Spread Spectrum Modulation

- The definition of spread spectrum may be stated in two parts:

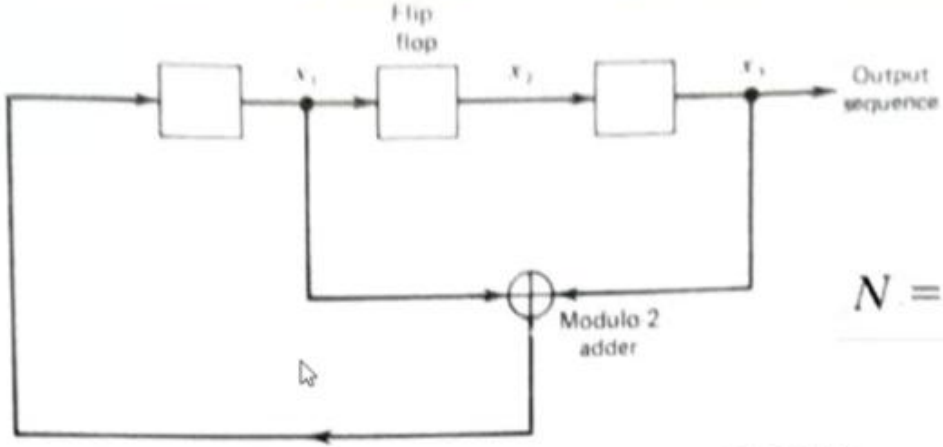
- 1. Spread spectrum is a means of transmission in which the data of interest occupies a bandwidth in excess of the minimum bandwidth necessary to send the data.
- 2. The spectrum spreading is accomplished before transmission through the use of a code that is independent of the data sequence. The same code is used in the receiver (operating in synchronism with the transmitter) to despread the received signal so that the original data may be recovered.

Although standard modulation techniques such as frequency modulation and pulse-code modulation do satisfy Part 1 of this definition, they are not spread spectrum techniques because they do not satisfy Part 2 of the definition.

Pseudo noise sequences

- A pseudo-noise (PN) sequence is defined as a coded sequence of 1's and 0's with certain autocorrelation properties.
- The class of sequences used in spread-spectrum communications is usually periodic in that a sequence of 1's and 0's repeats itself exactly with a known period.
- The maximum-length sequence, a type of cyclic code, represents a commonly used periodic PN sequence.. Such sequences have long periods and require simple instrumentation in the form of a linear feedback shift register. Indeed, they possess the longest possible period for this method of generation.

Maximum length sequence generator



$$N = 2^m - 1$$

Figure 9.1 Maximum-length sequence generator.

Consider the three-stage feedback shift register shown in Fig. 9.1. It is assumed that the initial state of the shift register is 100 (reading the contents of the three flip-flops from left to right). Then, the succession of states will be as follows:

100, 110, 111, 011, 101, 010, 001, 100, ...

The output sequence (the last position of each state of the shift register) is therefore

0011101

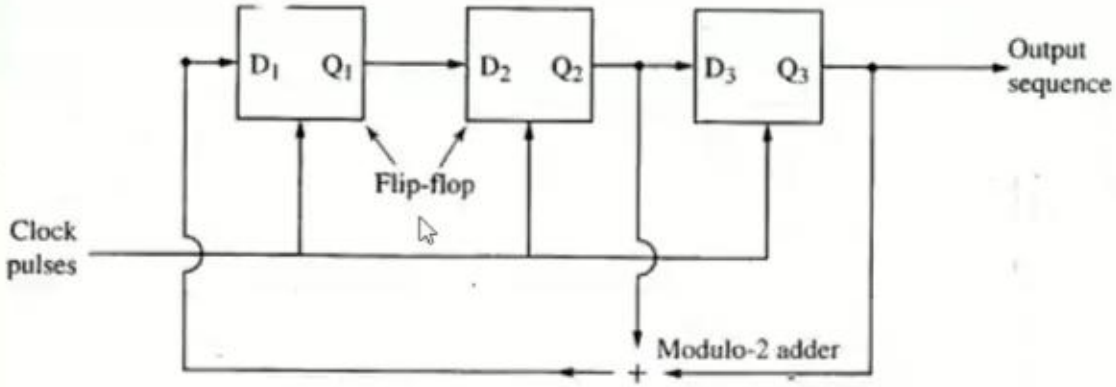


Fig ①: 3 stage maximum length sequence generator.

Clock pulse	Present state (Q_1, Q_2, Q_3)	Next state $(Q_2 \oplus Q_3, Q_1,$
(Initial)	(1,1,0)	(1,1,1)
1	(1,1,1)	(0,1,1)
2	(0,1,1)	(0,0,1)
3	(0,0,1)	(1,0,0)
4	(1,0,0)	(0,1,0)
5	(0,1,0)	(1,0,1)
6	(1,0,1)	(1,1,0)
7	(1,1,0)	(1,1,1)

DP9.5. Figure DP9.5 shows a 4-stage linear feedback shift register. If the initial state is 1111, find the output sequence of the shift register.

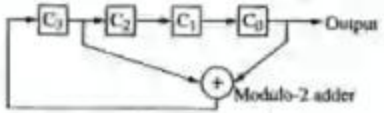


Figure DP9.5