Problem 6.21

To overcome the error-propagation problem experienced in Problem 6.20, we use precoding before the duobinary coding, as shown in Fig. 6.14. The precoder is defined by

$$d_k = b_k \oplus d_{k-1} \tag{1}$$

where the symbol $\oplus$ denotes modulo-two addition (i.e., EXCLUSIVE OR) According to Eq. (1), we have

$$d_k = \begin{cases} \text{symbol 1} & \text{if either } b_k \text{ or } d_{k-1} \text{ is 1} \\ \text{symbol 0} & \text{otherwise} \end{cases}$$

As before, the pulse-amplitude modulator output is therefore defined by $a_k = \underline{+}1$. Applying this sequence to the duobinary conversion filter, we get

$$c_k = a_k + a_{k-1} \tag{2}$$

Note that unlike the linear operation of duobinary coding of Eq. (2), the precoding of Eq. (1) is nonlinear.

The combined use of Eqs. (1) and (2) yields

$$c_k = \begin{cases} 0 \text{ if the original data symbol } b_k \text{ is 1} \\ \pm 2 \text{ if } b_k \text{ is 0} \end{cases} \tag{3}$$

From Eq. (3), we therefore deduce the following decision rule for detecting the original data sequence b_k from c_k, as follows:

If $|c_k| < 1$, say symbol b_k is 1

If $|c_k| > 1$, say symbol b_k is 0 (4)

which can be realized by using a rectifier followed by a threshold device.

The solutions to parts (a), (b) and (c) of the problem in response to the input sequence 0010110 are presented in Table 1.

Table 1: Illustrating Example 3 on Duobinary Coding

Binary sequence $\{b_k\}$		0	0	1	0	1	1	0
Precoded sequence $\{d_k\}$	1	1	1	0	0	1	0	0
Two-level sequence $\{a_k\}$	+1	+1	+2	-1	-1	+1	-1	-1
Duobinary coder output $\{c_k\}$		+2	+2	0	-2	0	0	-2
Binary sequence obtained by applying decision rule of Eq. (7.76)		0	0	1	0	1	1	0