

DPCM, DM AND ADM

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OUTLINE

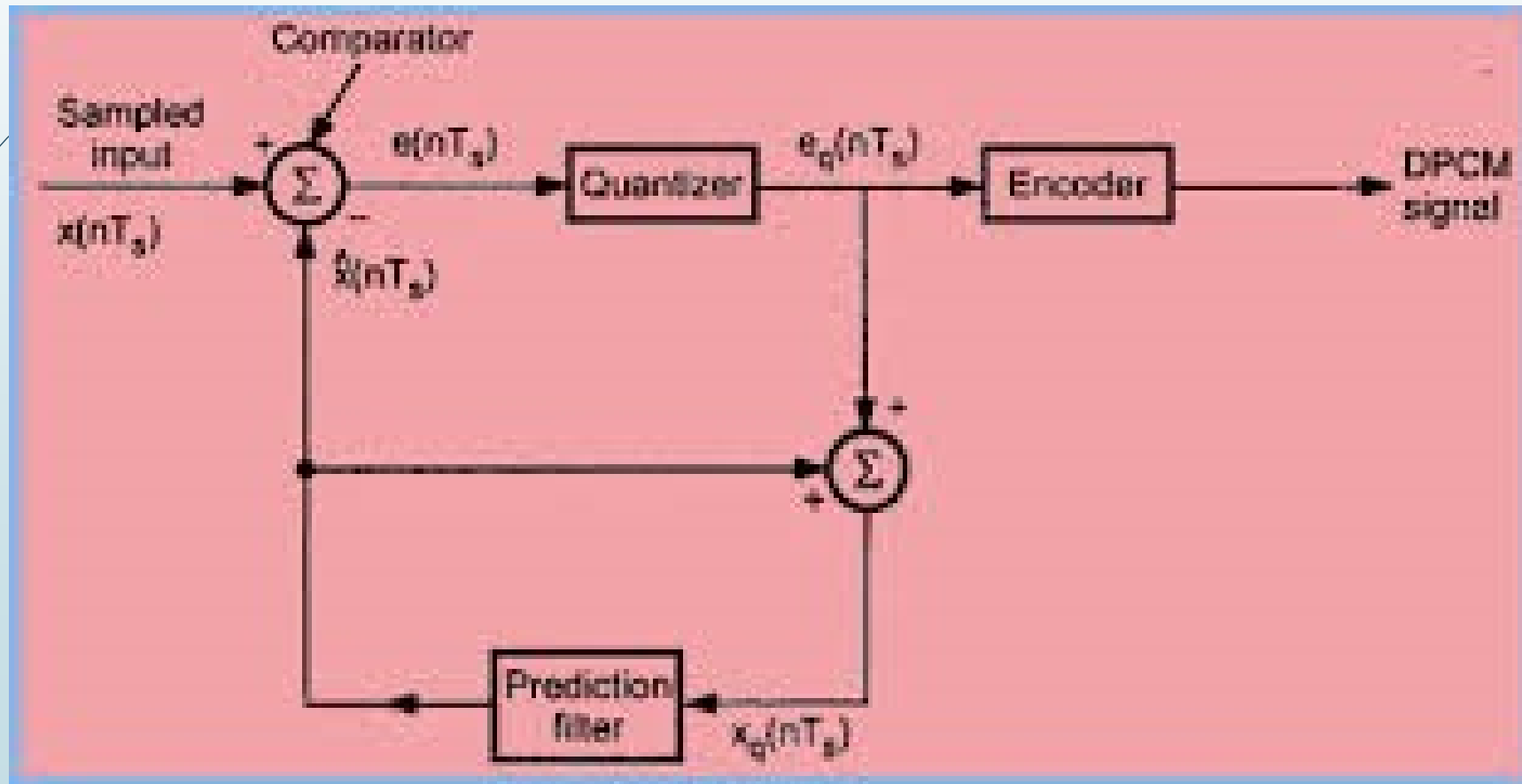
- **Overview of PCM**
- **DPCM**
- **DM**
- **ADM**

PCM

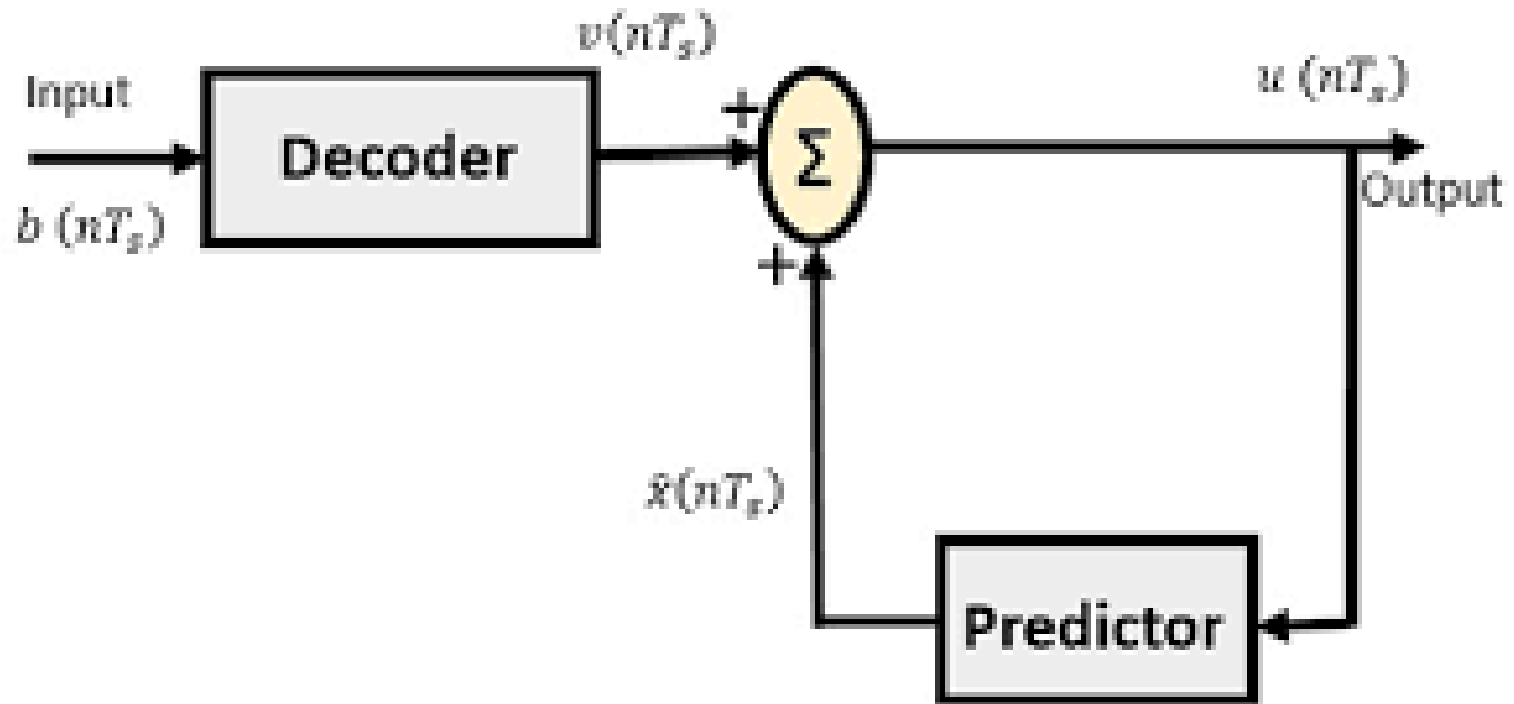
- Pulse digital base band data transmission techniques are PCM, DPCM, DM and ADM.
- PCM stands for Pulse Code Modulation.
- In n- bit PCM, step size = $\Delta = \frac{V_{\max} - V_{\min}}{2^n}$
- Where 2^n = no. of quantization levels.
- The quantization noise power in PCM = $N_q = \frac{\Delta^2}{12}$
- In order to decrease the quantization error, either we have to increase the value of n or decrease the value of $V_{\max} - V_{\min}$.
- $V_{\max} - V_{\min}$ is known as dynamic range of the input message signal.

DPCM

- Differential Pulse Code Modulation (DPCM) is the process of converting an analog to digital signal in which the difference between the **successive samples** are **applied** to the quantizer.
- Block diagram of DPCM transmitter is shown here.



DPCM RECEIVER



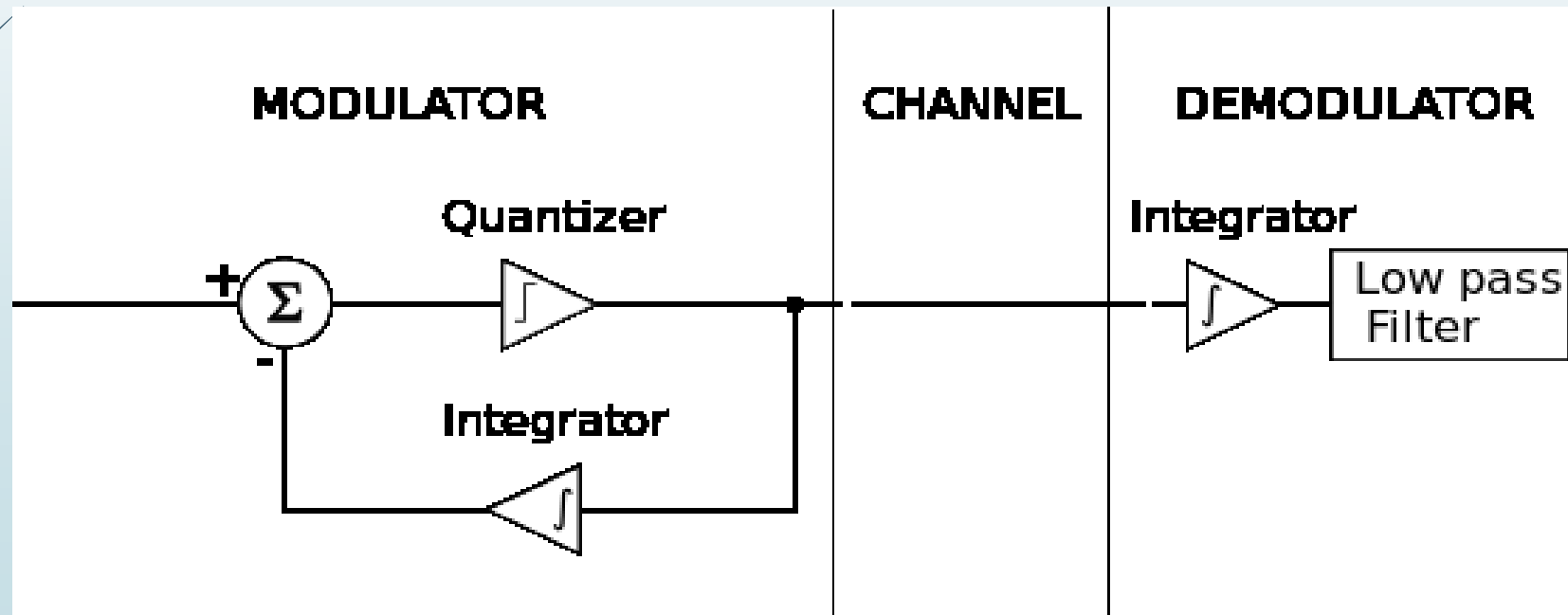
Why DPCM?

- Reduces the quantisation error without increasing the no. of bits of n .
- Dynamic range of the quantizer can be minimised.
- For the dynamic range, the difference between two successive samples are applied.
- Bit rate is same as PCM
- *Bit rate:* $R_b = \frac{n}{T_s}$
- Quantisation noise is reduced

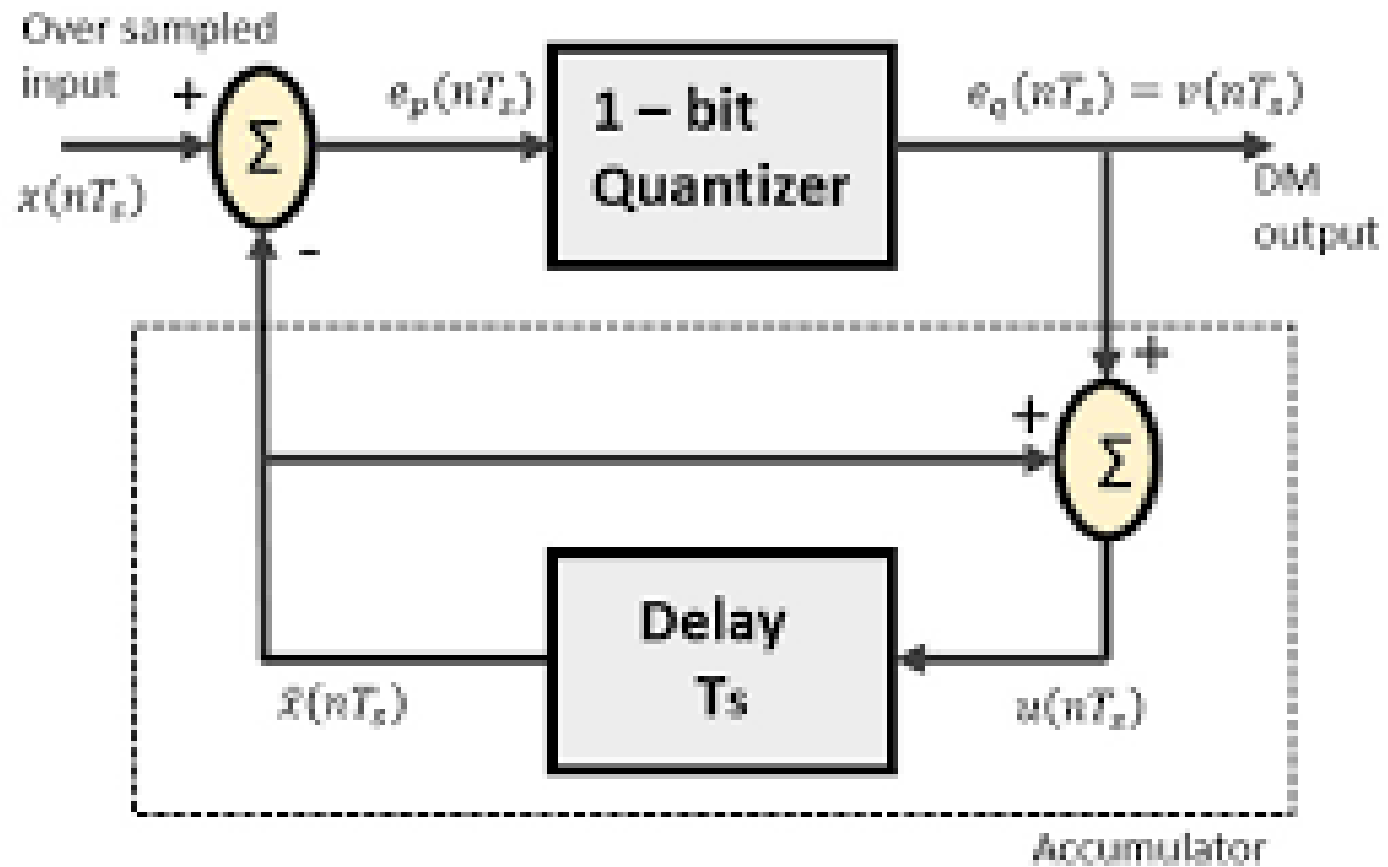
DISADVANTAGE: Hardware complexity.

DM

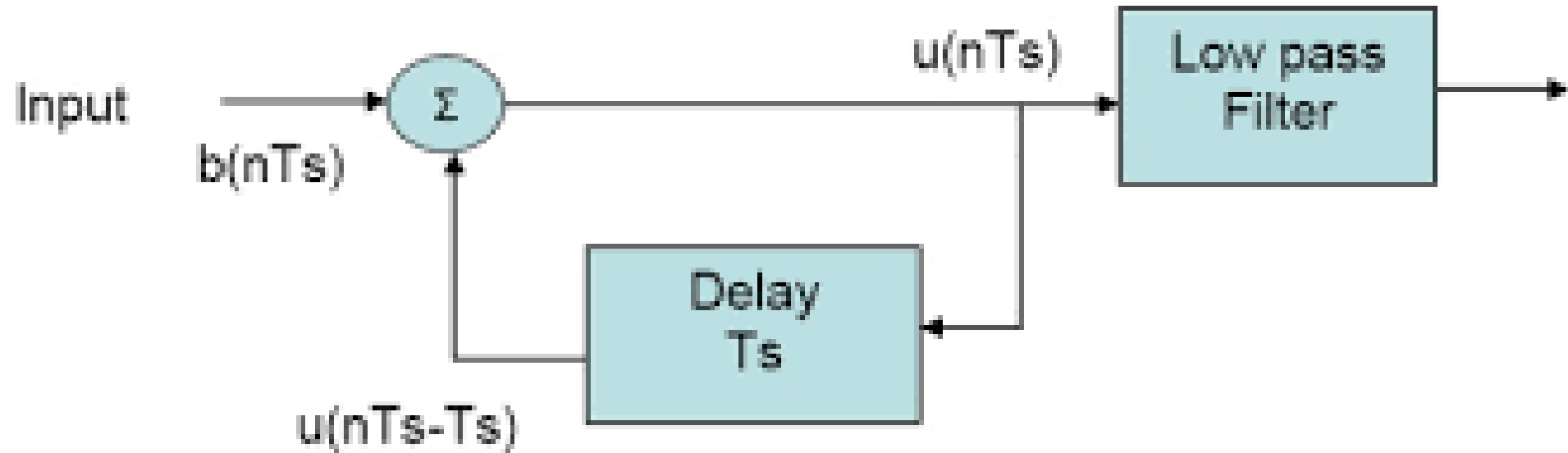
- ❑ It is used to reduce the bandwidth of the signal
- ❑ It has 1-bit encoder.
- ❑ It is always considered as 1-bit DPCM.



DM TRANSMITTER

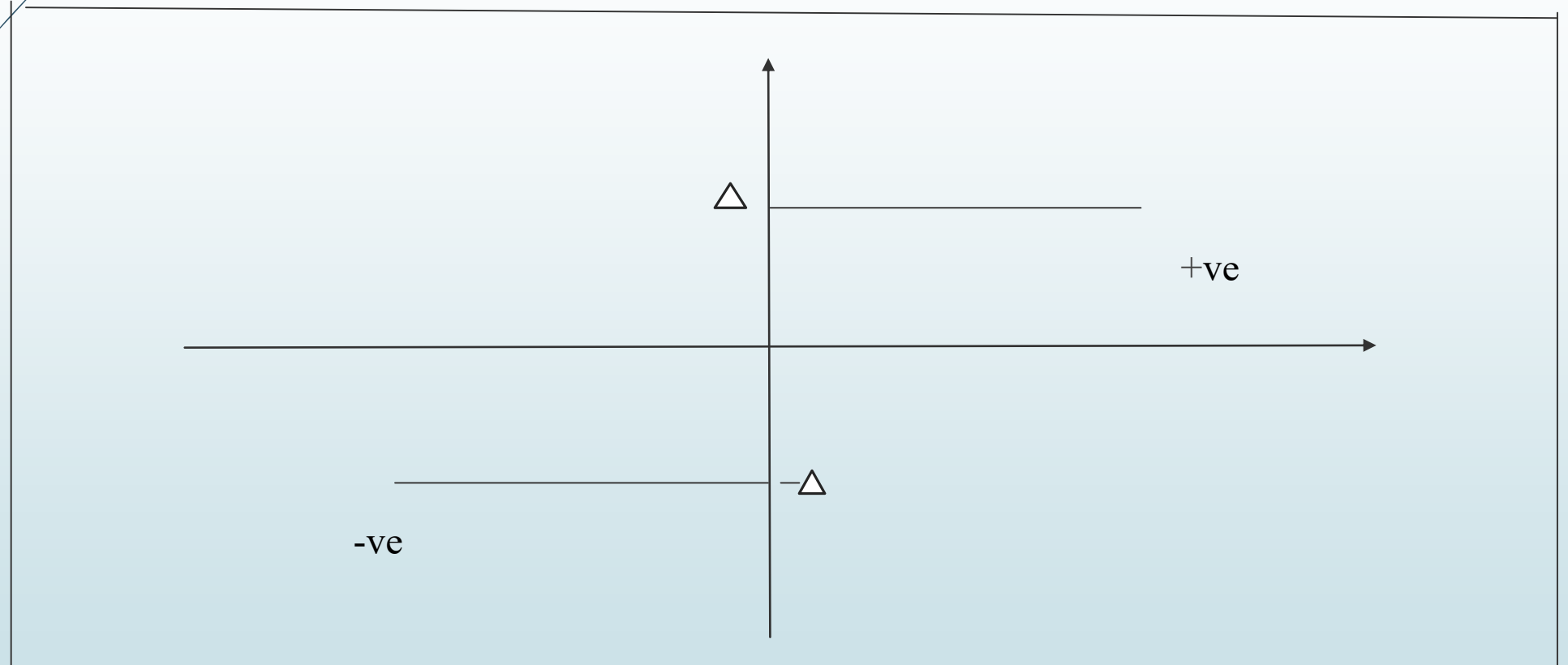


DM RECEIVER



Block diagram for Receiver of a DM system

Transfer characteristics of Quantizer in DM in terms of step size



➤ In PCM, DPCM:- $R_b = (1/T_s) * n$

➤ In DM:- $n=1$

$$R_b = 1/T_s = \text{pulse rate}$$

➤ At the receiver '1' is decoded as $+\Delta$ and '0' is decoded as $-\Delta$.

➤ So, the input to the LPF increases or decreases in terms of Δ . The signal reconstruction depends on the value of Δ .

Types of DM errors:-

1. Slope overload error:

- When the step size is very low; slope overload error occurs.

$$\frac{\Delta}{T_s} < \frac{d}{dt}m(t)$$

2. Granular Noise Error:

- When the slope of reconstructed signal is high as compared to $\frac{d}{dt}m(t)$; then Granular noise occurs.

$$\frac{\Delta}{T_s} > \frac{d}{dt}m(t)$$

NOTE:

- ✓ When the slope of transmitted waveform and slope of reconstructed waveform are same; there will be no error.

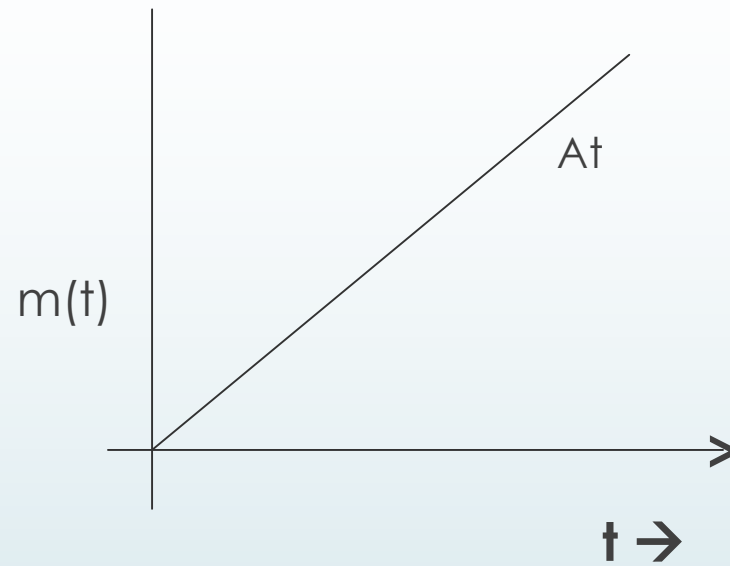
$$\frac{\Delta}{T_s} = \frac{d}{dt}m(t)$$

Here; $\Delta = T_s \frac{d}{dt}m(t)$

$$\Delta = \frac{\text{Slope of the signal } \frac{d}{dt}m(t)}{\text{sampling rate } 1/T_s}$$

➔ CASE 1:

$$m(t) = At$$

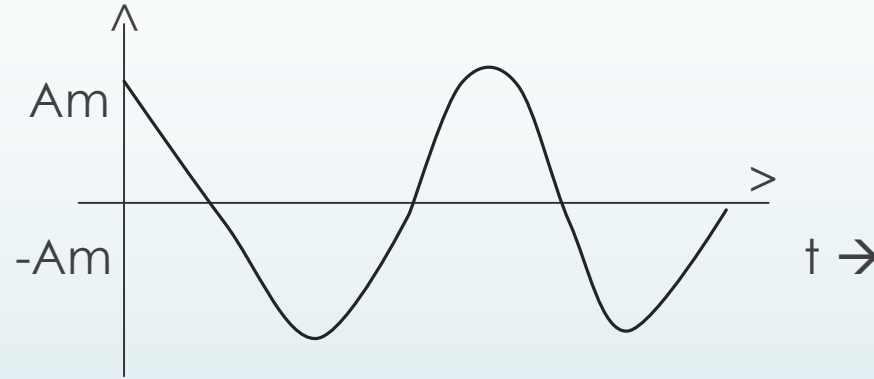


$$\frac{d}{dt} m(t) = \frac{d}{dt} (At) = A$$

$$\triangle = \frac{A}{1/Ts} = TsA$$

► CASE 2:

► If $m(t) = A_m \cos 2\pi f_m t$



Slope: $\frac{d}{dt} m(t) = \frac{d}{dt} A_m \cos 2\pi f_m t = -A_m \sin 2\pi f_m t \cdot 2\pi f_m$

$$\boxed{\frac{d}{dt} m(t) = -A_m 2\pi f_m \sin 2\pi f_m t}$$

$$\left. \frac{d}{dt} m(t) \right|_{\text{max}} = A_m 2\pi f_m$$

$$\triangle = \frac{A_m 2\pi f_m}{1/T_S}$$

PROBLEMS

Q1. The i/p to the delta modulator is $m(t)=5t$ and sampling rate is 5000 samples/sec. Determine the step size.

Ans- Here, $m(t)=5t$. So, $dm(t)/dt=5$.

Step size= $5/5000=5mV$.

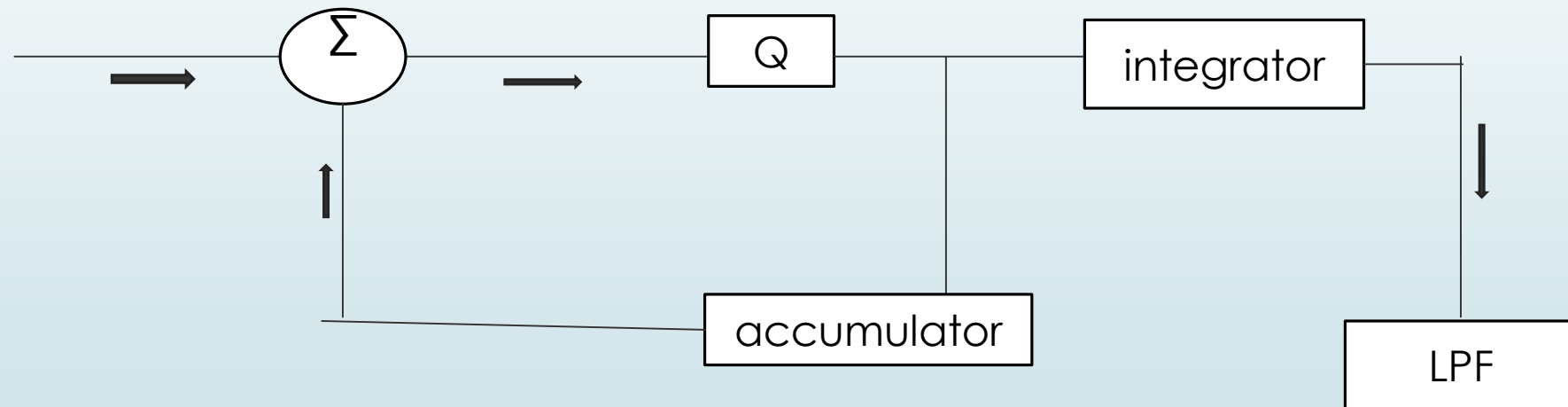
Q2. The i/p to the delta modulator is $m(t)=5\cos 2\pi 1000t$ and the pulse rate is 56000 pulses/sec. Determine the step size.

Ans- Here $A_m=5$ V, $f_m=1000$, pulse rate=bit rate=sampling rate=56000.

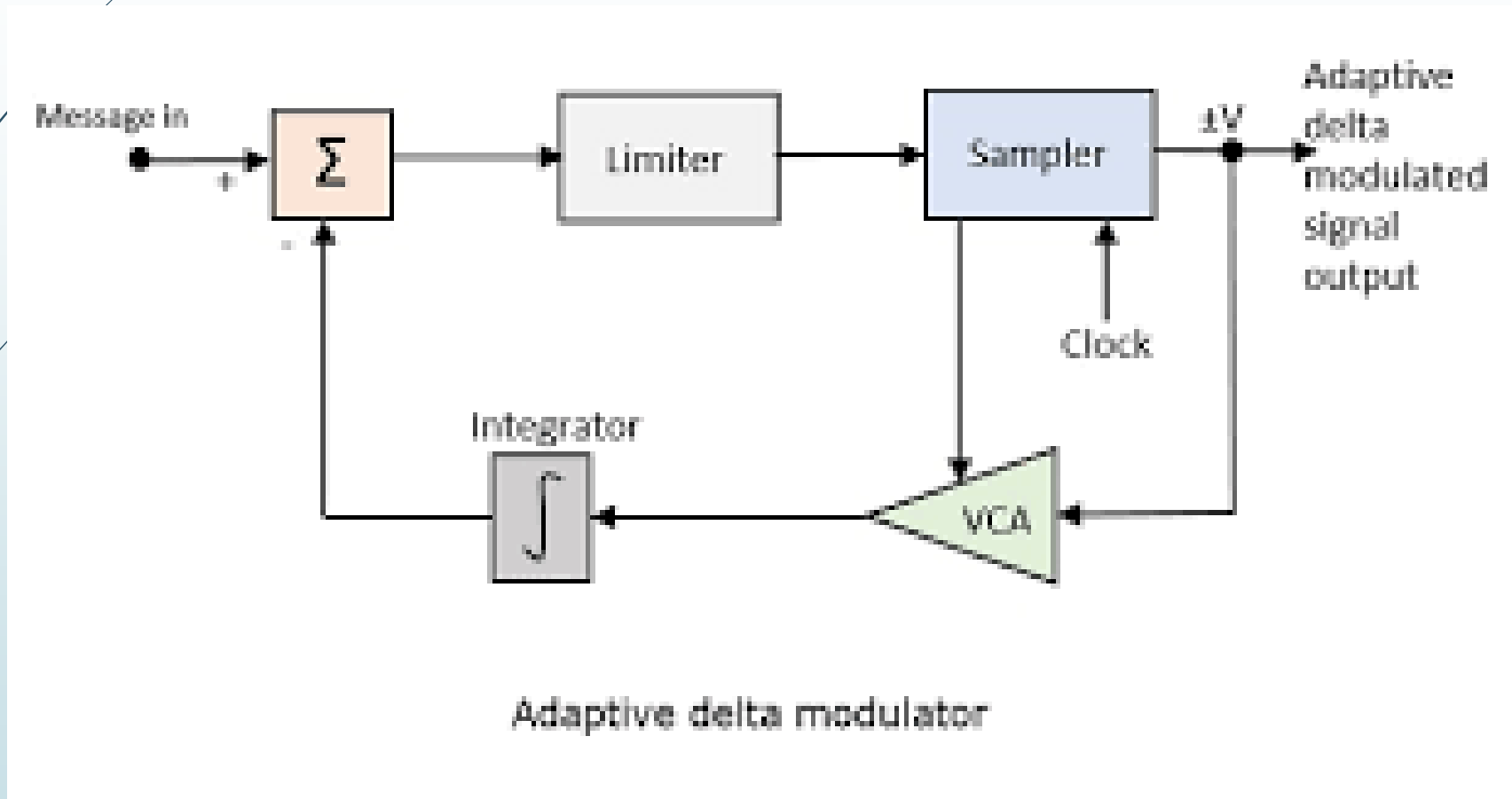
Step size= $\Delta = \frac{5 \times 2\pi \times 1000}{56000}$ V (volt).

ADM :

- Stands for adaptive delta modulation
- In ADM additional hardware is designed to provide **variable step size** .
- Thereby reducing slope overload effects without increasing the granular noise .



ADM TRANSMITTER





THANK YOU