Chapter 60
Design of Compensators for Comb Decimation Filters

Gordana Jovanovic Dolecek
Institute INAOE Puebla, Mexico

ABSTRACT

This chapter presents different methods proposed to compensate for the comb pass band droop. Two main groups of methods are elaborated: methods that require multipliers and multiplier-less methods. The width of pass band depends on the decimation factor and the decimation of the stage which follows the comb decimation stage. In that sense, the compensation can be considered as a one in the wideband, or in the narrowband. There exit methods which can be used for both: wideband and narrowband compensations (with different parameters). Usually there is a trade-off between the compensator complexity and the provided quality of compensation.

INTRODUCTION

Decimation is the process of decreasing the sampling rate by an integer, called decimation factor. Decimation has applications in communications, audio signal processing, Sigma Delta Analog to Digital converters, among others. In order to prevent aliasing (unwanted replicas of the input signal), the signal must be previously filtered by a low pass filter, called decimation filter (Jovanovic Dolecek, 2003). The comb filter is the simplest decimation filter usually used in the first decimation stage (Hogenauer, 1981). This filter does not require multipliers, because all its coefficients are equal to unity. In order to achieve correct performance, the comb decimation filter should have a flat pass band of interest. However, comb magnitude characteristic has a droop in the pass band of interest which may deteriorate the decimated signal. The solution is to compensate for a comb pass band droop by an additional simple filter, called compensator. Different methods are proposed for compensator designs. The objective of this paper is to categorize and describe the most important methods, proposed so far, and to propose some future direction for the compensator designs.

DOI: 10.4018/978-1-5225-7598-6.ch060

BACKGROUND

The transfer function of comb filter is given by the following equation:

$$H(z) = \left[\frac{1}{M} \frac{1-z^{-M}}{1-z^{-}} \right]^K \tag{1}$$

where M is the decimation factor and K is the order of the filter.

The magnitude response of the filter is given as:

$$\left| H(e^{j\omega}) \right| = \left| \frac{1}{M} \frac{\sin(\omega M/2)}{\sin(\omega/2)} \right|^K \tag{2}$$

The comb pass band is defined by the pass band edge (Kwentus &Willson, 1997):

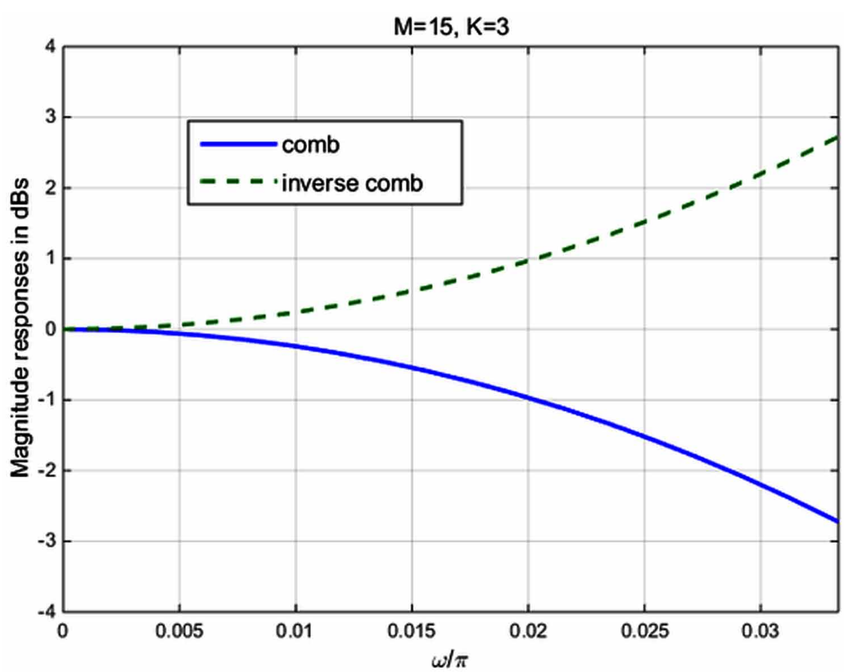
$$\omega_p = \pi / RM \tag{3}$$

where R is the decimation factor of the stage that follows the comb decimation stage.

For values $R<4$, the pass band is considered as a wideband, and in an opposite case it is a narrowband.

As an example, Figure 1 shows the wide pass band zoom ($R=2$), of the magnitude response of comb filter with the decimation factor $M=12$ and an order equal to $K=3$. Note that the response is not flat

Figure 1. Magnitude and inverse magnitude characteristics of comb, M=15, K=3, R=2



Related Content