In selecting the intermediate frequency f_D, a compromise must be reached. Lowering f_D allows the reduction of the speed and complexity of the second filter. On the other hand, as f_D approaches $2f_B$ so that the intermediate OSR $(OSR_1 = f_D/(2f_B))$ drops below 4, condition (b) may not hold even for $K = L + 1$; furthermore, the droop of the sinc^K filter at f_B becomes large. Hence, an intermediate OSR of 4 seems to be about optimal. In [13], useful graphical design information is given for the added noise and droop introduced by this approach.

A sinc^3 filter may be constructed from a combination of three of the accumulator sections already introduced in Section 2.9. However, a more economical realization of sinc^K filters for $K > 2$ is provided by the *Hogenauer structure* [14] shown in Fig. 3.23a. This structure is obtained by factoring the transfer function of the sinc^3 filter as follows

$$H(z) = \left(\frac{1}{1-z^{-1}}\right)\left(\frac{1}{1-z^{-1}}\right)\left(\frac{1}{1-z^{-1}}\right)\left(\frac{1-z^{-N}}{N}\right)\left(\frac{1-z^{-N}}{N}\right)\left(\frac{1-z^{-N}}{N}\right) \quad (3.28)$$

and realizing each factor by an accumulator or differencing stage. By performing the decimation just before the differencer stages, the N-period delays needed to

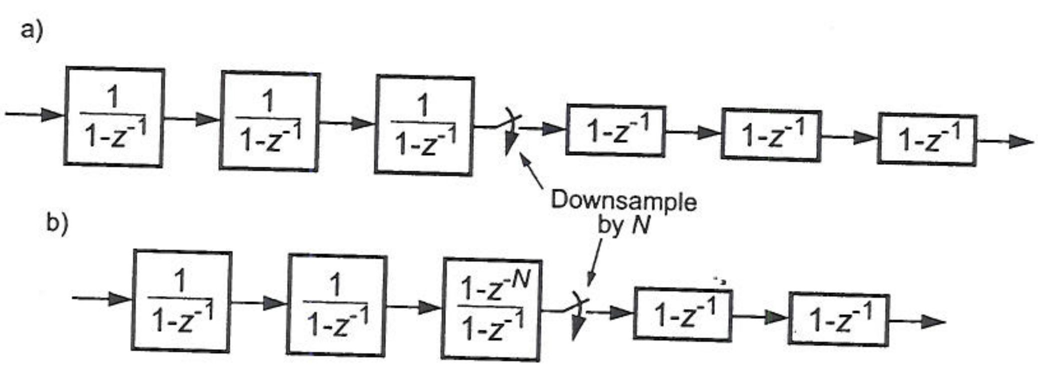

Figure 3.23: Hogenauer structure of a sinc^3 filter.