

# Part-2 Coursework EE303: Communication Systems

## "DS/QPSK Spread Spectrum Systems"

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### 1 Aims

- The main objective of this assignment-study is to design and analyse the performance of a QPSK Digital Communication System which is then extended to a Direct-Sequence QPSK Spread Spectrum Communication System operating in the presence of a Jammer.

### 2 Equipment and Software

- PC (operating system XP, Vista or Windows 7) or Mac
- MATLAB, Visual C++ or any other suitable language.
- One text file of 300 characters (including spaces) representing the "desired" message for transmission.
- One text file of 300 character (including spaces) representing one co-channel interfering message (jammer).

### 3 Tasks

- With reference to Figure-1 a message of 300 characters is applied at point A2 of a Digital Communication System (this is the "desired" message).
- The system involves a QPSK modulator with its constellation diagram shown in Figure-2.
- The transmitted signal is corrupted by additive (complex) white Gaussian channel noise and a jamming signal.
  1. Demodulate the received signal and get the message at point  $\hat{A}_2$  (see Figure-1) and
  2. plot on the constellation diagram the receiver's decision variables

under the following conditions (defining 7 different Tasks)

**Task 1:** Absence of both noise and jammer [5%]

**Task 2:** For  $\text{SNR}_{in} = 30\text{dB}$  at point  $\hat{T}$  and absence of jammer [5%]

**Task 3:** For  $\text{SNR}_{in} = 20\text{dB}$  at point  $\hat{T}$  and absence of jammer [5%]

**Task 4:** For  $\text{SNR}_{in} = 0\text{dB}$  at point  $\hat{T}$  and absence of jammer [5%]

**Task 5:** For the Tasks 2, 3 and 4, at point  $\hat{B}$ , what is:

- the total number of bits in error? [6%]
- the bit error probability? [6%]
- the theoretical bit error probability? [18%]

**Task 6:**

- For a  $\text{SNR}_{in} = 30\text{dB}$  at the receiver's input ("desired" signal). In this task the jammer transmits a jamming message of 300 characters, at the same time, on the same frequency band with a power 10dB above the desired signal power . [10%]

**Task 7:**

- The system of Figure 1 is extended to the spread spectrum communication system shown in Figure 3 and the jammer operates as a "broadband" jammer. With reference to Task 6, the desired PN code and the PN-code employed by the jammers are gold sequences generated using two primitive polynomials as shown below: [40%]

	1st polynomial (m-sequence)	2nd polynomial (m-sequence)
desired:	$D^5 + D^2 + 1$	$D^5 + D^3 + D^2 + D + 1$
Jammer:	$D^5 + D^3 + 1$	$D^5 + D^4 + D^2 + D^1 + 1$

- Please note that the 2nd m-sequence is delayed by  $k$ -bits and added (modulo-2) to the 1st m-sequence, where  $k$  is the smallest integer that:
  - gives a "balanced" gold sequence and
  - satisfies the inequality:

$$k \geq (\text{alphabetical order of the 1st letter of your surname} + \text{alphabetical order of the 1st letter of your formal firstname}) \bmod 31 \quad (1)$$

## 4 Main Assumptions

- The system is fully synchronised
- There are no multipaths
- The path coefficient ( $\beta$ ) is assumed equal to 1
- The angle  $\phi$  (see Figure-2) is given, in degrees, according to the following expression

$$\phi \triangleq (\text{alphabetical order of the 1st letter of your surname}) \\ + 2 \times (\text{alphabetical order of the 1st letter of your formal firstname}) \quad (2)$$

- The pn-codes are generated by setting the initial state of the shift register be all ones

## 5 Deliverable

- MATLAB/C file(s) - with brief comments.
- A "pdf" document with the results of the above seven tasks supported by 2-5 lines of some brief comments per task.
- A user interface is useful but not essential.
- Please upload a zip file (including all the files) named by your login name (eg. kl209.zip).

## 6 Deadline

- 5.30pm, 29th Dec 2017.

## 7 References

- Lecture Notes on Communication Systems
- your own references.

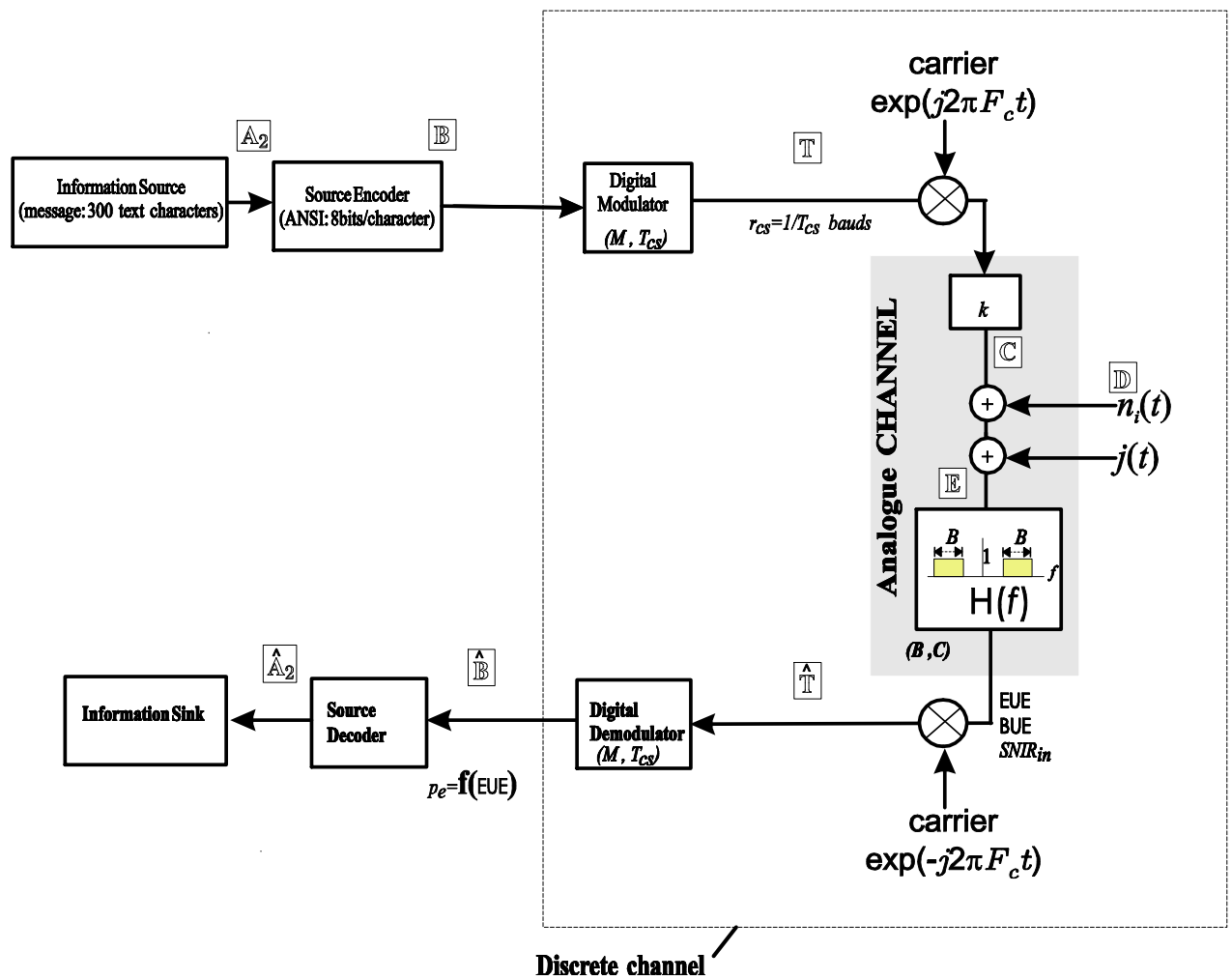


Figure 1: A Conventional Digital Communication System Operating in the Presence of a Jammer.

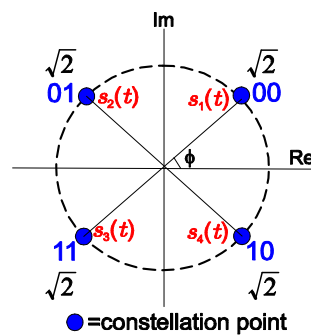


Figure 2: QPSK constellation diagram.

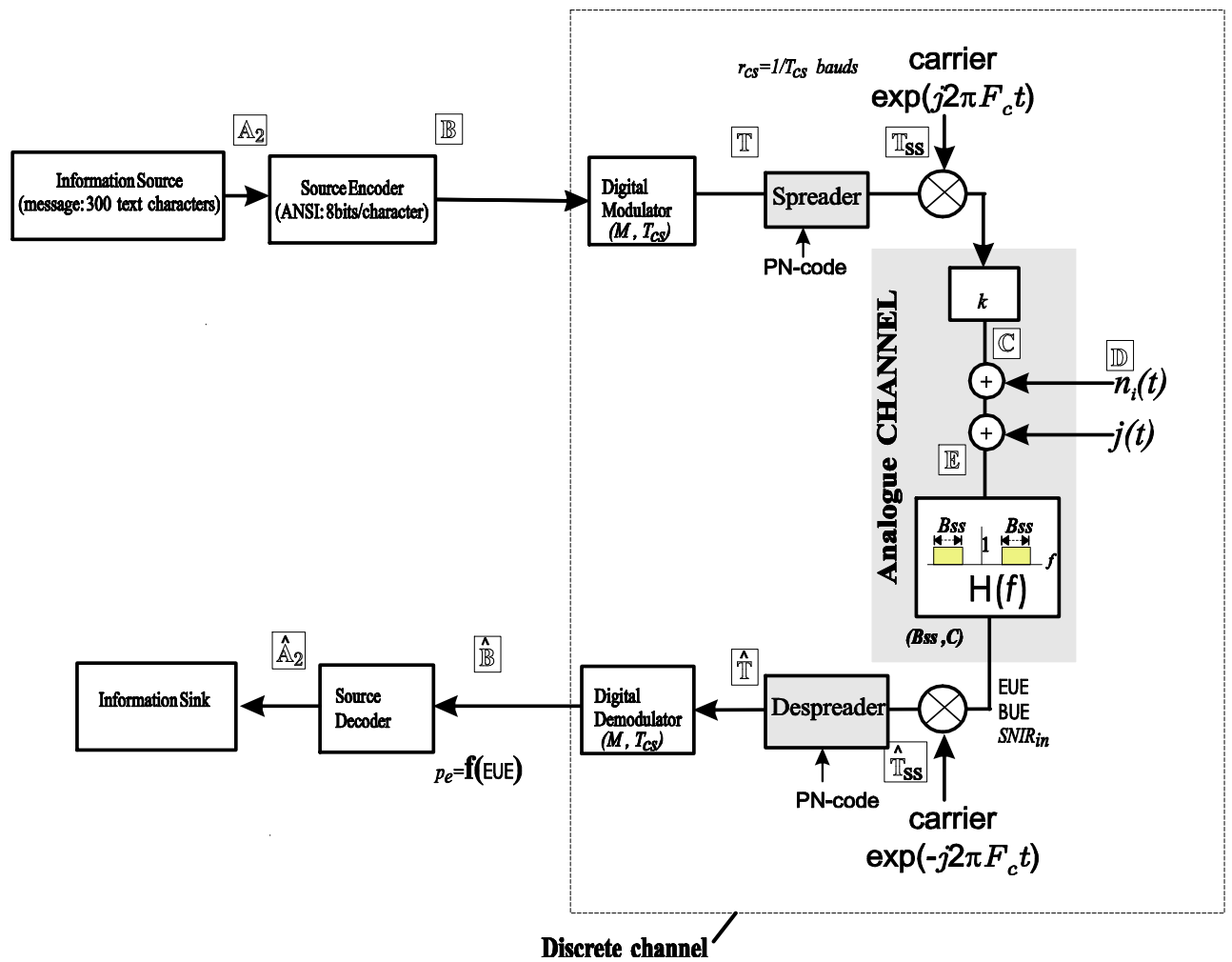


Figure 3: A Spread Spectrum Communication System Operating in the Presence of a Jammer.