
بسم الله الرحمن الرحيم

Ministry of Higher Education and Scientific Research
Foundation of Technical Education
Technical College / Al-Najaf

Training package in
PCM, DM, and DPCM system
For students of second class

Lecturer
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1 / A –Ta

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1 / B –Rationale :-

PCM is not only quantize the sample analog signal into a number of discrete levels but also use a code to designate each level at each sample time.

Differential PCM (DPCM) is used for possible bandwidth savings; delta modulation (DM) uses simpler circuitry to send and received coded transmissions.

1 / C –Central Idea :-

1) PCM, DM, and DPCM signals
2) Generation and detection PCM, DM, and DPCM signals

1 / D –Objectives:-

- Define quantization
- Define PCM, DM, and DPCM signals
- Describe the PCM process
- Describe the DM process
- Describe the DPCM process

2/ Pre test :-

Multiple Choice Questions With Answer

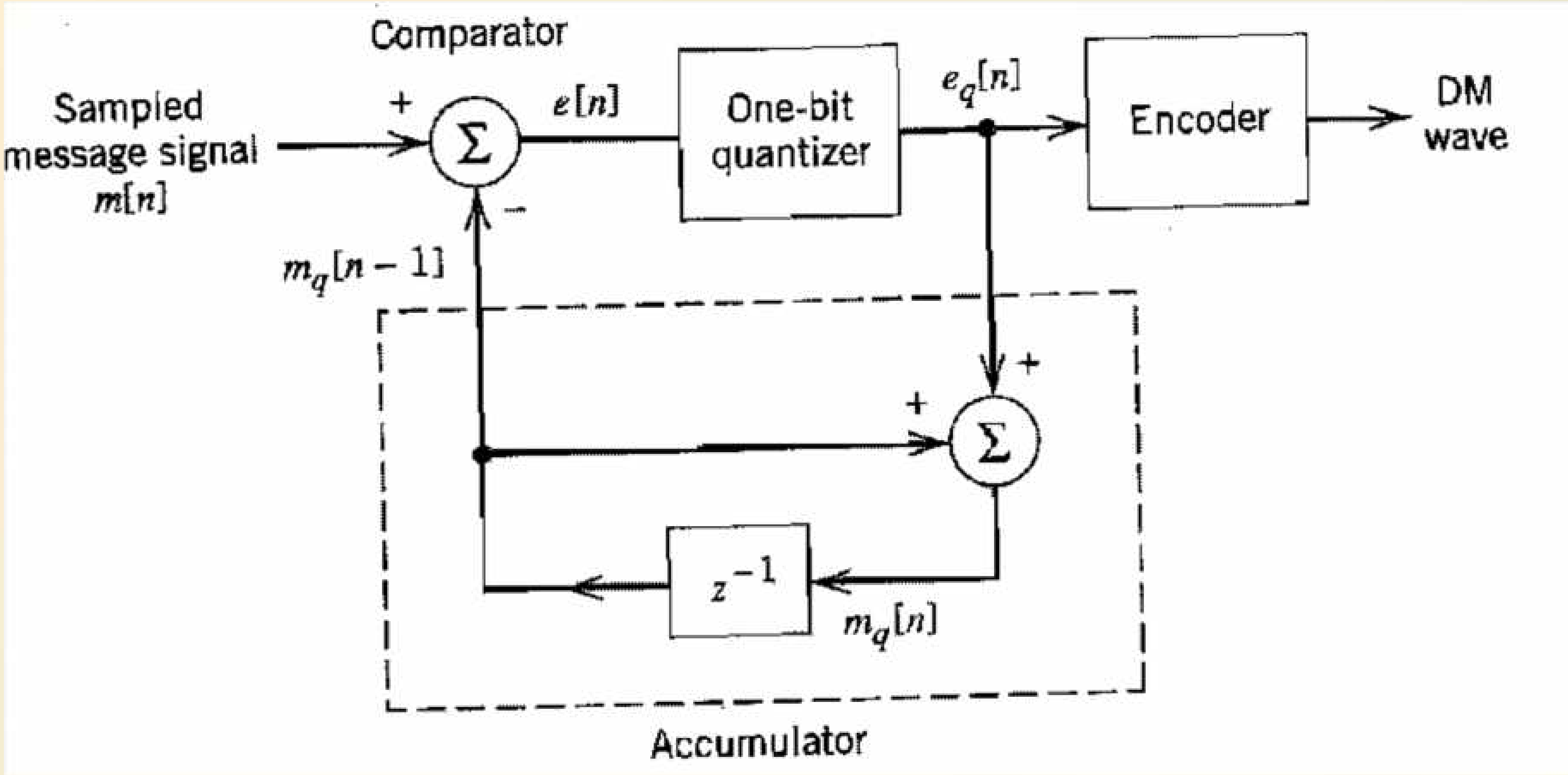
1.Indicate which of the following system is digital ١

(a) PPM (b) PWM (c) PDM (d) PCM

2. A ………system is used with only a one-bit output, that bit being used for the sign of the sample difference. ٢

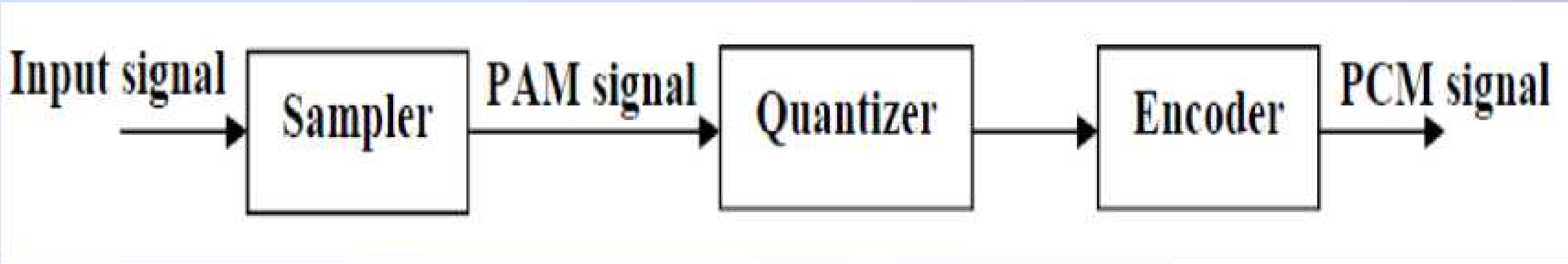
(a) PCM (b) DPCM (c) DM

3. Draw the block diagram of a delta-modulation transmitter .



3/ Performance Objectives :-

Pulse code modulation (PCM) is the name given to the class of baseband signals obtained from the quantized PAM signals by encoding each quantized sample into a digital word.



The source of information is sampled and quantized to one of L levels, then each quantized sample is digitally encoded into a k-bits code word.
Where ,
k=log2 L
L = 2k

The essential features of binary PCM are shown in figure below. Assume that an analog signal, x(t), is limited in its excursions to the range (-4V to +4V). The step size between quantization levels has beenset at 1V. Thus eight quantization level are employed, these located at
-3.5V, -2.5V, ………., +3.5V.

The code number 0 may be assigned to the level at -3.5V; the code number 1 may be assigned to the level at -2.5V, and so on until the level at 3.5V, which is assigned the code number 7.

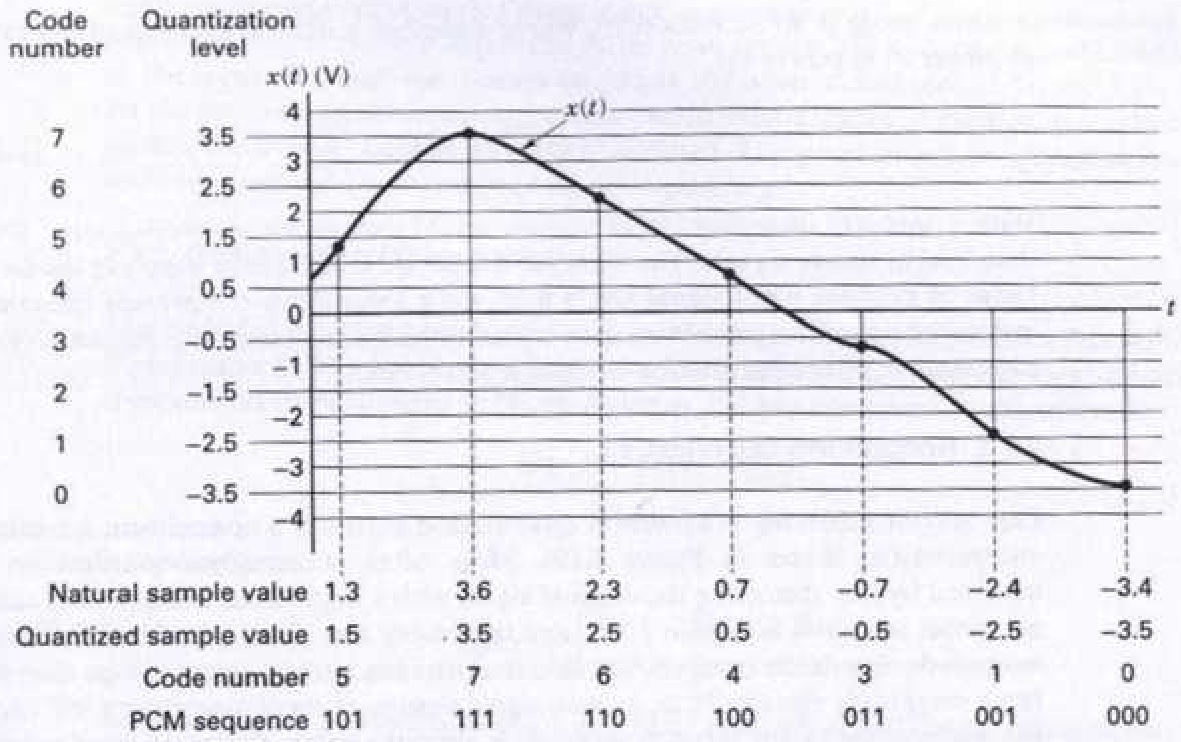


Figure 2.16 Natural samples, quantized samples, and pulse code modulation. (Reprinted with permission from Taub and Schilling, *Principles of Communications Systems*, McGraw-Hill Book Company, New York, 1971, Fig. 6.5-1, p. 205.)

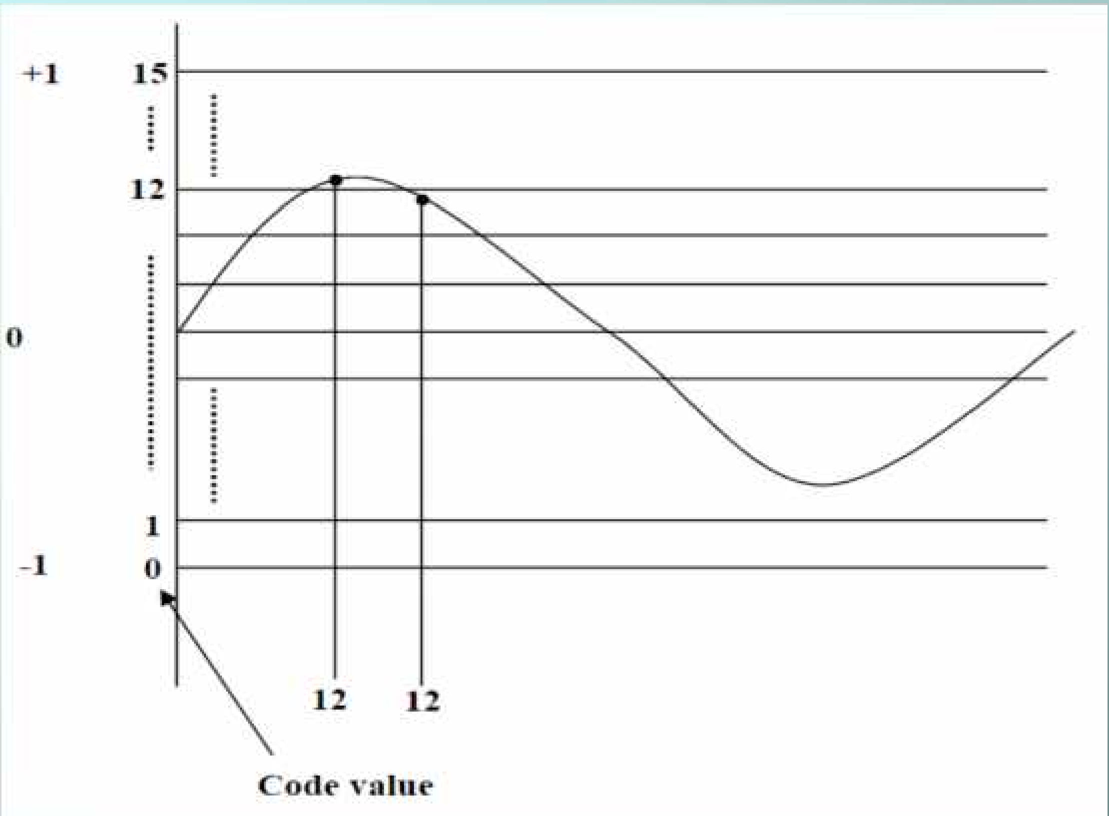
Each code number has its representation in binary arithmetic, ranging from 000 for code number 0 to 111 for code number 7.

From the above figure each sample of analog signal is assigned to the quantization level closest to the value of the sample. Beneath the analog waveform, x(t), are seen four representations of x(t) as follows:-

- the natural sample value, the quantized sample value, the code numbers, and the PCM sequence.

Quantization

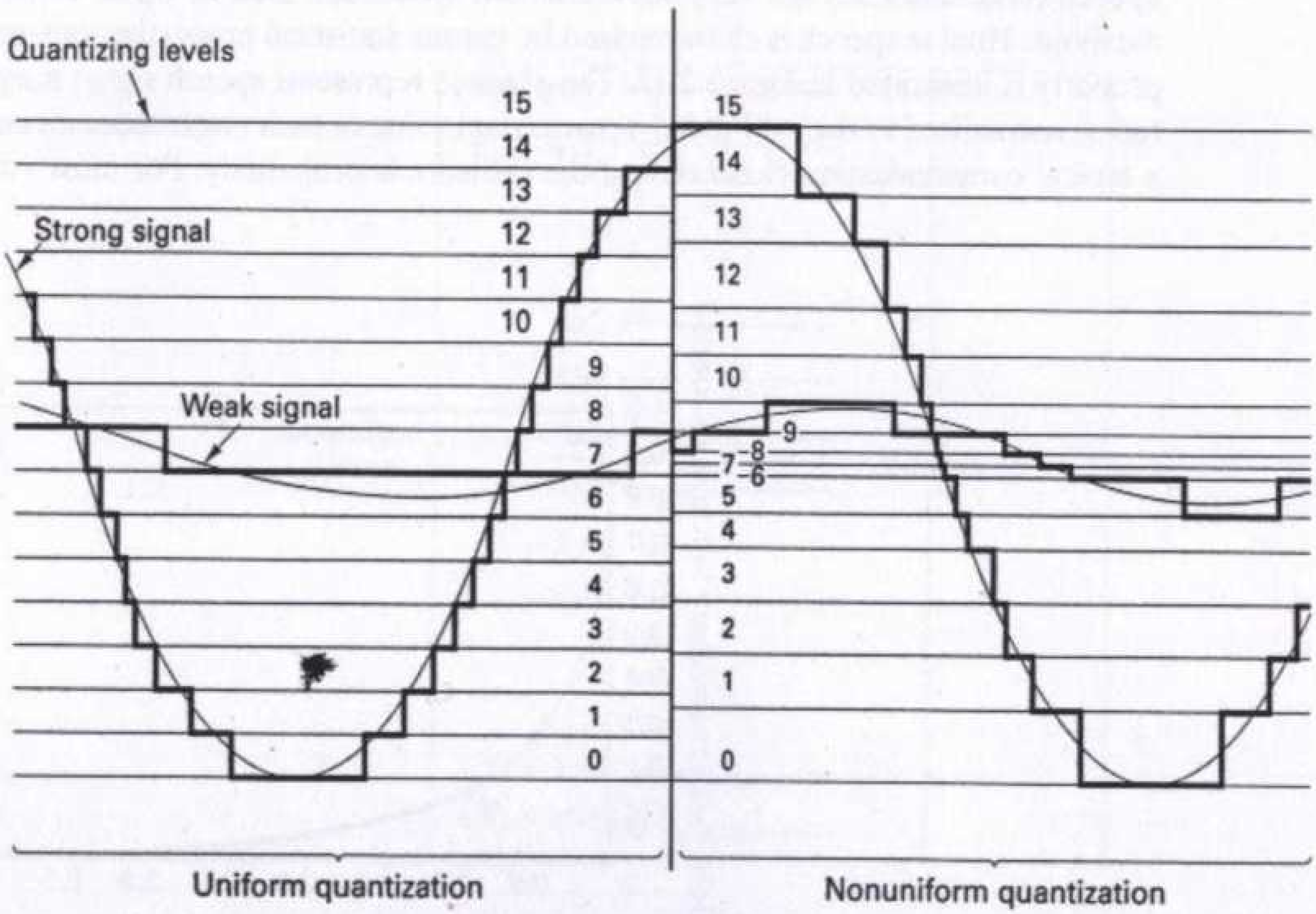
The objective of the quantization step in PCM process is to represent each sample by a fixed number of bits.



The more quantization level, the better quality the system will deliver. However, increasing the number of quantization level has two major costs:-

1) The cost of designing a system with large binary code size needed.
2) The time it takes to process this large number of quantizing steps by the coder.

Therefore, a very large number of quantizing levels may induce unwanted delays in the system.


Quantizing levels
Strong signal
Weak signal
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Uniform quantization
Nonuniform quantization

Encoding

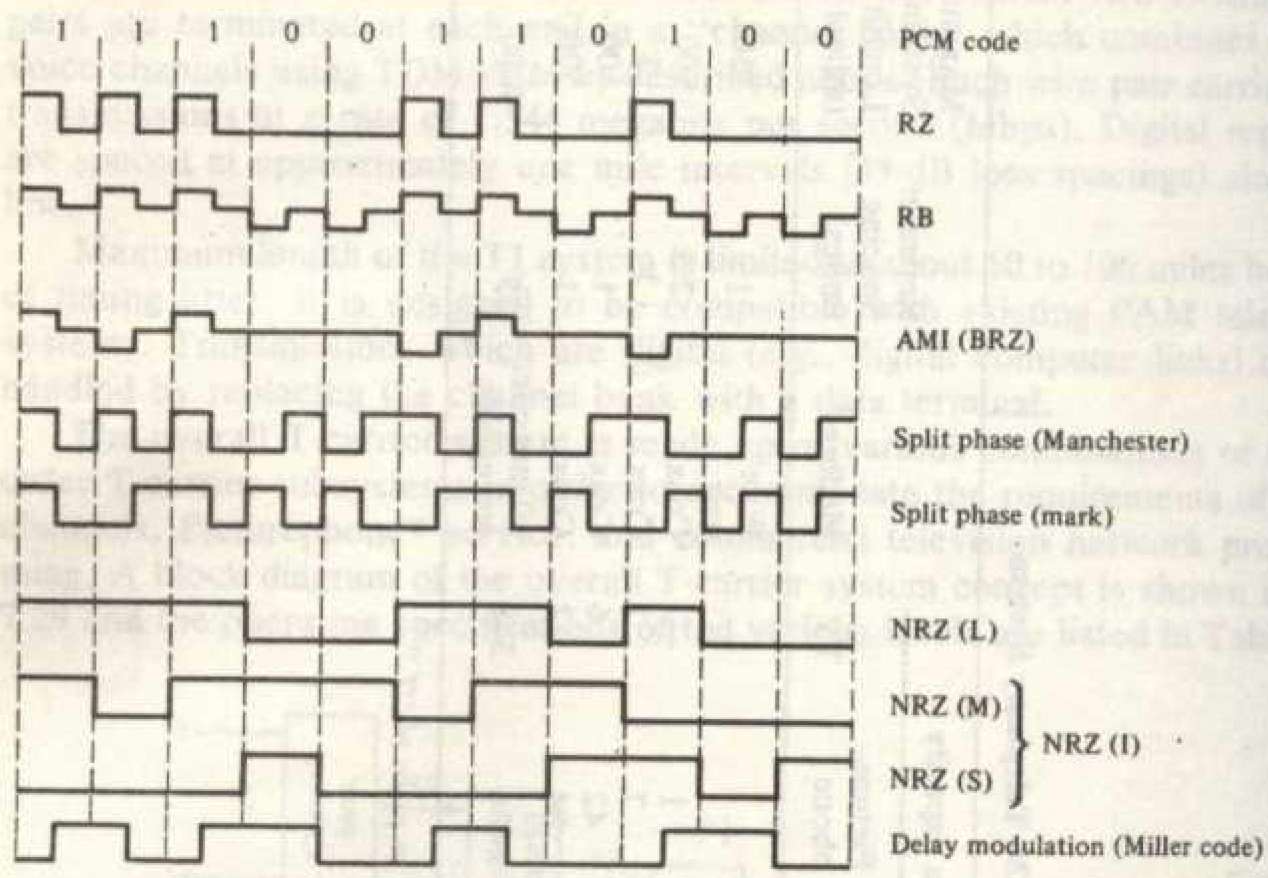


Fig. 7.30 Some methods of representing binary data.

Delta modulation (DM)

the difference between the input and the approximation is quantized into only two levels, namely, ï a , corresponding to positive and negative differences, respectively.

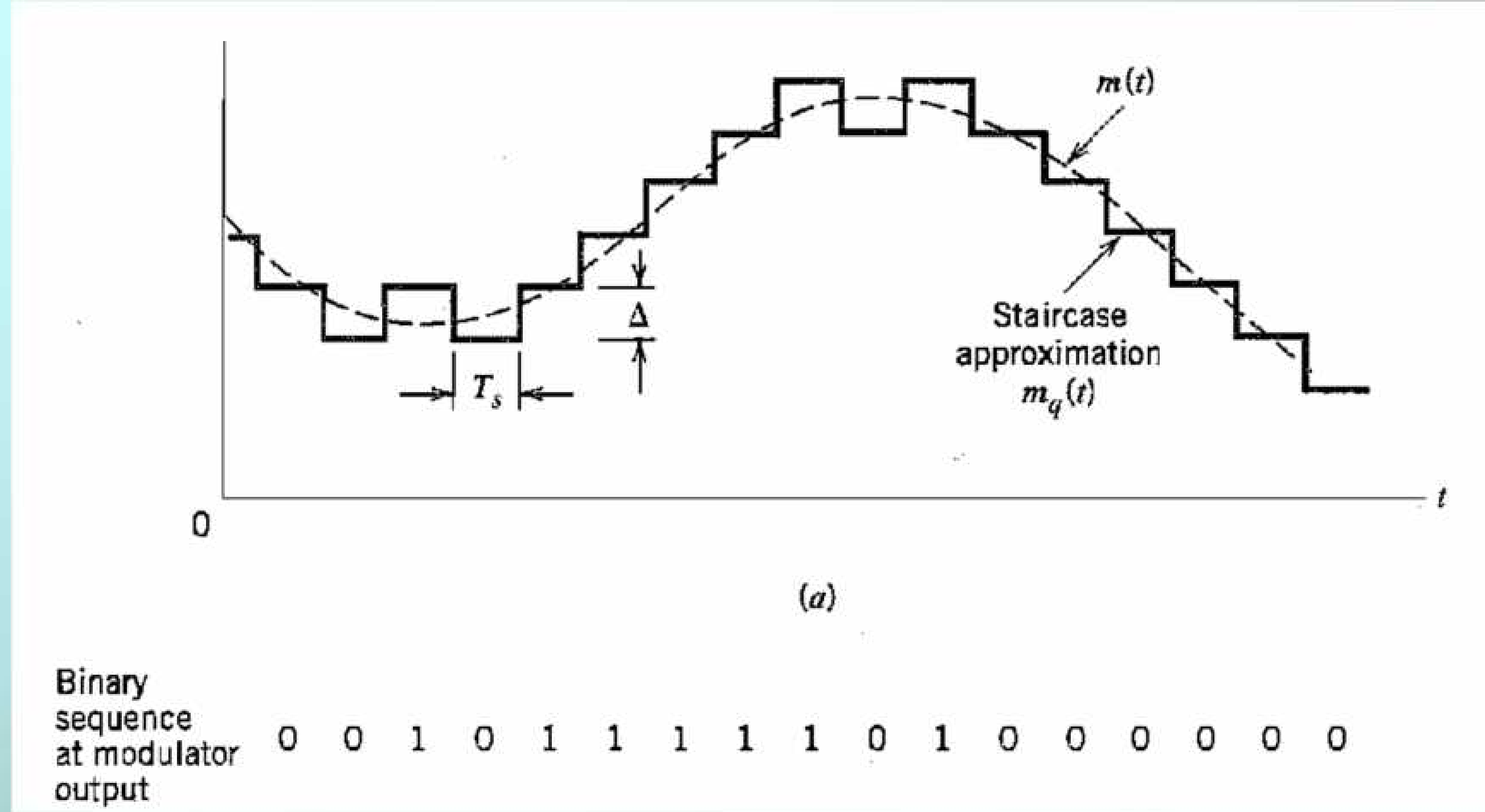
Thus, if the approximation below the signal at any sampling epoch, it is increased by a , on the other hand, the approximation lies above the signal, it is diminished by a.

Denoting the input signal as m(t), and its stair case approximation as mq(t), the basic principle of DM may be formalized in the following set of discrete time relations:-

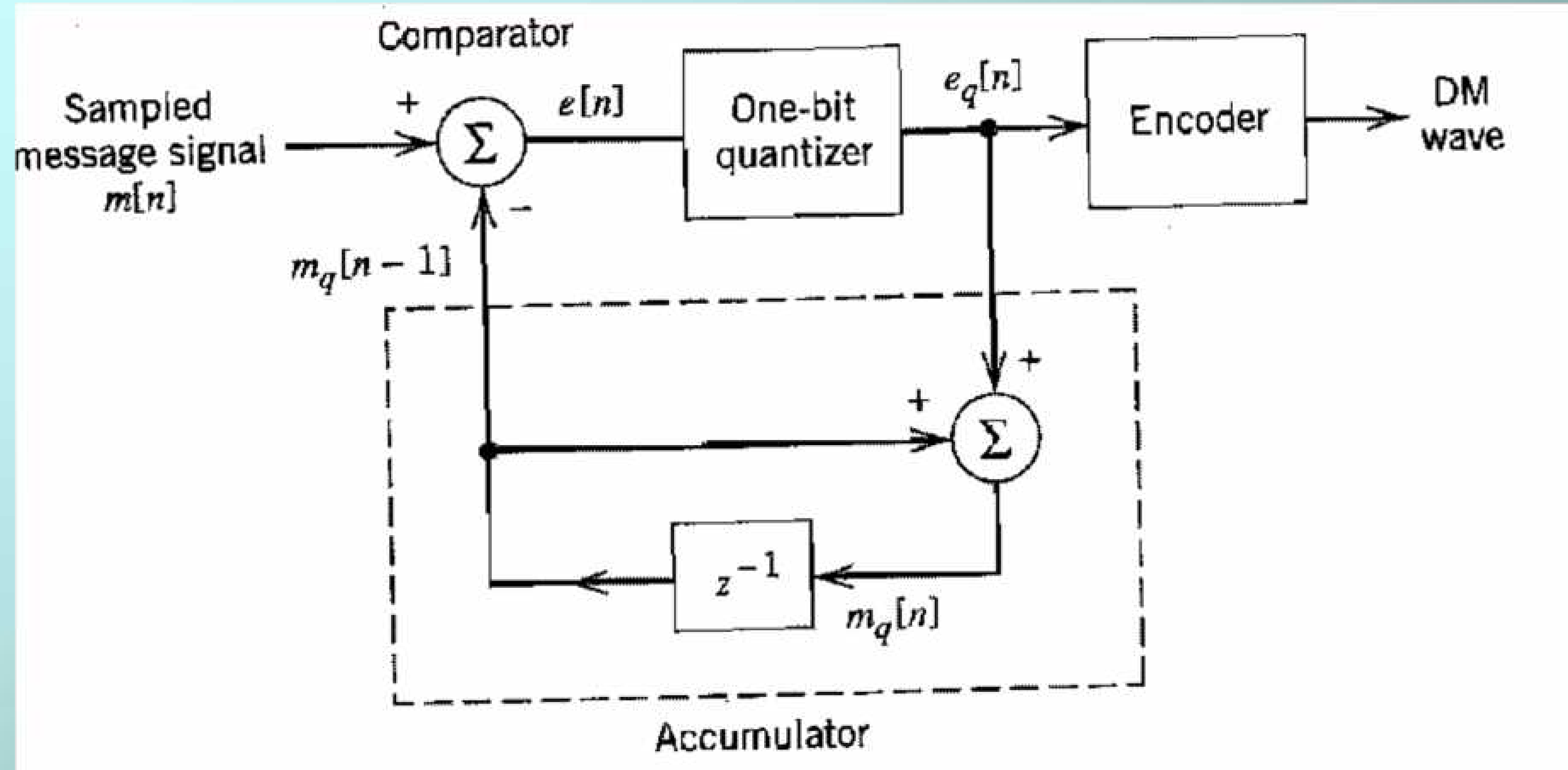
$$e(nT_s) = m(nT_s) - m_q(nT_s - T_s) \qquad \text{............(a)}$$

$$e_q(nT_s) = \Delta Sgn[e(nT_s)] \qquad \text{............(b)}$$

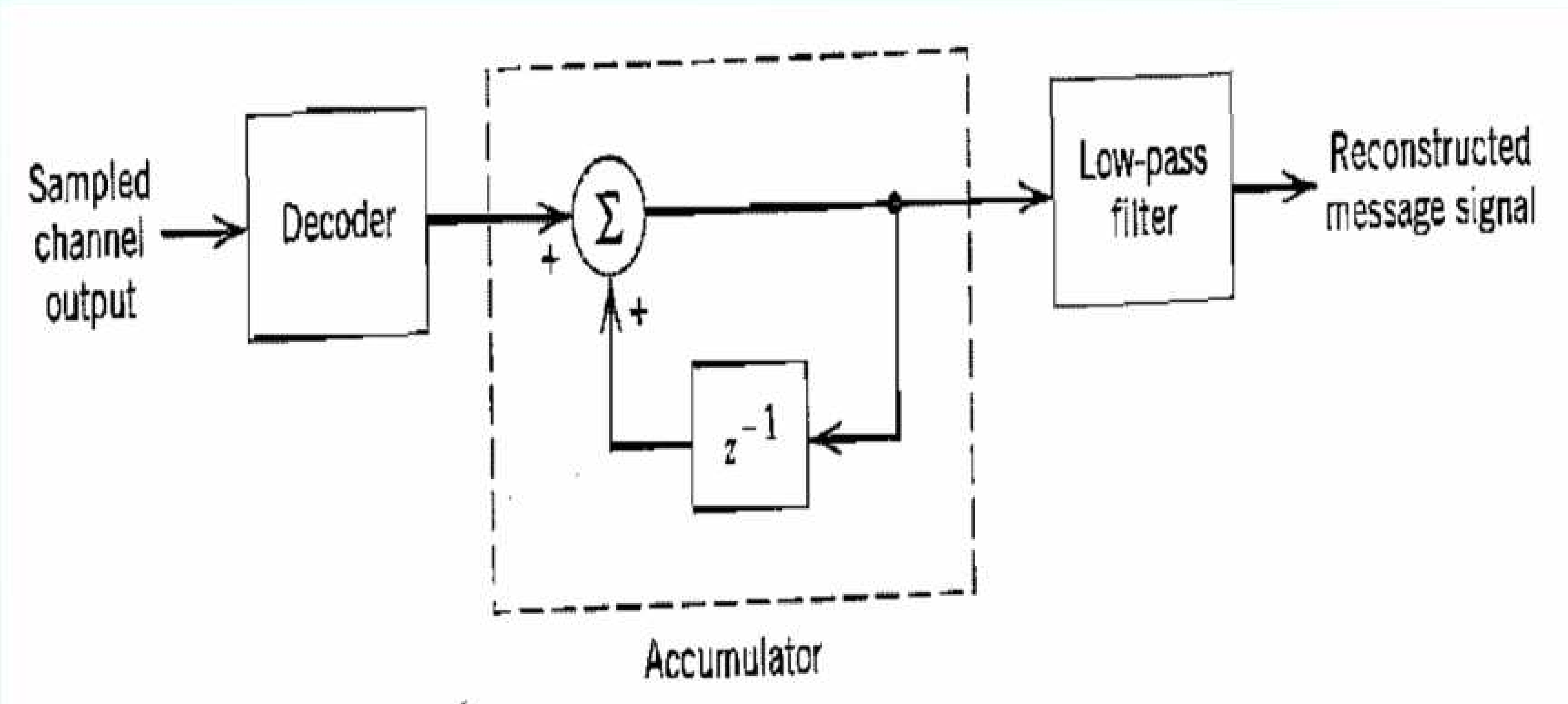
$$m_q(nT_s) = m_q(nT_s - T_s) + e_q(nT_s) \qquad \text{............(c)}$$


m(t)
Staircase approximation
m_q(t)
T_s
Δ
0
t
(a)
Binary sequence at modulator output
0 0 1 0 1 1 1 1 1 0 1 0 0 0 0 0 0

DM system



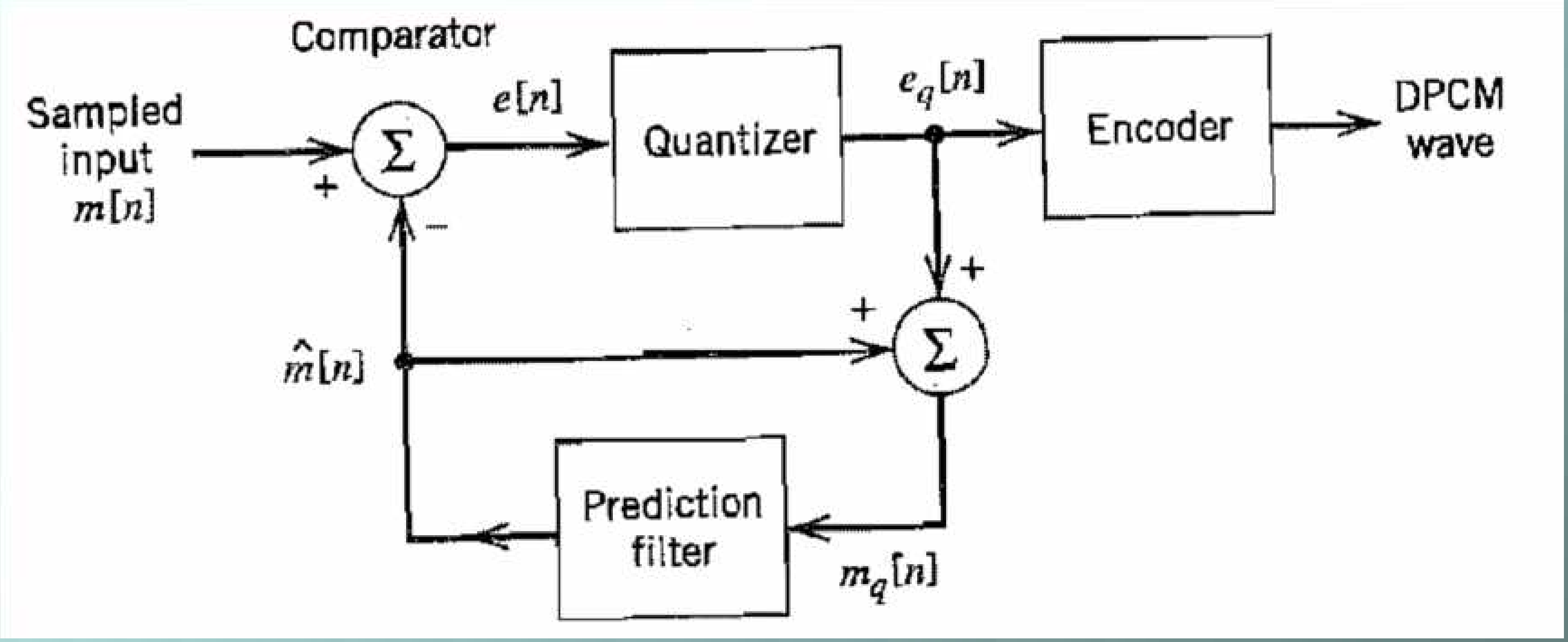
Transmitter



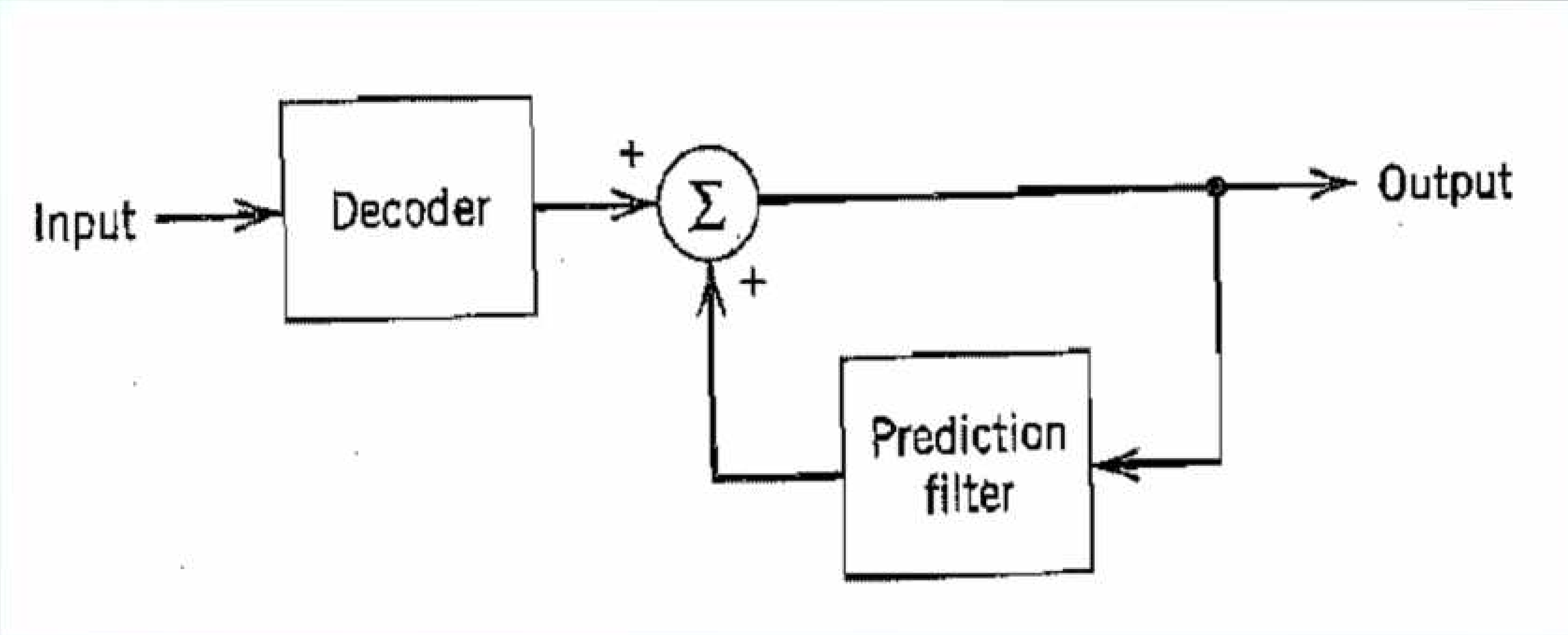
Sampled channel output
Decoder
+
+
Σ
z^{-1}
Accumulator
Low-pass filter
Reconstructed message signal

Receiver

DPCM system



Transmitter



Receiver

Quiz /

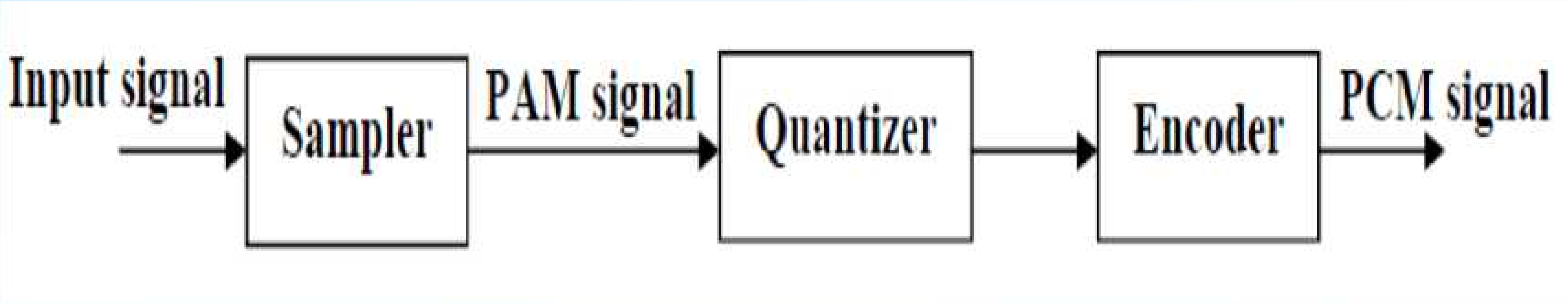
Define the following terms

١ **PCM** is not only quantize the sample analog signal into a number of discrete levels but also use a code to designate each level at each sample time.

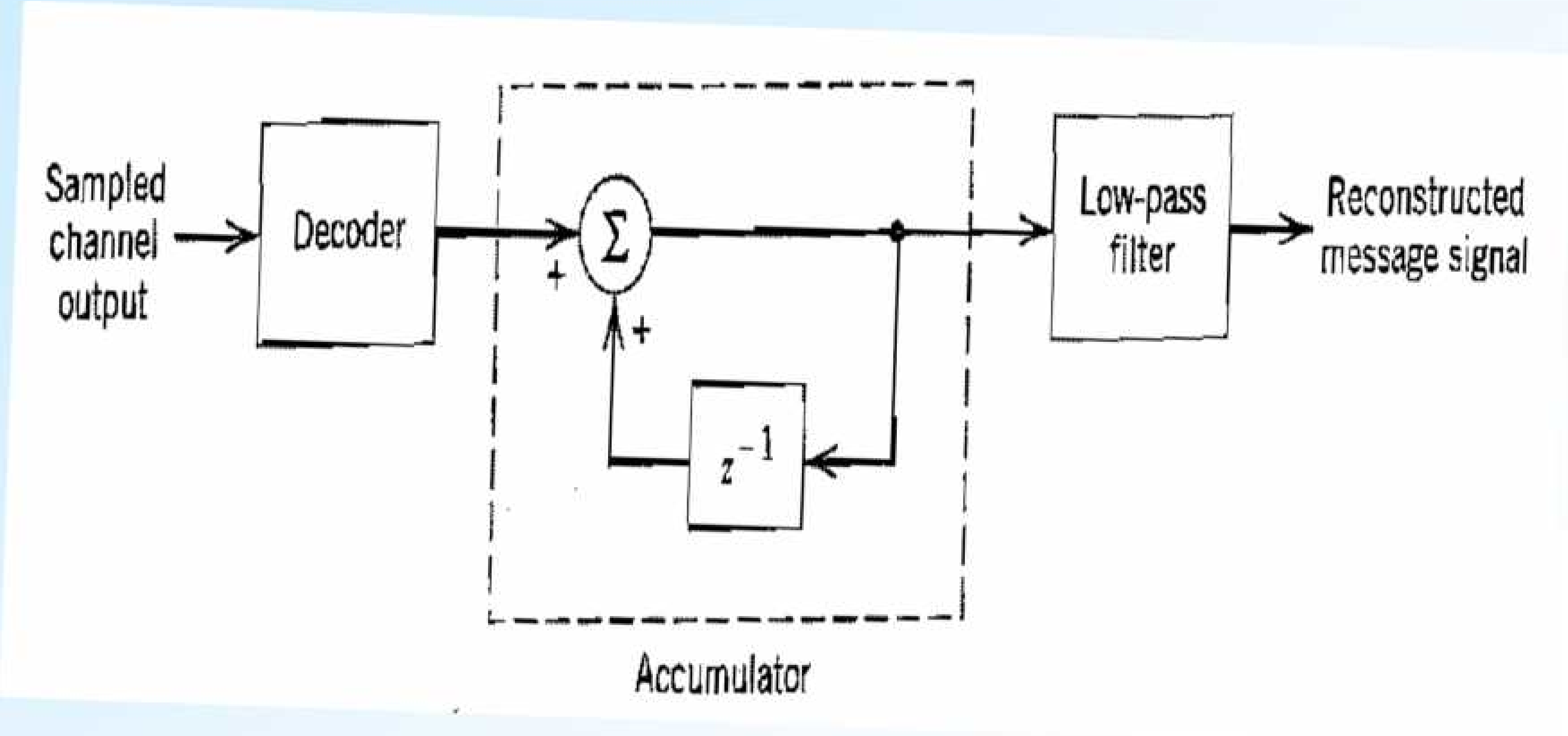
٢ **DPCM system** is used with only a one-bit output, that bit being used for the sign of the sample difference.

5/ Post test :-

1. Draw the block diagram for generation PCM signal



2. Draw the block diagram of a delta-modulation receiver .



3. What are the two major costs for increasing the number of quantization level.

1) The cost of designing a system with large binary code size needed.

2) The time it takes to process this large number of quantizing steps by the coder.

References

1 T. R. Ganesh Babu, and G. Srinivasan:
" Communication Theory and systems", 2006.

2 Sanjay Sharma: "Communication Systems (Analog and Digital) "

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