Design of Low-Sensitive Analog and Digital Filters

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Abstract

Classical filter design is typically based on the assumption that the cost is proportional to the filter order. Here we revisit this assumption and show that is may be advantageous to instead use filter structures that have low sensitivity to element errors. We first discuss the mechanism behind the low sensitivity of doubly resistively terminated lossless networks and estimated of the passband deviation due to element errors as well as lossy elements. These estimates yield insight into how the frequency response approximation can be used to reduce the passband sensitivity. Furthermore, we compare the properties of classical approximations, Butterworth, Chebyshev I and II, and Cauer filters from a sensitivity and cost point of view. Finally we compare the sensitivity of three classes of wave digital filter structures: ladder, lattice, and circulator-tree structures. We find it is important that the transmission zeros are created by reflection and not by cancellation as is done in lattice structures.