Letters

Comments on "Sidelobe Suppression in Low and High Time–Bandwidth Products of Linear FM Pulse Compression Filters"

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In the above paper,[1] the authors have computed sidelobe suppression of linear FM pulse compression filters using Hamming weighting functions. They claim to have extended previous results of some other authors from a time–bandwidth (*TB*) product of 50 to 720. Although they refer to surface acoustic wave (SAW) chirp filters, the calculations do not explicitly show any SAW device parameters.

It is to be pointed out that the suppression of sidelobes by using different weighting functions (apodization) is a well-established SAW filter design technique, and has been in use for about 20 years. SAW chirp filters are commercially available from several vendors with the following typical performance characteristics as far as the maximum *TB* products are concerned:

Technology	Maximum *TB* Product
Interdigital (IDT) in-line devices	1000
Slanted array correlator (SAC) devices	3000
Reflective array compressor (RAC) devices	15 000

The analyses as outlined by the authors in sections II and III are only a revisit of earlier work by several authors (see Cook and Bernfeld [1], for example).

Morgan [2] has given an excellent exposition on SAW chirp filters in chapter 9 of his book. For large *TB* products (> 100) the stationary phase approximation was used to obtain some spectra of flat-envelope linear FM waveforms. The results plotted on page 224 of the book show that the amplitude is essentially flat, and falls off rapidly outside the band. Ripples present in both the amplitude and the phase characteristics become more significant as the *TB* product is reduced. The authors arrived at the same conclusion. But the claim by the authors of achieving lower insertion loss in higher *TB* product devices is wrong. The insertion loss of interdigital devices become unacceptable for large *TB* products, because the inactive regions of the IDT's act as capacitive shunt, reducing the impedance. This is one of the reasons why RAC devices are preferred for $TB > 1000$.

Finally, since the stationary phase approximation gives erroneous results for low *TB* product devices, a method called the reciprocal-ripple method, introduced by Judd [3], is used for such devices.

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[1] K. M. El-Shennaway, O A. Alim, and M. A. Ezz-El-Arab, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-35, pp 807–811, Sept. 1987.

Reply[2] by Khamies Mohammed El-Shennawy[3]

The latest work in the field appears to be that cited in [4] and [5] of our paper (references [4] and [5] here), describing low *TB* products using the convolution technique. Our paper extends the work cited in [4], [5], and [8] of our paper (references [4], [5], and [6] here) and that of Gerard *et al.* (reference [7] here) to a *TB* product of 720.

Dr. Roy states that analyses of time–bandwidth products exceeding 1000 have been obtained, but with limited time-domain description to specify sidelobe suppression (Gerard, reference [8] here). He discusses the effects of shunt capacitance and impedance in practice, but our paper is a theoretical work using the inverse discrete Fourier transform (DFT) Fresnel integral algorithm to obtain sidelobe suppression of the received signal in the time domain.

The Fourier transform (eq. (3) of our paper) of the impulse response for the linear FM pulse compression filters is calculated; hence the insertion loss (eq. (10) of our paper) is obtained at $TB = 50$ and 720, and a comparison has been made. Dr. Roy states no reduction of insertion loss for $TB > 3000$, which is outside of our range of *TB*.

Our work obtains sidelobe suppression using DFT for $TB = 50$, 100, 150, 200, 250, $\cdots$, 720 at different sampling rates. A comparison of sidelobe suppression has been carried out for cases of no weighting and with external Hamming weighting (tables I and II of our paper).

References

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[7] H M. Gerard *et al.*, "The design and applications of highly dispersive acoustic surface wave filters," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-21, pp. 176–186, Apr. 1973.
[8] H. M. Gerard, "Surface wave ID electrode chirp filters," in *Surface-Wave Filters*, M. Mathews, Ed. New York: Wiley, 1977, ch 8.

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