New Exercises

to the book

Quantization Noise

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`http://www.mit.bme.hu/books/quantization/`

New exercises last compiled: August 20, 2008

15.16 Following the lines of Subsection 15.7.3 in the Corrigenda, determine a formula similar to (15.26b) accounting for the roundoff error of the complex coefficients W_N, using the same value of q for their storage as for the signal. Assume that the input is white noise.

15.17 Repeat the calculations given in Subsection 15.7.3 in the Corrigenda, to determine a formula similar to (15.26b) for a downscaled scheme: after each addition/subtraction, before storage (quantization) the samples are divided by 2. See Fig. 15.17.1.

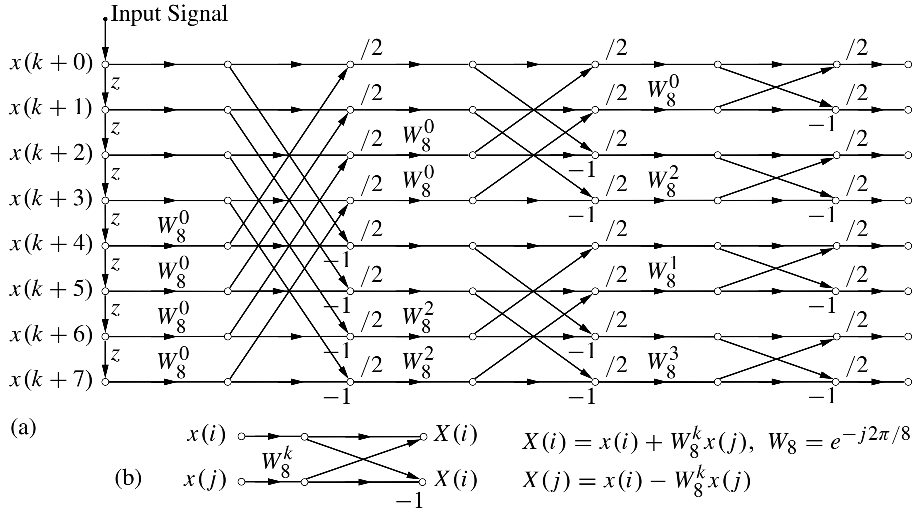

Figure 15.17.1 DIT FFT scheme with downscalings by 2

15.18 Verify the results of Exercise 15.17 by computer simulation, for $B = 32$, $N = 256$, uniformly distributed random numbers in $(-1, 1)$. Make a "fair" comparison with the results of Exercise 15.6.

15.19 Repeat Exercise 15.16 for the downscaled scheme given in Fig. 15.17.1: after each addition/subtraction, before storage (quantization) the samples are divided by 2. See Fig. 15.17.1.

15.20 Verify the results of Exercise 15.19 by computer simulation, for $B = 32$, $N = 256$, uniformly distributed random numbers in $(-1, 1)$.

15.21 Determine a formula similar to (15.27), accounting for the roundoff error of the complex coefficients W_N in the DFT, assuming the same value of q for their storage as for the signal. Assume that the input is white noise, uniform in (-1/32,1/32), $B = 16$, numbers in (-1,1), $N = 256$. Compare it to (15.27).

15.22 Assume that the input signal is represented on 12 bits: 10 integer bits, and two fractional bits. Assume that in the FFT, 16-bit integer arithmetic is used. Determine the variance of the roundoff error calculated for $X(k)$, due to input roundoff. Is this different from the effect of input roundoff in a DFT?

15.23 Following the lines of Subsection 15.7.3 in the Corrigenda, determine the formula equivalent to (15.26b) for the case of decimation-in-frequency (DIF) FFT (see Fig. 15.23.1). Is this bound different from the one obtained for DIT FFT? Why?

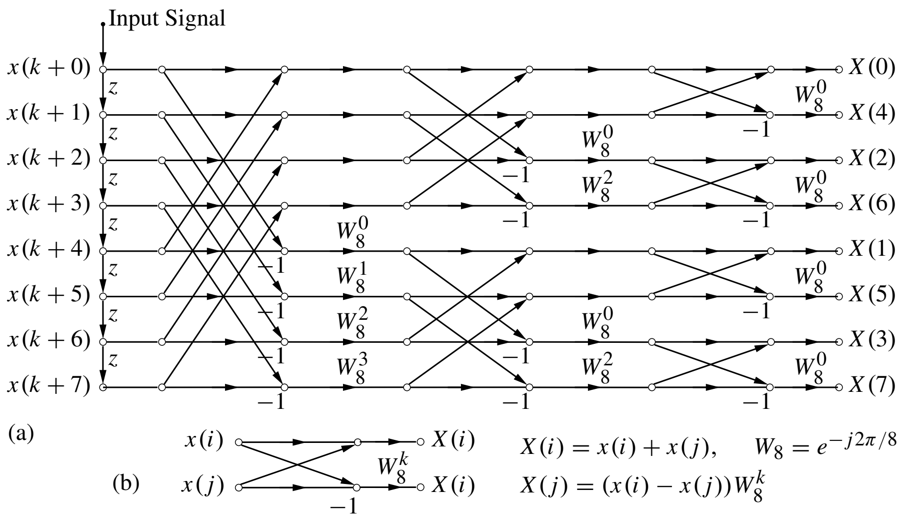

Figure 15.23.1 DIF FFT scheme

15.24 Verify the formula obtained in Excercise 15.23 by computer simulation.

19.39 Prove that

(a) among all zero-order dithers with zero mean, the dither uniformly distributed in $\pm q/2$ has the smallest variance,

(b) among all first-order dithers with zero mean, the dither triangularly distributed in $\pm q$ has the smallest variance.