

Ain Shams University

Faculty of Engineering

Electronics and Communication Department

ECE 451 – Communication Systems (2)

Fall 2021



Course Mini-Project
Implementation of a Digital Modulation
Group No.17 (256-PSK)

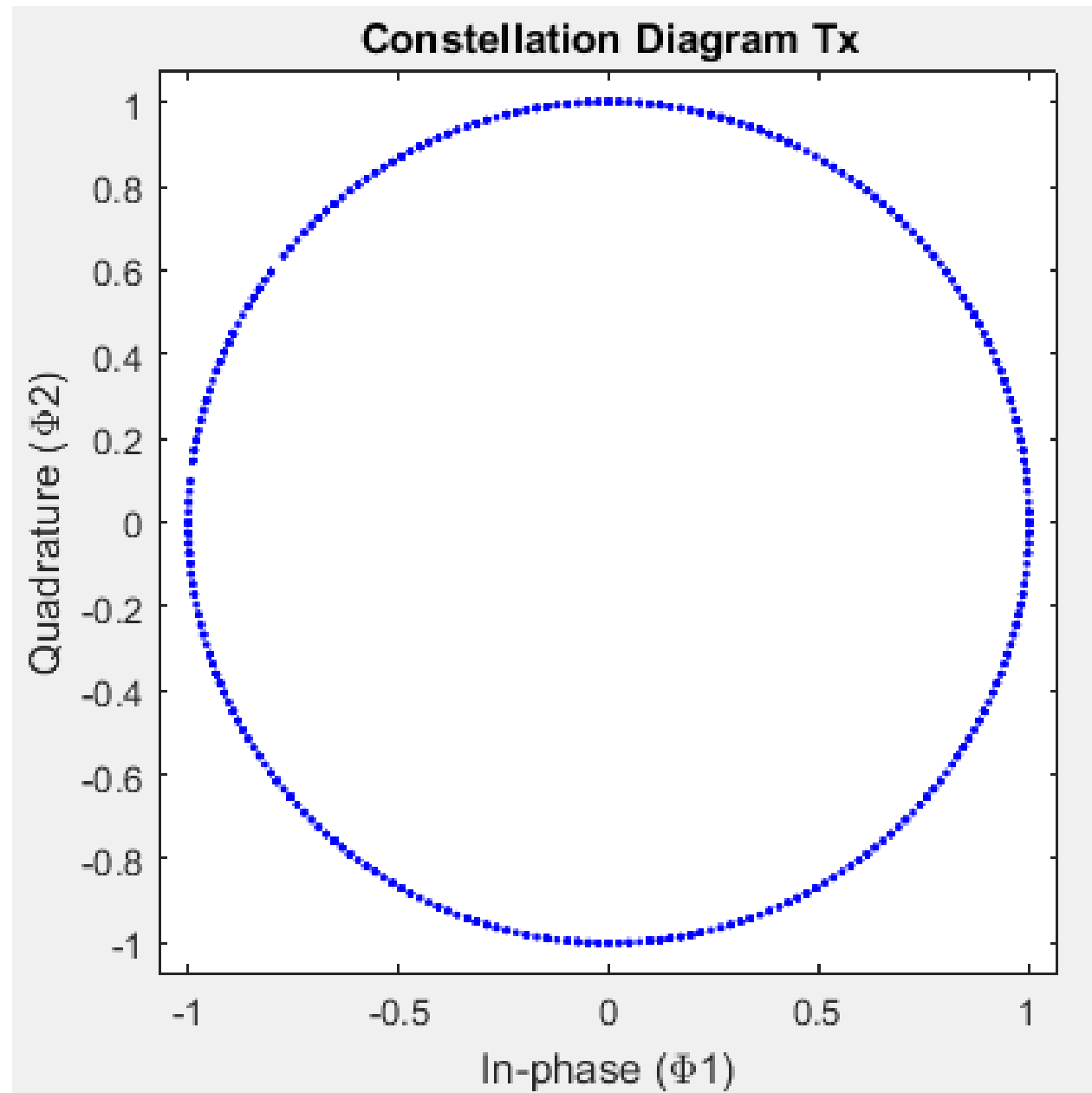
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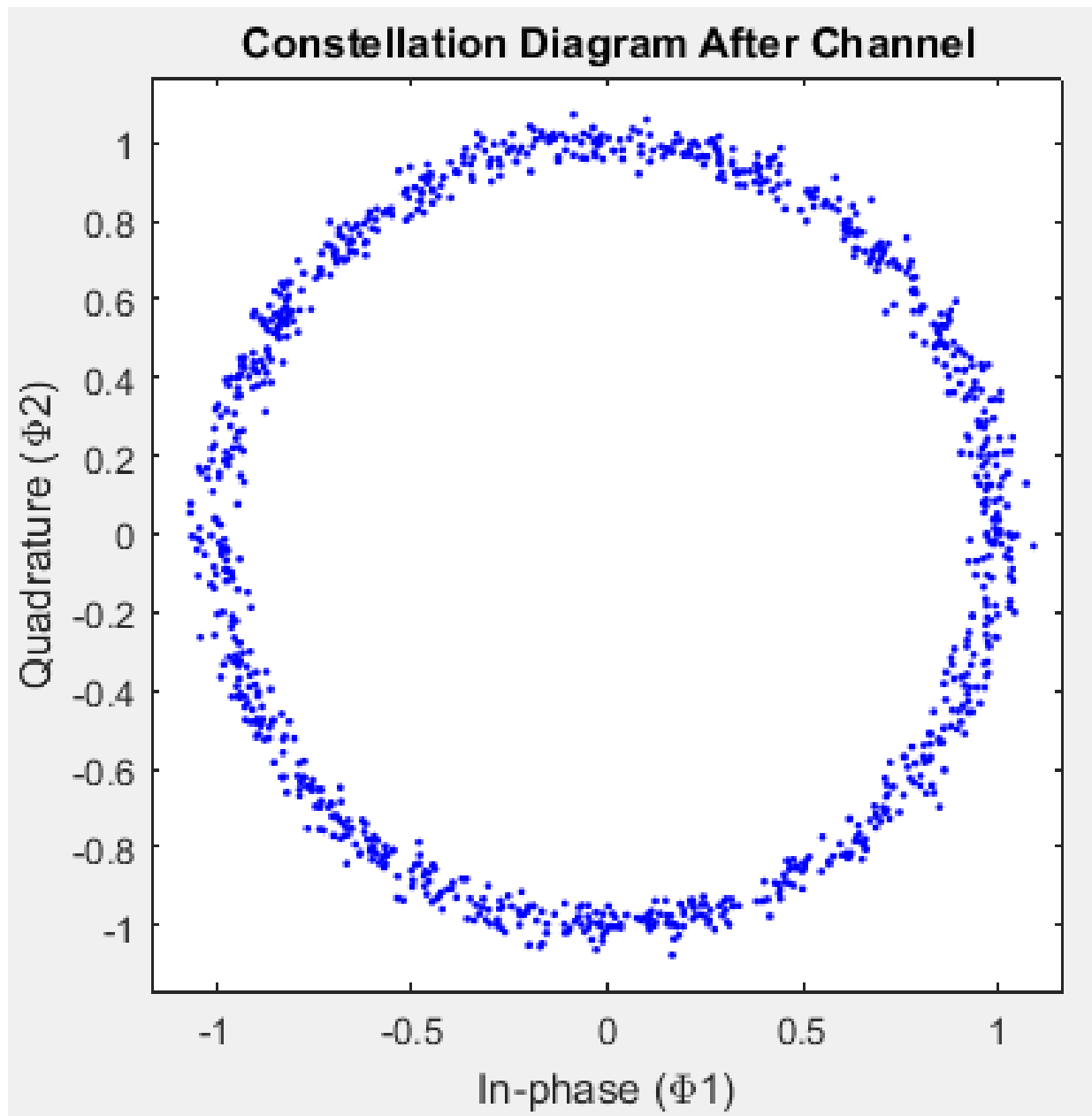
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1. Constellation diagram of the signals at the input

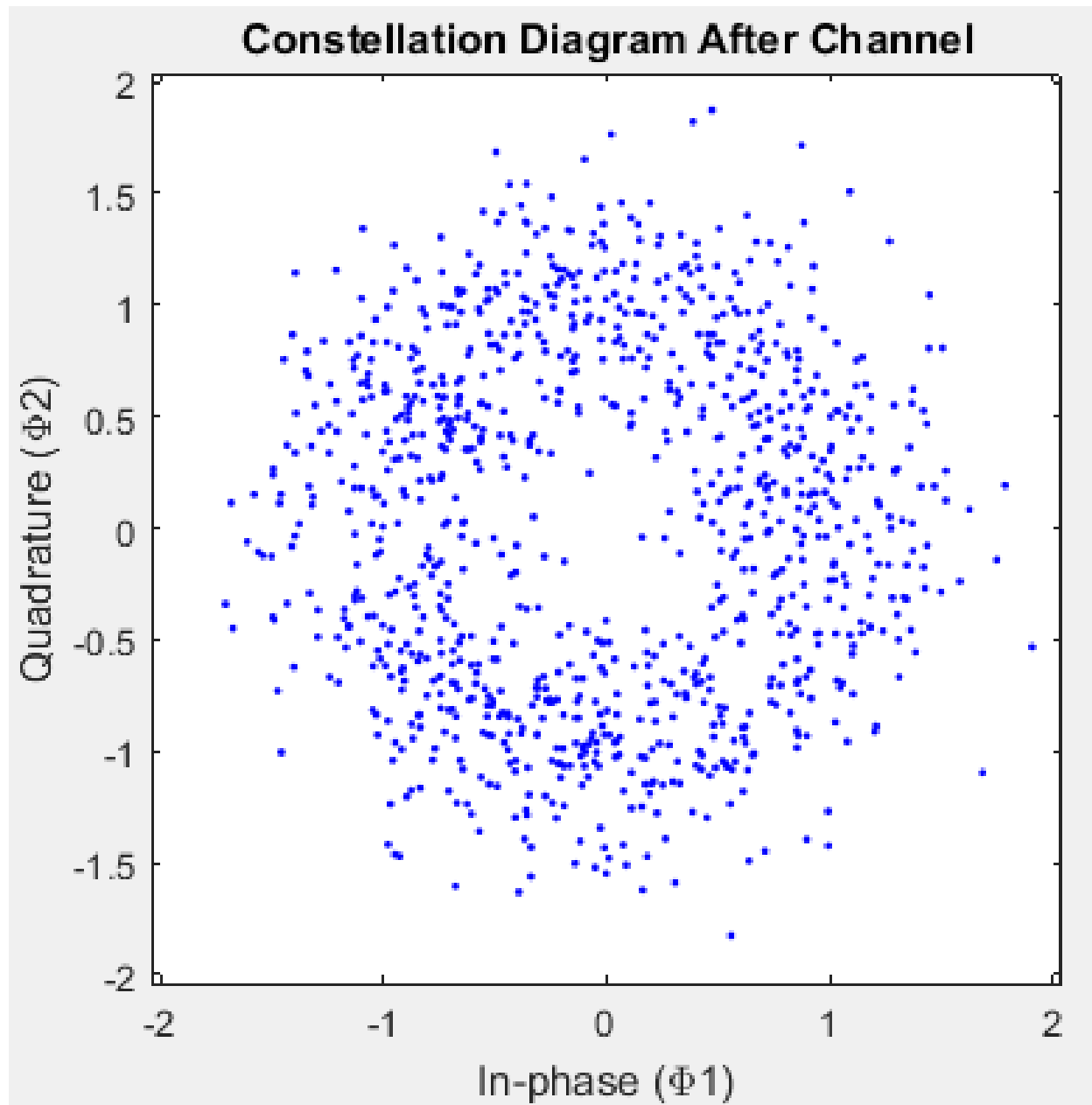


2. The Signal to Noise ratio (SNR) in dB takes the values {30, 10, 5, 0, -3 dB}.

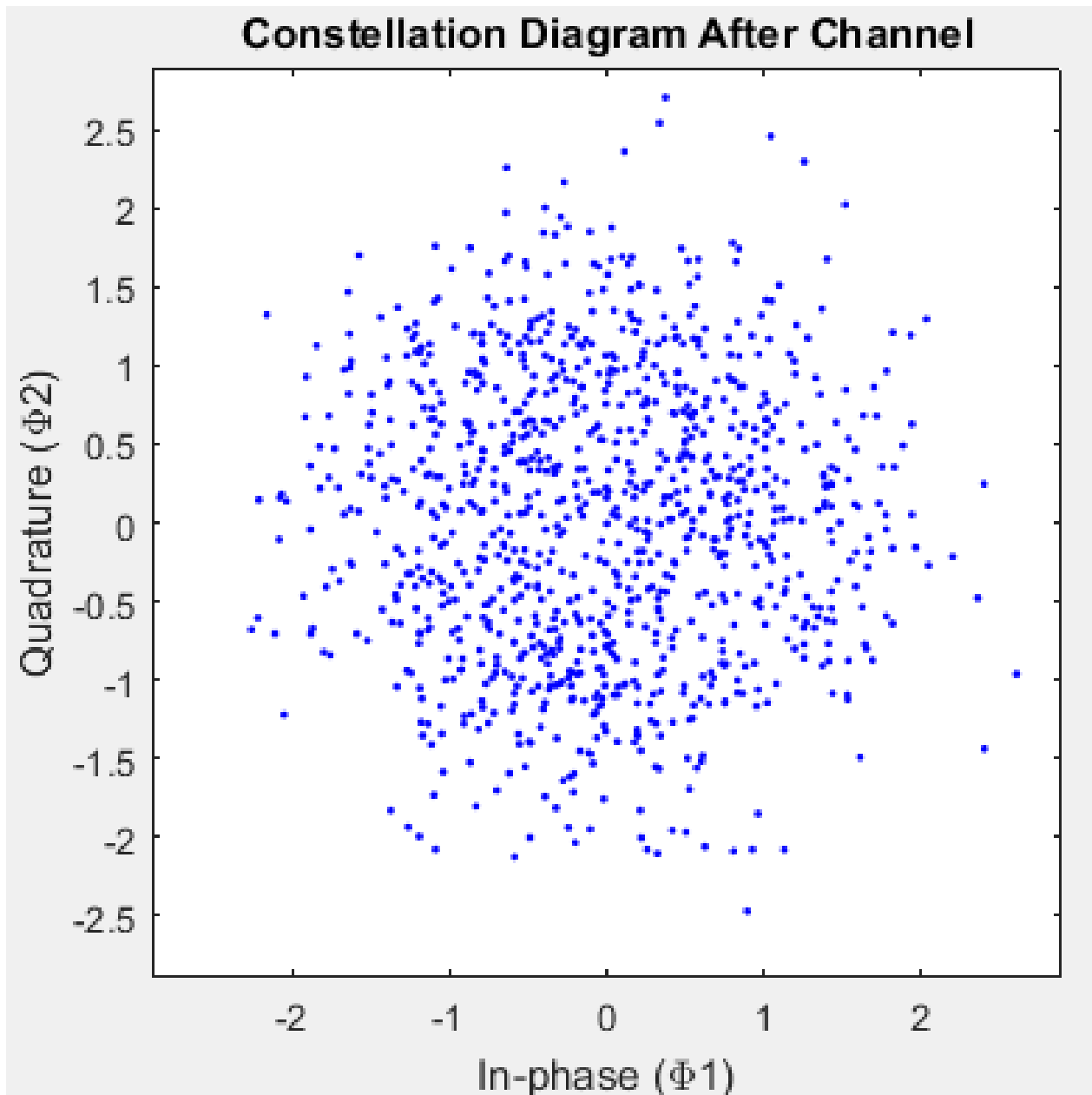
- at SNR=30 dB



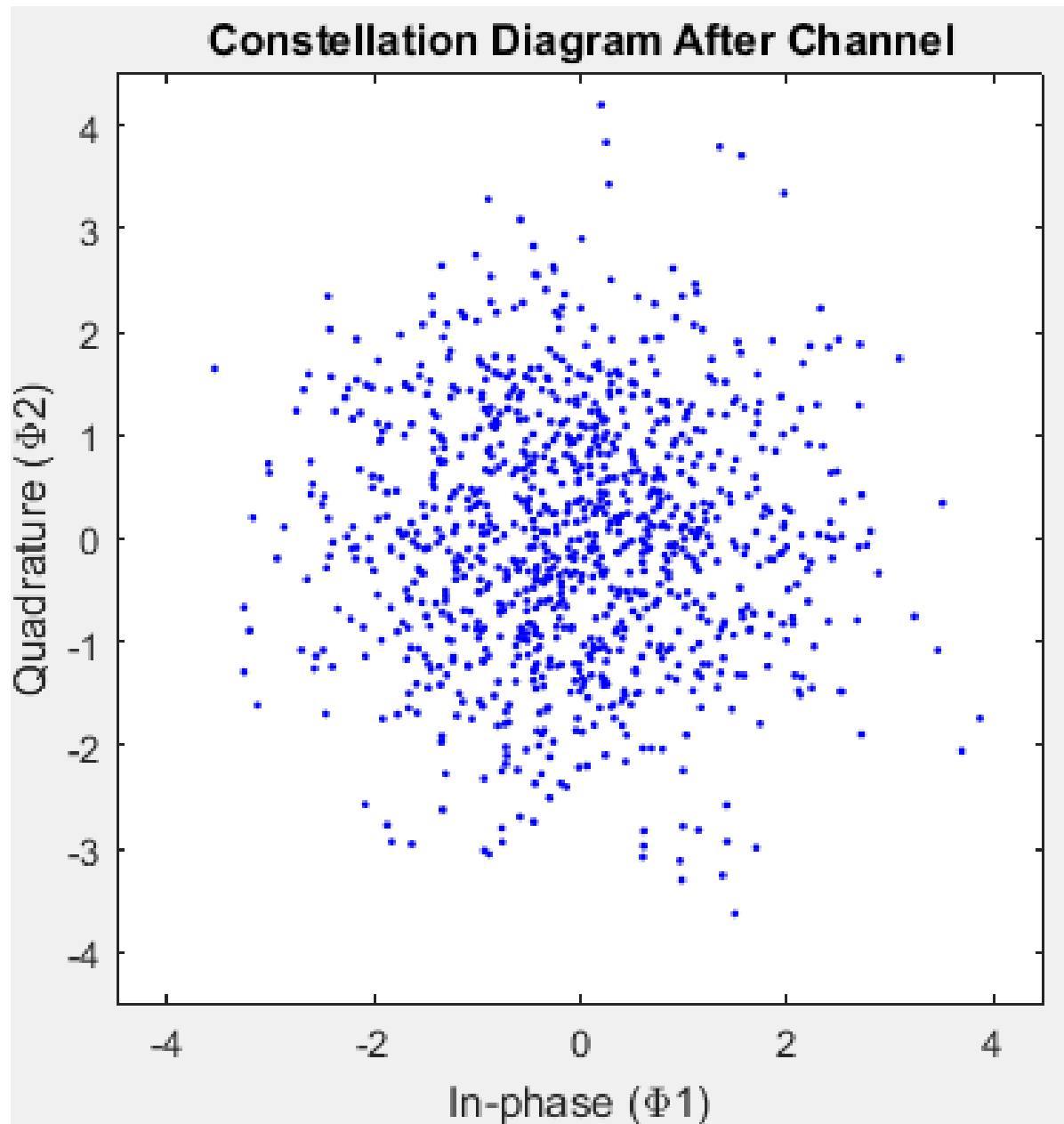
- at SNR=10 dB



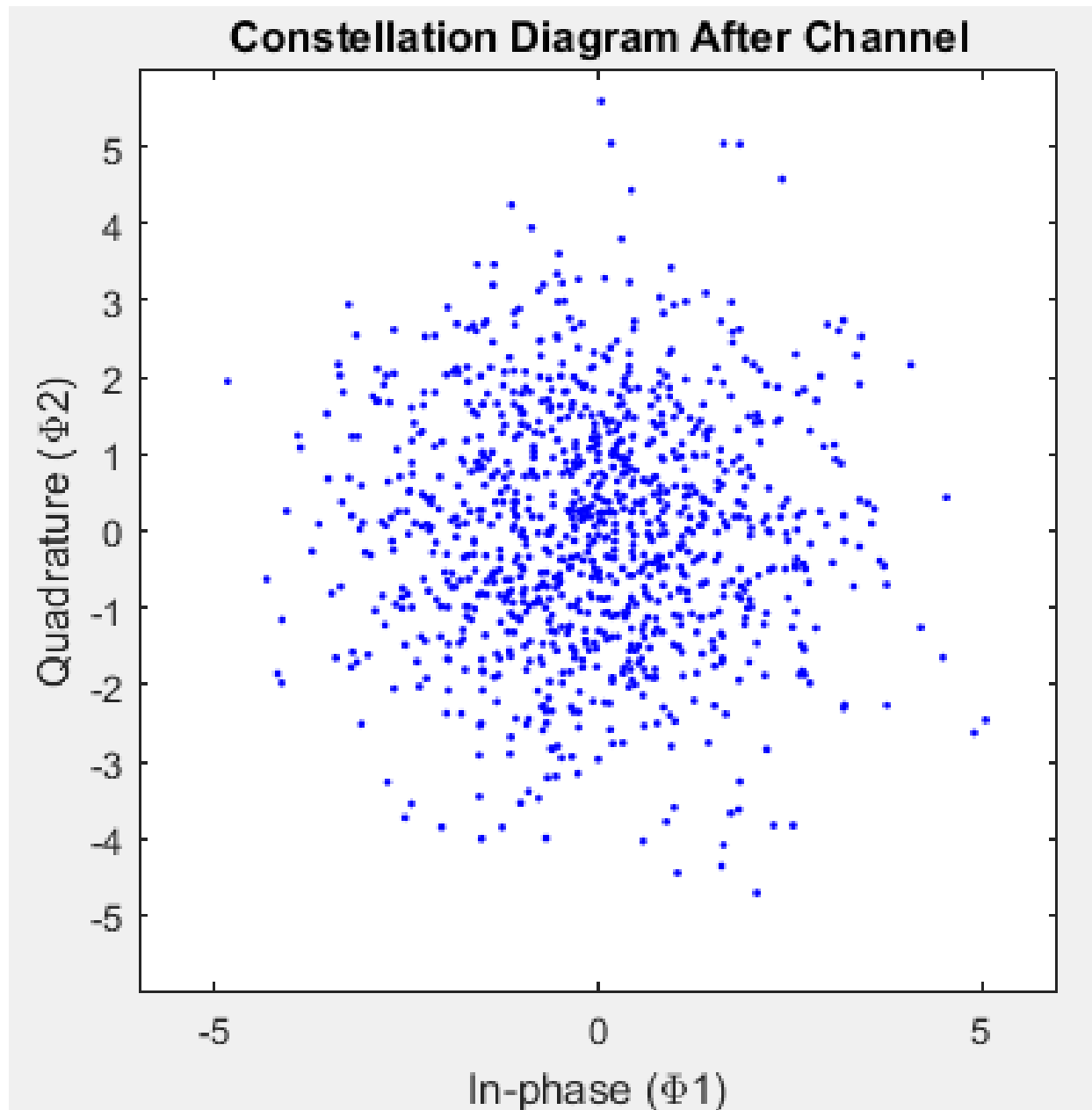
- at SNR=5 dB



- at SNR=0 dB



- at SNR=-3 dB



- Comment:

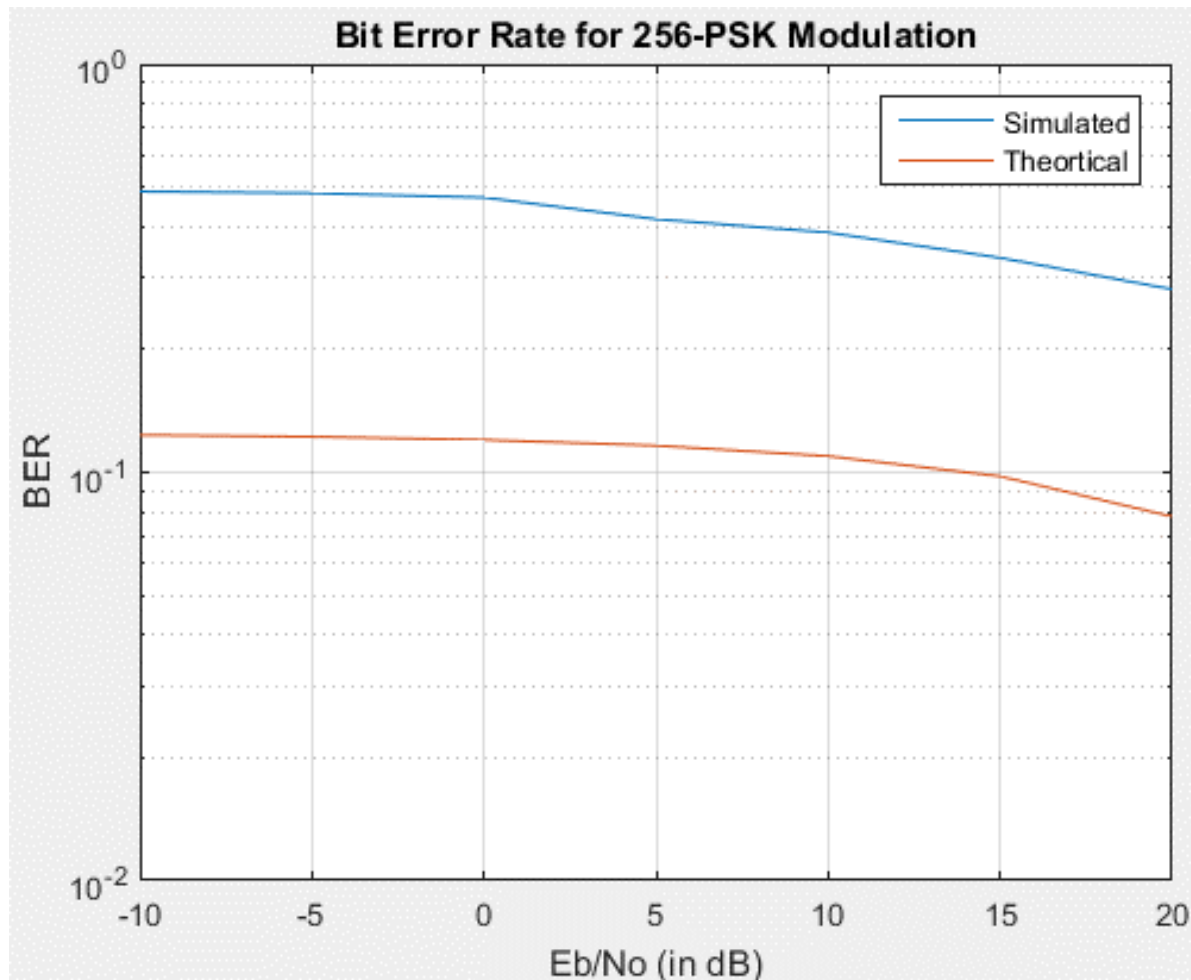
As SNR decreases signal is more affected by noise which make it difficult to be recovered as constellation diagram becomes ambiguous.

3. BER vs. Eb/No

- Theoretical formula:

$$P_{eb} = \frac{2}{\log_2 M} Q \left(\sqrt{\frac{\log_2(M) E_b}{N_0}} \sin \left(\frac{\pi}{M} \right) \right)$$

- Simulated and theoretical



- Comment:

BER which includes Q function is not accurate because it has some approximations, but the simulated BER curve is more accurate because it compares all error bits with total transmitted bits without any approximations.

4. Input stream of mapper vs output stream of de-mapper

- Without noise

At Mapper

	1	2	3	4	5	6	7	8
1	1	0	1	0	1	0	1	1
2	1	1	1	1	1	1	1	1
3	1	0	0	1	1	1	0	1
4	1	0	0	0	0	0	1	1
5	1	1	1	0	1	0	1	1
6	0	1	1	0	1	1	0	0
7	0	0	1	0	1	0	1	0
8	0	1	0	0	0	1	1	0
9	0	1	1	1	0	0	1	0
10	0	0	0	0	1	0	0	1
11	1	1	0	1	0	0	0	1
12	0	0	0	0	1	1	0	0
13	1	1	1	0	1	1	0	1
14	1	1	1	1	1	1	1	1
15	1	0	0	1	1	1	0	0
16	0	0	0	0	0	0	1	1
17	1	1	1	0	1	1	0	0
18	0	0	1	1	1	1	1	1
19	1	0	1	0	0	1	0	0
20	0	0	1	0	1	1	0	1
21	1	0	1	0	1	0	1	0
22	0	1	0	0	0	1	1	0
23	1	1	1	0	1	0	1	0
24	0	1	1	0	1	1	0	0

At De-mapper

	1	2	3	4	5	6	7	8
1	1	0	1	0	1	0	1	1
2	1	1	1	1	1	1	1	1
3	1	0	0	1	1	1	0	1
4	1	0	0	0	0	0	1	1
5	1	1	1	0	1	0	1	1
6	0	1	1	0	1	1	0	0
7	0	0	1	0	1	0	1	0
8	0	1	0	0	0	1	1	0
9	0	1	1	1	0	0	1	0
10	0	0	0	0	1	0	0	1
11	1	1	0	1	0	0	0	1
12	0	0	0	0	1	1	0	0
13	1	1	1	0	1	1	0	1
14	1	1	1	1	1	1	1	1
15	1	0	0	1	1	1	0	0
16	0	0	0	0	0	0	1	1
17	1	1	1	0	1	1	0	0
18	0	0	1	1	1	1	1	1
19	1	0	1	0	0	1	0	0
20	0	0	1	0	1	1	0	1
21	1	0	1	0	1	0	1	0
22	0	1	0	0	0	1	1	0
23	1	1	1	0	1	0	1	0
24	0	1	1	0	1	1	0	0

- With noise

At Mapper

	1	2	3	4	5	6	7	8
1	1	0	0	0	1	1	0	1
2	1	1	0	0	1	1	0	0
3	1	1	1	1	1	0	0	1
4	0	0	1	0	0	0	0	1
5	1	0	1	0	1	0	1	0
6	1	0	0	0	1	1	1	0
7	0	1	1	0	0	0	0	0
8	1	0	0	1	1	1	0	1
9	0	1	0	0	0	0	0	1
10	1	1	1	0	1	0	1	0
11	0	0	1	1	1	0	0	1
12	1	1	0	0	0	0	0	1
13	1	0	0	0	1	0	1	1
14	1	0	0	1	0	1	1	1
15	0	0	1	0	1	0	1	1
16	0	1	0	0	1	1	1	0
17	1	1	1	1	0	0	0	0
18	1	1	1	1	0	0	0	0
19	1	1	1	0	0	1	1	0
20	1	0	0	1	0	0	1	1
21	0	0	0	0	1	0	0	0
22	0	1	1	1	0	1	1	0
23	1	0	0	1	1	1	0	1
24	1	1	0	0	1	1	1	1

At De-mapper

	1	2	3	4	5	6	7	8
1	1	0	0	0	1	0	1	0
2	1	1	0	0	1	1	1	1
3	1	1	1	1	0	0	0	1
4	0	0	1	0	0	1	1	1
5	1	0	1	0	1	0	1	0
6	1	0	0	0	0	1	1	1
7	0	1	1	0	0	0	0	0
8	1	0	0	1	1	1	0	0
9	0	0	1	1	1	1	0	0
10	1	1	1	1	0	0	0	1
11	0	0	1	1	1	0	0	1
12	1	1	0	0	0	0	0	0
13	1	0	0	0	1	0	1	1
14	1	0	0	1	1	0	0	0
15	0	0	1	0	1	0	1	0
16	0	1	0	0	1	1	0	1
17	1	1	1	1	0	0	0	1
18	1	1	1	1	0	1	1	0
19	1	1	1	0	0	0	1	1
20	1	0	0	1	0	1	0	1
21	0	0	0	0	1	1	0	0
22	0	1	1	1	0	1	1	1
23	1	0	1	0	0	0	0	0
24	1	1	0	0	1	0	1	1