CHAPTER 4 : Digital Transmission

Solutions to Review Questions

Review Questions

1. In ***parallel transmission*** we send data *several* bits at a time. In ***serial transmission*** we send data *one* bit at a time.

2. We mentioned ***synchronous***, ***asynchronous***, and ***isochronous***. In both synchronous and asynchronous transmissions, a bit stream is divided into independent frames. In synchronous transmission, the bytes inside each frame are synchronized; in asynchronous transmission, the bytes inside each frame are also independent. In isochronous transmission, there is no independency at all. All bits in the whole stream must be synchronized.

3. A ***data element*** is the smallest entity that can represent a piece of information (a bit). A ***signal element*** is the shortest unit of a digital signal. Data elements are what we need to send; signal elements are what we can send. Data elements are being carried; signal elements are the carriers.

4. Both ***PCM*** and ***DM*** use sampling to convert an analog signal to a digital signal. PCM finds the value of the signal amplitude for each sample; DM finds the change between two consecutive samples.

5. In decoding a digital signal, the incoming signal power is evaluated against the ***baseline*** (a running average of the received signal power). A long string of 0s or 1s can cause ***baseline wandering*** (a drift in the baseline) and make it difficult for the receiver to decode correctly.

6. ***Block coding*** provides redundancy to ensure synchronization and to provide inherent error detecting. In general, block coding changes a block of m bits into a block of n bits, where n is larger than m.

7. The ***data rate*** defines the number of data elements (bits) sent in 1s. The unit is bits per second (bps). The ***signal rate*** is the number of signal elements sent in 1s. The unit is the baud.

8. When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies, called ***DC components***, that present problems for a system that cannot pass low frequencies.

9. ***Scrambling,*** as discussed in this chapter, is a technique that substitutes long zerolevel pulses with a combination of other levels without increasing the number of bits.

10. The three different techniques described in this chapter are ***line coding***, ***block coding***, and ***scrambling***.

11. In this chapter, we introduced ***unipolar***, ***polar***, ***bipolar***, ***multilevel***, and ***multitransition*** coding.

12. A ***self-synchronizing*** digital signal includes timing information in the data being transmitted. This can be achieved if there are transitions in the signal that alert the receiver to the beginning, middle, or end of the pulse.

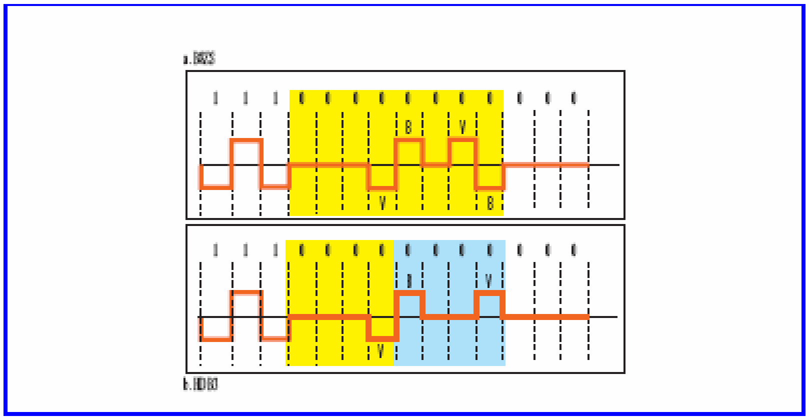
Exercises

13. The data stream can be found as
    a. NRZ-I: **10011001**.
    b. Differential Manchester: **11000100**.
    c. AMI: **01110001**.

    19. The data rate is 100 Kbps. For each case, we first need to calculate the value f / N.
        We then use Figure 4.6 in the text to find P (energy per Hz). All calculations are approximations.
        a. f /N = 0/100 = 0 →___ **P = 1.0**
        b. f /N = 50/100 = ½ →___ **P = 0.5**
        c. f /N = 100/100 = 1 →___ **P = 0.0**
            a. f /N = 0/100 = 0 →___ **P = 0.0**
            b. f /N = 50/100 = ½ →___ **P = 0.3**
            c. f /N = 100/100 = 1 →___ **P = 0.4**
            d. f /N = 150/100 = 1.5 →___ **P = 0.0**

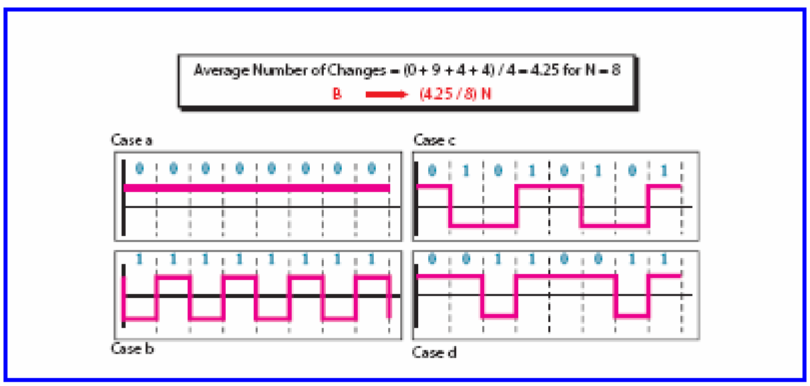
    20. See Figure 4.7. Since we specified that the last non-zero signal is positive, the first bit in our sequence is positive.

Figure 4.7 *Solution to Exercise 26*



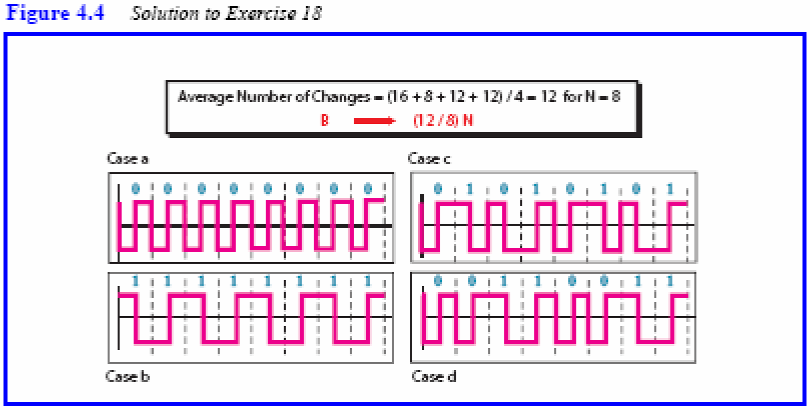
22. See Figure 4.2. Bandwidth is proportional to **(4.25/8)N** which is within the range in Table 4.1 (B = 0 to N) for the NRZ-I scheme.

Figure 4.2 *Solution to Exercise 16*



23. See Figure 4.4. B is proportional to **(12/8) N** which is within the range in Table 4.1
(B = N to 2N) for the differential Manchester scheme.

Figure 4.4 *Solution to Exercise 18*



27. We use the formula **s = c × N × (1/r)** for each case. We let c = ½.

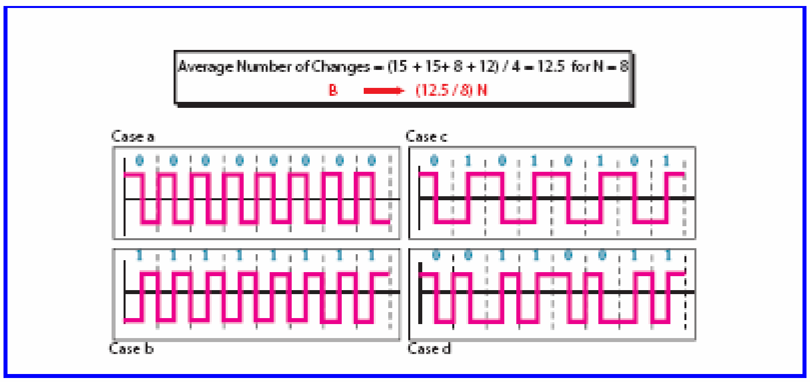
a. r = 1 → s = (1/2) × (1 Mbps) × 1/**1** = **500 kbaud**

b. r = ½ → ___ s = (1/2) × (1 Mbps) × 1/(**1/2**) = **1 Mbaud**
c. r = 2 → ___ s = (1/2) × (1 Mbps) × ½ = **250 Kbaud**
d. r = 4/3 → ___ s = (1/2) × (1 Mbps) × 1/(**4/3**) = **375 Kbaud**

25. In 5B/6B, we have 2^5 = 32 data sequences and 2^6 = 64 code sequences. The number of unused code sequences is 64 − 32 = **32**. In 3B/4B, we have 2^3 = 8 data sequences and 2^4 = 16 code sequences. The number of unused code sequences is 16 − 8 = **8**.

26. See Figure 4.3. Bandwidth is proportional to **(12.5 / 8) N** which is within the range in Table 4.1 (B = N to B = 2N) for the Manchester scheme.

Figure 4.3 *Solution to Exercise 17*



27.

We use the formula **s = c × N × (1/r)** for each case. We let c = 1/2.

a. r = 1 → s = (1/2) × (1 Mbps) × 1/**1** = **500 kbaud**
b. r = 1/2 → s = (1/2) × (1 Mbps) × 1/(**1/2**) = **1 Mbaud**
c. r = 2 → s = (1/2) × (1 Mbps) × 1/**2** = **250 Kbaud**
d. r = 4/3 → s = (1/2) × (1 Mbps) × 1/(**4/3**) = **375 Kbaud**