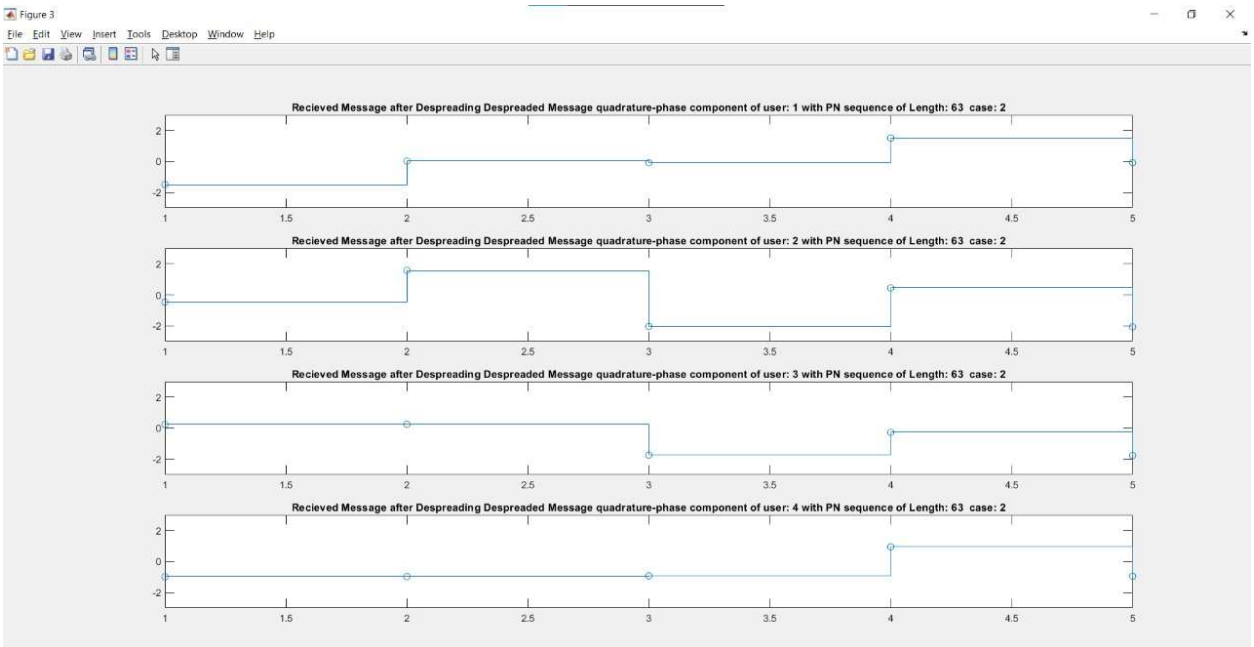


Figure 41: Received message quadrature component after de-spreading with PN sequence of length 63 2nd case

✓ Estimated transmitted information

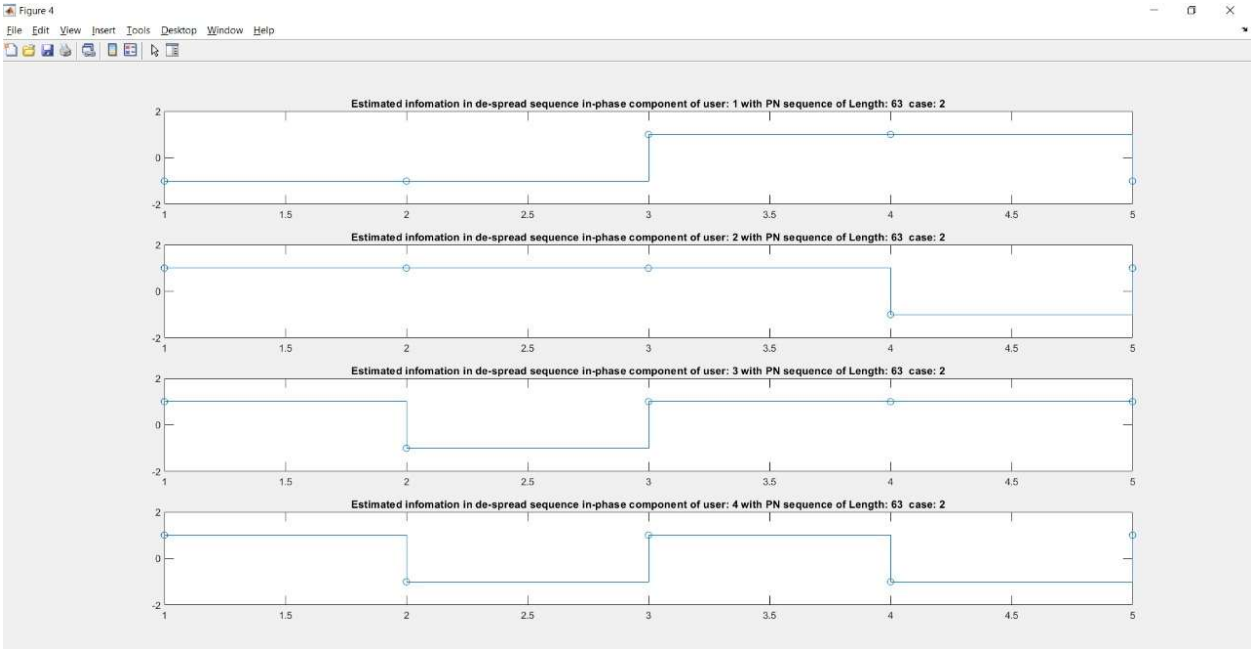


Figure 42: Estimated information in-phase component with PN sequence of length 63 2nd case

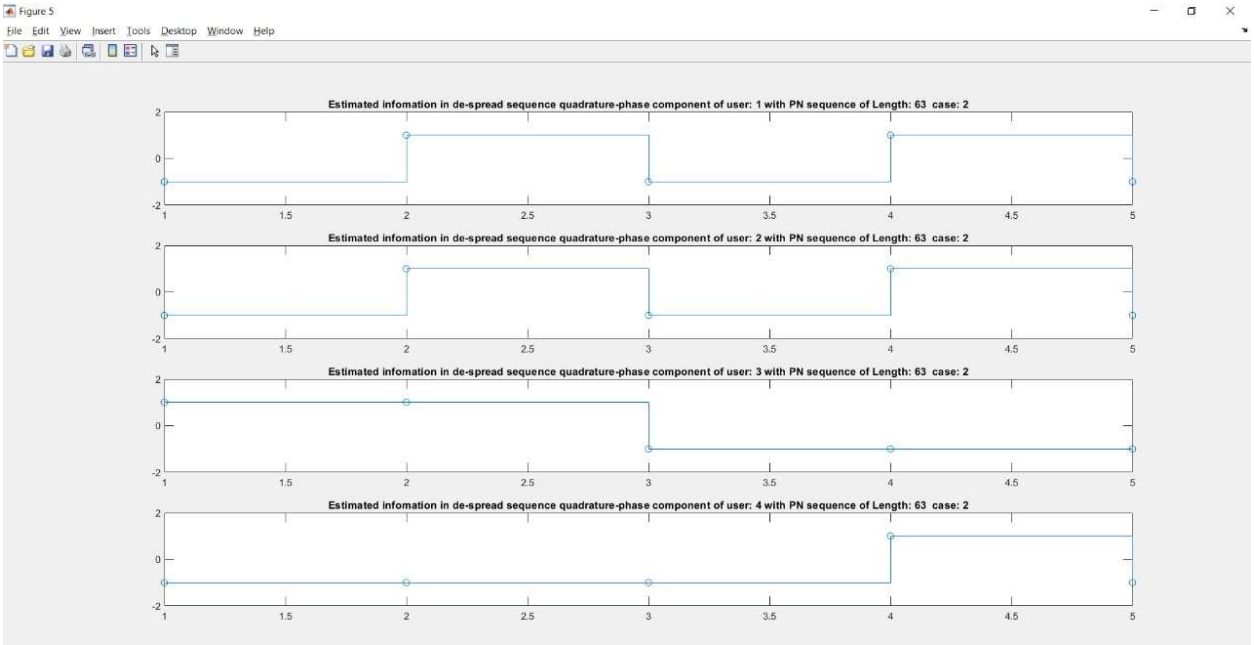
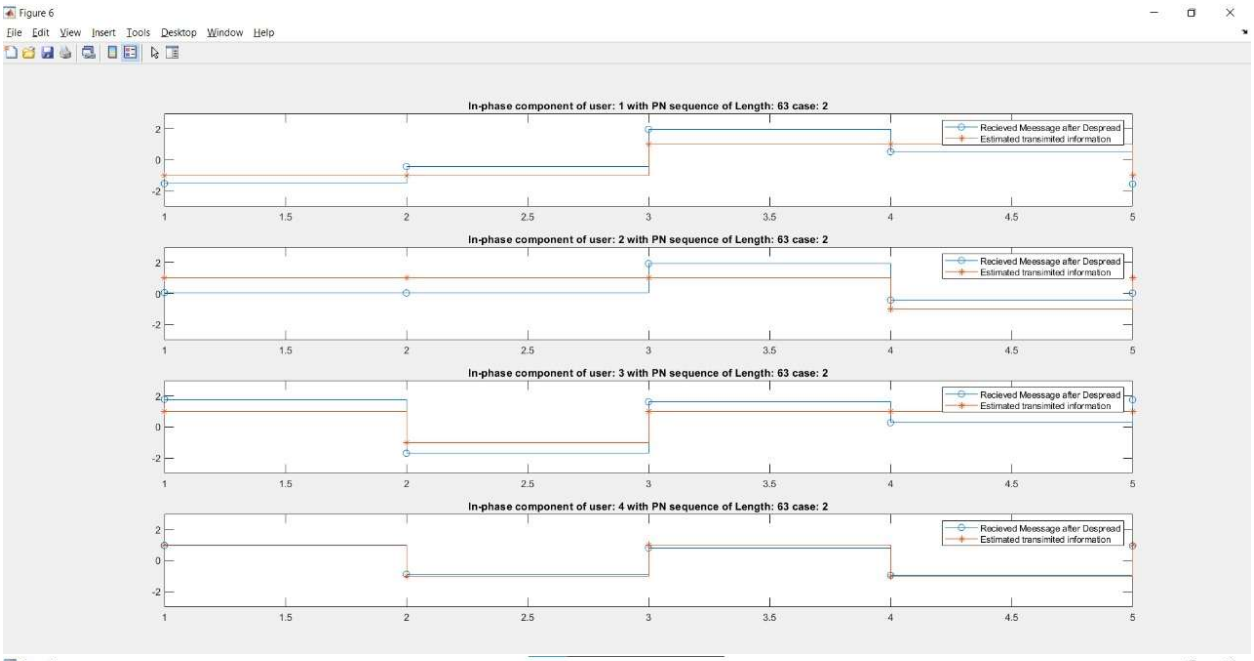
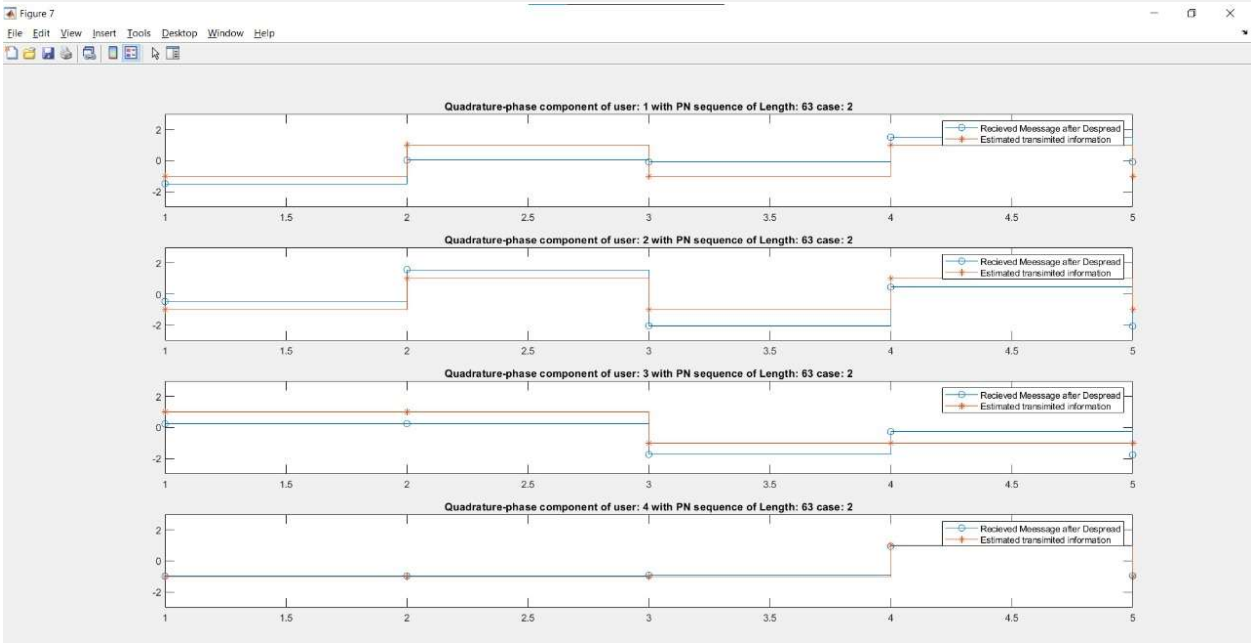


Figure 43: Estimated information quadrature component with PN sequence of length 63 2nd case

- ✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: As we increased the PN sequence and the impulse response is not ideal, there's no much errors compared to case 2 at maximal length equal 7 or 15.

Channel Case (3):

- ✓ Before de-spreading

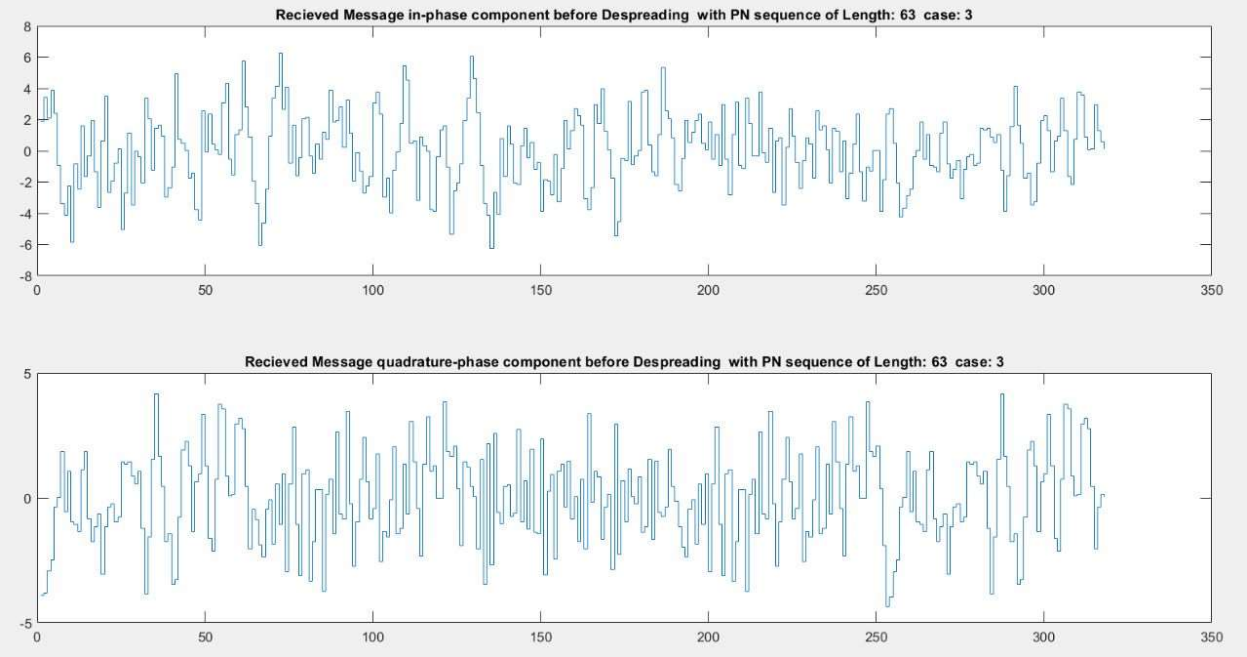


Figure 44: Received message in-phase component before de-spreading with PN sequence of length 63 3rd case

✓ After de-spreading

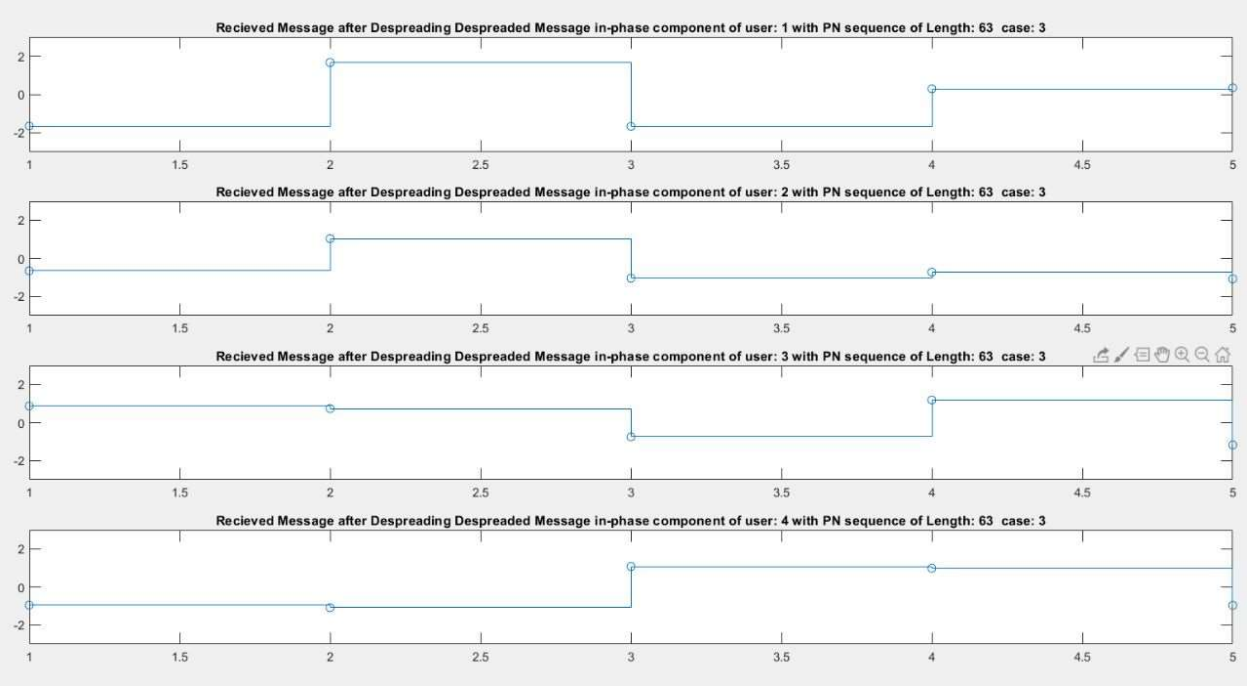


Figure 45: Received message in-phase component after de-spreading with PN sequence of length 63 3rd case

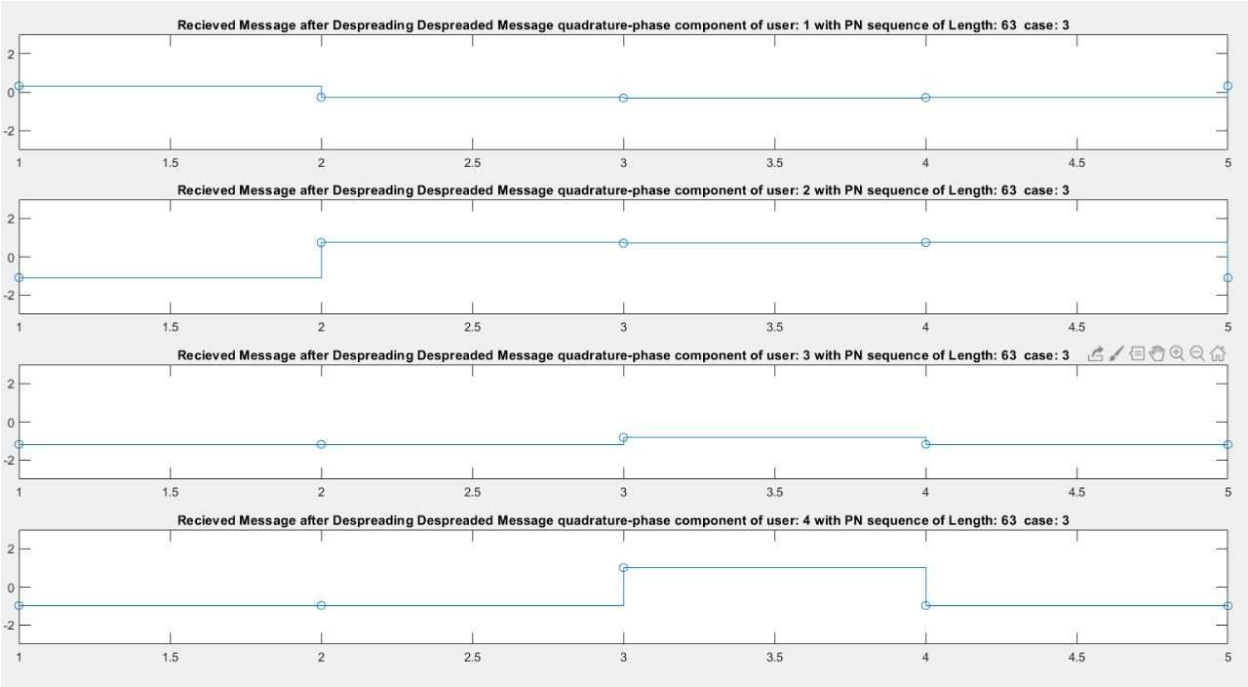


Figure 46: Received message quadrature component after de-spreading with PN sequence of length 63 3rd case

✓ Estimated transmitted information

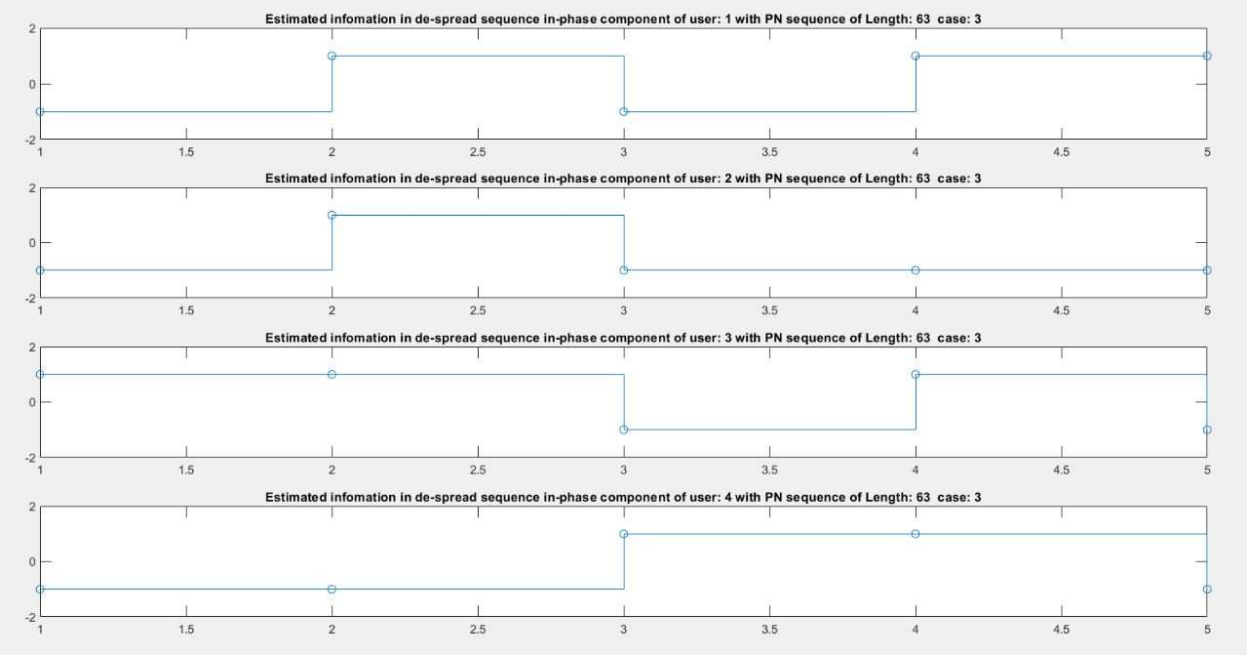


Figure 47: Estimated information in-phase component with PN sequence of length 63 3rd case

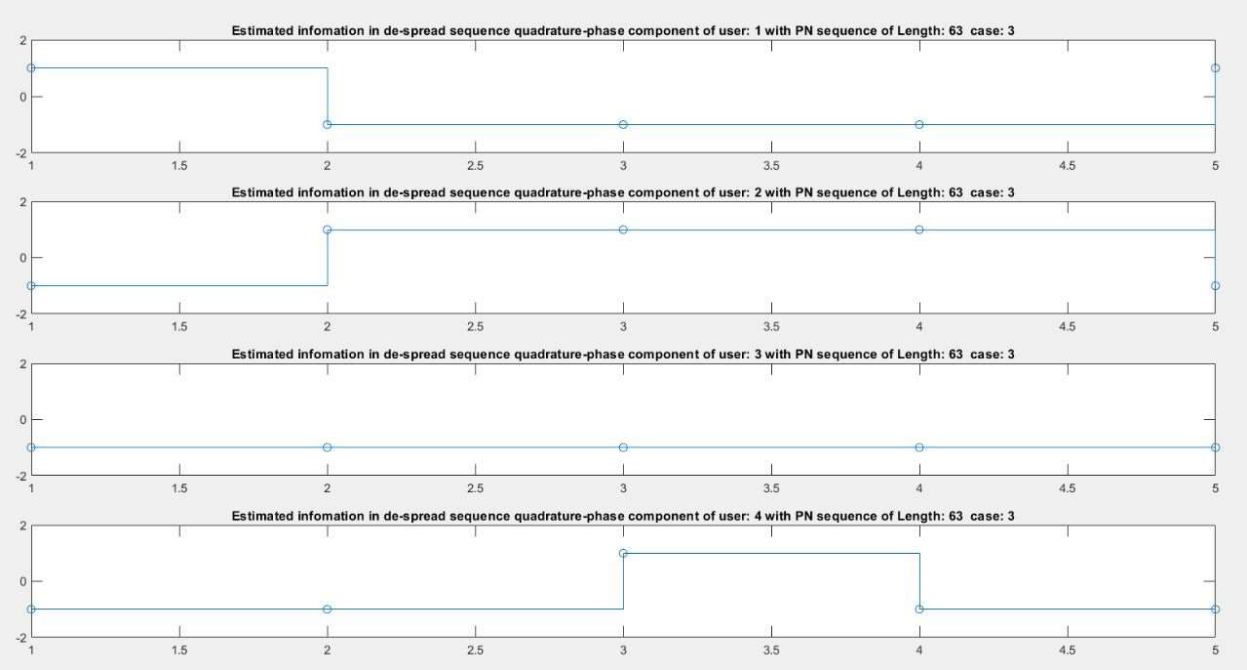
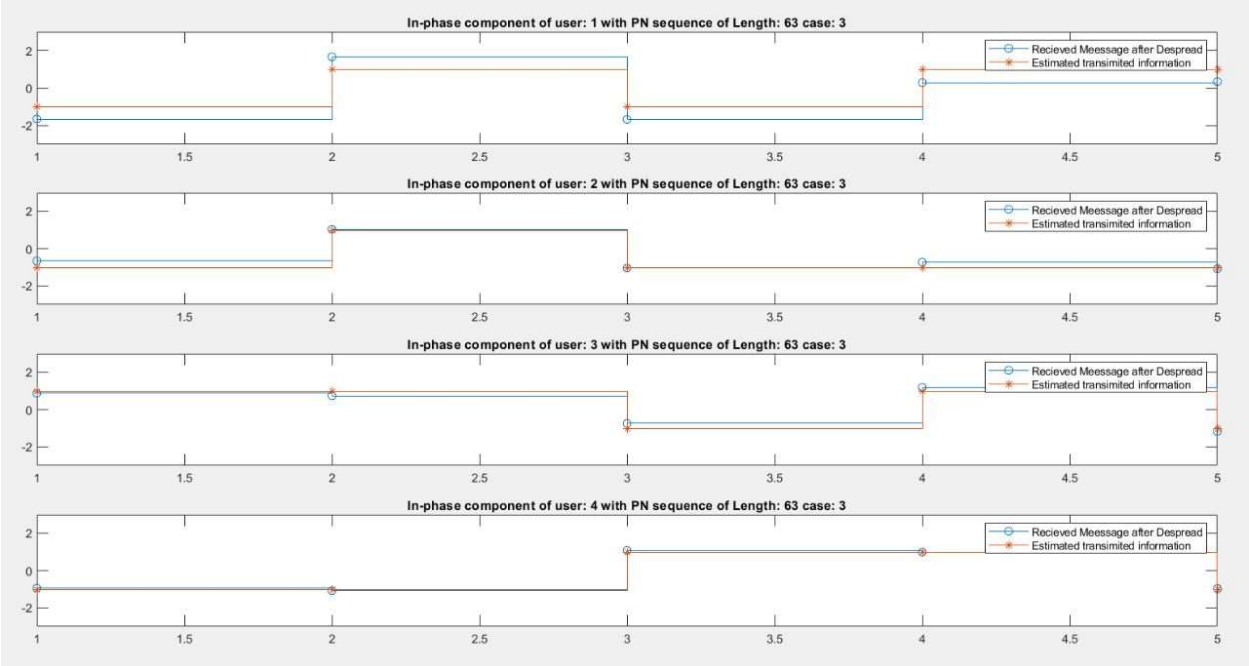
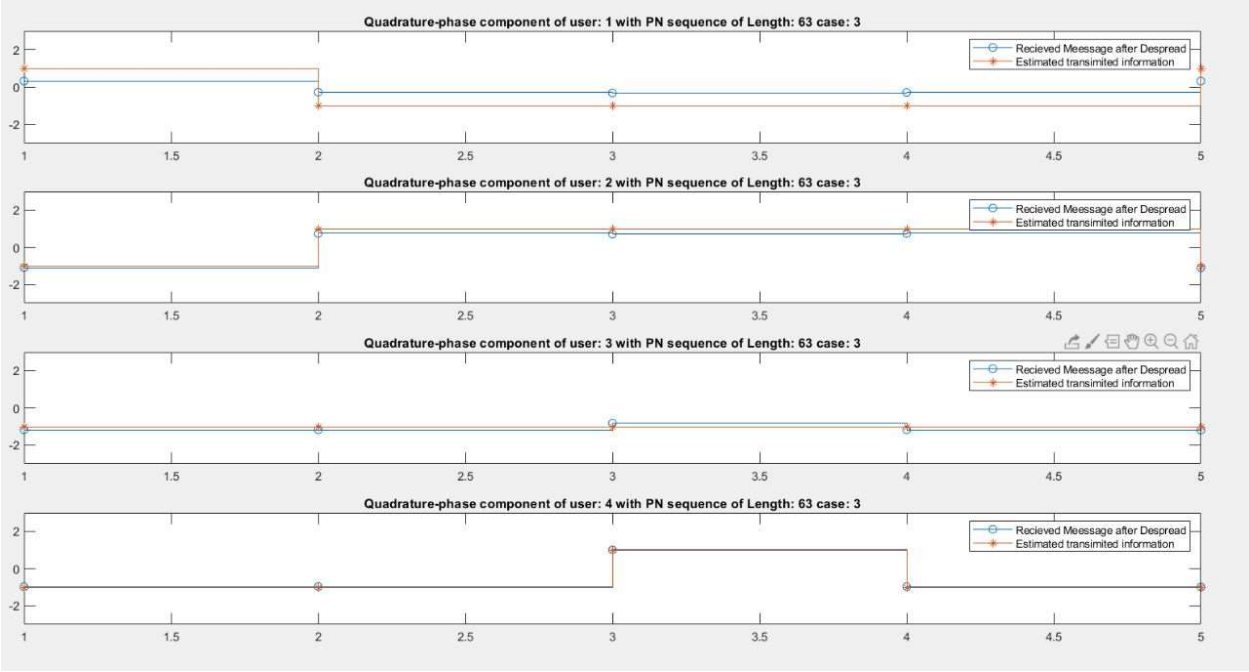


Figure 48: Estimated information quadrature component with PN sequence of length 63 3rd case

✓ Comparison between Received message after despreading and estimated transmitted information by plotting them on the same graph





Comment: As we increased the PN sequence and the impulse response is not ideal, there's no much errors or delay or multipath components compared to that at maximal length 7 or 15.

General Comments

- ✓ At Case 1: For all maximal length (7,15,63), no errors are found since the channel impulse response is [1] (i.e. ideal).
- ✓ At Case 2: some errors are found since the channel impulse response became [1 0.8 0.3 0.05] (i.e. Not ideal). Although that didn't happen at large maximal length (i.e. maximal length=63).
- ✓ At Case 3: some errors are found since the channel impulse response had an attenuation [1 0.8 0.3 0.05], [0.9 0.7 0.4 0.1], [1 0.2 0.01 0], [1 0.2 0.01 0] (i.e. Not ideal and the 0 in last 2 rows in last column is zero padding). Although that didn't happen at large maximal length (i.e. maximal length=63).
- ✓ Conclusion about the 3 cases that the best ideal case is of course case 1 then case 3 and the best non-ideal is case 2.
- ✓ At maximal length: As the maximal length increases, the probability that an error occurs decreases
- ✓ Errors are inversely proportional to 1/maximal length.
- ✓ As the PN sequences used are quasi orthogonal (shifted versions from each other) when we multiply them together, we get another shifted version from them C1xC2=C3.
- ✓ When we conv a signal with C which is a shifted version from the PN sequence used in spreading, we will have a little bit of interference not equal to zero but equals to 1/N even if the channel is ideal. So, as we increase N the error decreases
- ✓ The best case among all cases and maximal length (i.e. 9 results) is the case at maximal length equal 63 and impulse response equal 1.