ACTIVE RC SYNTHESIS OF SINGLE AND MULTIVARIABLE NETWORK FUNCTIONS USING OPERATIONAL AMPLIFIERS

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ABSTRACT

The thesis is concerned with the synthesis of single and multivariable network functions using operational amplifiers (OA's) and RC networks, in a form suitable for hybrid integrated circuit (IC) fabrication. An attempt is also made to evolve generalized and unified active synthesis schemes for multivariable network functions, which, as a special case, can be adapted for single-variable functions as well. The MV techniques are suitable for active lumped-distributed synthesis.

Active simulation of grounded inductance is considered in detail. A technique for grounding the condensers of an OA:RC network, with low active and passive components, has been given, and its application is demonstrated by deriving grounded condenser circuits for inductance simulators (IS's) and filters. A computer aided method, based on the dominant pole technique (DPT) is proposed for the frequency limitation study of general second-order OA:RC networks. It has been applied to study the high frequency performance of some important IS's.

Floating inductance (FI) simulation, which is relatively more difficult than the grounded inductance simulation, is critically investigated. Active non-ideal FI's are considered, which enjoy a number of advantages over the ideal ones. The FI's discussed in this thesis have a low component count, unity capacitor spread and low sensitivity; they are easy to

design and adjust and do not require critical component matching. Moreover, the use of OA's in unity-gain connection gives highly stable operation. The disadvantage is that they realize a finite maximum Q, further, the highest usable frequency is limited to a small fraction of the gain-bandwidth product of the OA's.

A canonic, ω_o-invariant band-pass filter using a single OA in low gain (unity or two) connection is examined in details. Its grounded capacitor version is obtained without increasing the number of OAs used. Investigations based on sensitivity and frequency limitation study indicate that the filter with gain K = 2, is far superior with regard to active Q-sensitivity, gain-sensitivity product and the highest usable frequency over the one using K = 1. However, in the unity-gain case, the passive sensitivities are very low (≤ 1). The filters are suitable for IC implementation.

A generalized synthesis approach for active RC networks is developed using non-ideal simulated-L. The method generates a biquadratic filter section, and a basic block is shown to realize all the important filter sections. The structure has low component count and very low sensitivities.

Generalized active RC:CR, RC:LC and LC:RC transformations are developed for multivariable (MV) networks. The corresponding well known transformations of single-variable network functions follow as a special case of the general theory.

A computer based synthesis technique is given for the realization of two-variable (TV), nth-order, driving point immittance functions into ladder networks. The application of Routh's method to the continued fraction expansion (CFE) is extended to the MV case. The synthesis technique is based on the algorithm, which tests the TV function for realizability and simultaneously realizes it into one or more of the twenty proposed RC ladders.

Finally, a generalized synthesis technique is given for th realization of MV transfer functions and grounded and floating admittance polynomials. The synthesis scheme employs a new active device - the multivariable generalized immittance converter, obtained from OA's, capacitive elements and resistances. The synthesis scheme is capable of realizing a very large class of MV network functions and is also suitable for IC implementation. Antoniou's method for single-variable functions is shown to form a special case of the proposed technique.

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