1.16 Suppose a bipolar ADC is used with a precision of $N = 12$ bits, and a reference voltage of $V_r = 10$ volts.

(a) What is the quantization level q?

(b) What is the maximum value of the magnitude of the quantization noise assuming the ADC input-output characteristics is offset by $q/2$ as in Figure 1.6.2.

(c) What is the average power of the quantization noise?

Solution

(a) From (1.6.7)

$$\begin{aligned} q &= \frac{V_r}{2^{N-1}} \\ &= \frac{10}{2^{11}} \\ &= 0.0049 \end{aligned}$$

(b) The maxumum quantization error, assuming rounding, is

$$\begin{aligned} E_{\max} &= \frac{q}{2} \\ &= 0.0024 \end{aligned}$$

(c) From (1.2.8), the average power of the quantization noise is

$$\begin{aligned} E[e^2] &= \frac{q^2}{12} \\ &= 1.9868 \times 10^{-6} \end{aligned}$$