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OPTIMAL DESIGN OF A SINGLE-INPUT PARALLEL DC-DC CONVERTER DESIGNED BY SWITCHED CAPACITOR TECHNIQUES

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Abstract. *In the design of parallel-connected power converters, theoretical analysis to clarify the influence of process fluctuation is important, because the characteristic of a converter which consists of many circuit components is strongly influenced by the fluctuation of those components. Concerning parallel-connected switched-capacitor (SC) DC-DC converters, 1. the optimal setting of a duty factor to achieve best efficiency and 2. the change in characteristics caused by fluctuation of circuit components are analyzed in this paper. The validity of the theoretical analyses is confirmed by SPICE simulations and experiments. The results of this study are as follows: 1. The optimal setting of duty factor D can be derived by the proposed theoretical formulas, because the theoretical results correspond well with the simulated results. 2. The fluctuation of on-resistances affects power efficiency in proportion to the decrease of output load R_L. The value of the total SC resistance is important in power efficiency η, for example, an increase of 20 % in the total SC resistance causes a decrease of 2.2 % in efficiency when $R_L = 5\Omega$. 3. When fluctuation of input voltages is caused, the influence on power efficiency η increases according to output load R_L. 4. In the case of the fluctuation of capacitance, the influence of ripple factor R depends on fluctuating directions of capacitances.*
Keywords: DC-DC converters, Power converters, Switched capacitor circuits, Fluctuation analysis, Parallel-connected converters, Power efficiency

1. **Introduction.** In the field of portable electronics, switching converters [1-24] which offer large current outputs are becoming important due to the voltage lowering of semiconductor processes. For this reason, design analyses have been performed concerning parallel-connected DC-DC converters employing buck converters or boost converters [1]-[11]. For example, concerning single-input parallel DC-DC converters, parallel-connected