Abstracts

Applying Harmonic Balance to Almost-Periodic Circuits

K.S. Kundert, G.B. Sorkin and A. Sangiovanni-Vincentelli. "Applying Harmonic Balance to Almost-Periodic Circuits." 1988 Transactions on Microwave Theory and Techniques 36.2 (Feb. 1988 [T-MTT] (Special Issue on Computer-Aided Design)): 366-378.

Harmonic balance is a powerful technique for the simulation of nonlinear microwave circuits. It solves directly for the steady-state response of a circuit in the frequency domain, and so is often considerably more efficient than traditional time-domain methods when circuits exhibit widely separated time constants and mildly nonlinear behavior. With harmonic balance the linear component models are evaluated in the frequency domain, which for distributed devices results in easier model development and reduced computational complexity. Harmonic balance has had limited application for simulating circuits, such as mixers, that have a steady-state response that contains almost-periodic signals. The reason is that to model a nonlinear device, whose behavior is more conveniently computed in the time domain, harmonic balance requires the transformation of signals from the frequency domain into the time domain and vice versa. For circuits that have a periodic response, the discrete Fourier transform (DFT) is used. Previously, no satisfactory transform existed for almost-periodic signals. In this article, a new Fourier transform algorithm for almost-periodic functions (the APFT) is developed. It is both efficient and accurate. Unlike previous attempts to solve this problem, the new algorithm does not constrain the input frequencies and uses the theoretical minimum number of time points. Also presented is a particularly simple derivation of harmonic Newton (the algorithm that results when Newton's method is applied to solve the harmonic balance equations) using the APFT this derivation uses the same matrix representation used in the derivation of the APFT. Since the APFT includes the DFT as a special case, all results are applicable to both the periodic and almost-periodic forms of harmonic Newton. The simple derivation of harmonic Newton, combined with the rigorous definition of terms and the careful exploration of the error mechanisms of the APFT, makes this article a good base for future research.

- Return to main document.