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A DESIGN METHOD OF SWITCHED-CAPACITOR POWER CONVERTERS BY EMPLOYING A RING-TYPE POWER CONVERTER

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Abstract. *To solve the flexibility problem in conversion modes, we propose a design method for switched-capacitor (SC) power converters by using a versatile SC converter, and derive theoretical formulas to give circuit properties such as output voltage, power efficiency, etc. According to conditions specified by a user, the proposed converter offers the circuit structure realizing a DC-DC/DC-AC/AC-DC/AC-AC mode of operation and circuit characteristics. Although most of conventional converters offer only one conversion mode, the proposed versatile converter employing a ring-type power converter can achieve four conversion modes by controlling the timing of clock pulses. Moreover, the proposed analysis technique can provide theoretical results that are more accurate than conventional techniques, because the influence of on-resistances is considered in the proposed technique, where circuit characteristics are analyzed by assuming an equivalent circuit of the converter block. The validity of circuit design and theoretical results is confirmed by SPICE simulations. The simulation results show that the proposed system can offer the specified circuit structure and its characteristics.*

Keywords: Switched capacitor circuits, Programmable circuits, Power converters, Versatile converters, Ring-type converters, Coil-less circuits

1. **Introduction.** Recently, power converters designed by using switched-capacitor (SC) techniques have been receiving much attention. The SC power converter converts an input voltage by changing the connection of capacitors at high-speed. Since magnetic elements are not required to design SC power converters, thin circuit composition, light-weight and low-noise can be realized. Furthermore, there is a possibility that it can be implemented into an IC form. For this reason, SC power converters and its analysis techniques have been studied [1]-[17]. For example, CMOS charge-pump circuits, which offer a stepped-up DC voltage for mobile applications, have been proposed by Sun et al., Wu et al., and so on [6]-[9]. In these converters, the stepped-up integer voltage is provided from a DC input. On the other hand, SC power converters which perform AC-DC or DC-AC conversion have also been proposed. For example, SC AC-DC converters for a smart RF-ID tag have